Violin

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Introduction

In what follows, I will be documenting the course of the construction of a violin at the bench here in my workshop on Cape Breton Island in Nova Scotia. Naturally, it will reflect my own personal approach to this craft -- I make no claims to historical accuracy, scientific or technological insight, deep artistry or virtuosic craftsmanship. I have no Stradivarian secrets to reveal and no guarantees as to the success of the outcome. After building instruments for a living for over 25 years, I still find that I learn with every one, and I am still humbled by the mystery of the art and secret voices of these creations. But I like to think that I have learned something over the years, and that my guesses have now at least become more informed and educated than when I began -- experience must count for something.....

So with this disclaimer in mind, I invite you into my workshop for a glimpse of one person’s interpretation of the art of violin making and I hope that in sharing it with you, you will find something in it that you may find useful, informative, or interesting.

The Design

The design for this violin will not be based on any particular historical instrument, but the dimensions and proportions will be well within the range of those found in the various models of Stradivari, Guarneri, and the other great classical makers of the “Golden Age” of violin making that flourished in Cremona, Italy in the 17th and early 18th centuries. It was there that the violin evolved into its modern form, and with the notable exception of the setup of the neck, (and a corresponding alteration to the bridge and bass bar), it has remained much the same to the present day. There has been much interest and speculation concerning the significance of the geometric proportions to the early development of the violin’s design, and it is probable that at least some makers of the time were concerned with designing within a unifying scheme of geometric relationships. For a brief discussion of this tradition, see the essay on my website:

http://www.fiddletree.com/on_the_pythagorean_traditi.htm
Before the development of the modern science of acoustics a century or so later, it may have been that some early makers believed that a harmony of simple proportions in the outer form of the violin might be conducive to the harmony of its inner voice. But though this simple relationship may not be born out by our present knowledge of acoustical physics, it may be meaningful in other ways. The violin is more than just a voice -- it is a whole work of art, and its visual and tactile qualities as well as the history and ideas embodied in it are not without significance.

Based on the simple elements of the line and circle, the violin’s proportions are generated within a system of simple relationships to provide a visually unified and harmonious form. Below is a design I worked out several years ago, and is the one that I will use for this violin.

The Wood

If the layout of the design represents the rational, conceptual, and intentional aspect of violin making, then the material -- the wood itself -- presents us with the irrational, unknown, and “given” side of it. Every tree is unique, and even within a given species, there can be large variations in appearance, density and stiffness, and tonal qualities -- and these are the reflection of its life in the forest, its ancestry, climatic cycles, and the soil from which it grew. A large part of the art of violin making is the exploration of the materials used -- and with experience one hopes to gain some insight into the ever mysterious qualities of the wood in relation to ones designs, methods of working, and tonal objectives.
Certainly the choice of wood is an important decision in the planning of the instrument. It’s not always as simple as deciding between “good” and “bad” wood, but a subtler choice of what kind of sound the maker is looking for. Although some compensation can be made for different kinds of wood to try to attain a certain quality of voice, a better approach is to choose an appropriate wood, get to know it, and try to maximize its natural characteristics. For example, a piece of hard sugar maple may tend toward a clear, bright sound, but tending toward brittle when exaggerated..... a soft red maple may tend toward a more woody and darker sound, but if one is not careful, may tend toward mushy when taken to the extreme.

For this violin, I have chosen a piece of red maple from a log that I got from a local sawmill about 12 years ago. It is beautifully figured, fairly light and soft, and has proven itself in a number of instruments over the years. Here is a picture of the wood when I first brought it home and cut it up in the yard in front of my workshop.

The spruce soundboard is probably the most important piece of wood for the tonal qualities of the finished instrument. I am looking for something strong and bright, with a bit of a crisp snap to the tone. And so for the belly I will choose a nice piece of Kermodie Spruce -- a hybrid of engleman and sitka spruce from British Columbia -- light and stiff wood that is perfect for for a strong yet responsive tone. It has straight even grain and was cut from a billet that was wide enough for a number of one piece violin tops.
**Preparation**

Here I’ve gathered together the mold, templates and materials in preparation to start the work. I have selected a nicely figured one piece back as well as a one piece top. The mold and outline template are adapted from the drawing previously illustrated.

**Mold and blocks**

To begin, light weight spruce blocks for the corners and ends are roughed out and temporarily glued to the mold. Except for the areas where the blocks will be glued, the mold is rubbed with wax to keep excess glue from sticking to it.
The Ribs

The ribs are rough sawn on the bandsaw from the same material as the back, then scraped to a final thickness of 1mm. This scraper is re-ground from a hardware store utility knife blade.

Then, the curves of the inner C bouts are carved into the corner blocks and the C ribs are bent to shape on a hot bending iron. I try to bend the thin ribs dry, but will sometimes use a little moisture to help with the tight curves of the Cs. For now, the outsides of the corner blocks are left full for support while the C’s are glued into place.
The ends of the rib are cut square and clamped in place with a simple caul that simultaneously presses the rib ends onto the blocks and holds the rib tight against the mold. Throughout the construction of the violin, only good quality hot hide glue is used.

**Linings**

At this point, I will glue the lining to the ribs in order to protect the fragile wood. I use willow here-- it bends easily, and carves effortlessly into shape.... but any light wood will work. The lining is 2mm thick and 7 mm in height. The mold has been thicknessed to 18mm, so when the linings are seated down to the surface of the mold, I will have rough rib height of 32mm. The ends of the linings for the Cs are tucked in behind the blocks by making triangular knife cuts into the edges of the blocks, and correspondingly fitted lining ends.
The lining is glued in place. These little c-clamps are great, but clothes pins will work, too. When clamping, I will sandwich the rib between the lining and a small bent scrap of thin wood on the outside. This not only protects the rib from footprints from the clamp, but helps to even out any irregularities in the curve of the rib from bending the highly figured curly grained wood.

Now I’ll continue bending the other ribs. The rest of the blocks are shaped and the points of the corners are feathered to a knife edge where the upper and lower ribs will be joined. Here, I have selected a one piece lower rib, to complement the one piece back and top.
The rest of the ribs are glued and clamped in place with some shaped cauls to keep the rib ends tight against the blocks.

The remaining linings are then glued in place, the ends of the corners are trimmed, the surfaces are leveled, and the rib assembly is complete.
Preparing the back plate

With the rib assembly completed, it’s time to turn our attention to the back. First, one surface is planed flat and to a rough thickness of about 18mm (this will be lowered to around 16 in the course of carving the arch).

Then, the outline is traced from the rib assembly using a small washer to provide an even overhang of about 3mm. The back is then cut out with the bandsaw and cleaned up a bit. The finalizing of the outline and overhang will wait until just before the purfling channel is cut.

Arching the back

So far, the construction of the rib assembly has been a fairly routine operation. With the carving of the arched plate, we are approaching the heart of the violinmaker’s art. There are many approaches to this -- various schools of thought and different theories, and my own practice continues to change through the years. Without a doubt, the shape of the arch plays a significant role in shaping the tone of the instrument. The earliest violins tended to have a fairly high arching profile -- the classic Cremonese violins of Stradivari and Guarneri featured a lower and more streamlined profile. I don’t necessarily think of these changes as progressive improvements, but more as a reflection of changing musical taste and tonal objectives. To illustrate that shape makes a significant contribution to vibrational behavior, think of a musical saw -- it retains all the same properties of size, material, density -- but by changing the shape of its curve, a huge variety of tones can be brought out. A simple and full circular arch rising from the purfling to the centre line is quite stiff and offers a lot of resistance to deformation -- an arch rising in a low S-shaped curve has a lot of built-in spring and flexibility. For a violinmaker, it is not a matter of maximizing one or another quality, but of seeking a balance that is in accord with the kind of sound one is seeking. We need a certain amount of strength and resistance to give the tone a solid core that you can “dig into” with the bow, but at the same time we need a certain amount of compliance, sensitivity, and a light, quick response. Much of the challenge of violinmaking is to try to reconcile such opposing qualities, not by supressing one or the other, but by bringing a harmony between them.
I’ll start carving by establishing a flat ledge around the perimeter of the plate. This will make the purfling easier, and when the carving is finalized, it will be gently hollowed out to blend in with the main arch of the plate. I leave this at a width of 15mm in the upper and lower bouts where the arch will be rather low and scooped, but narrowing to about half that through the waist where the curve of the arch will be higher and fuller.

The ledge is finished to 4mm thick in the upper and lower bouts, slightly more in the waist, and swelling gently out to the tips of the corners. Then I proceed to to forming the long arch from the neck to tail. The shape of this arch has sometimes been described mathematically as a catenary -- the shape taken by a chain freely suspended from two level points. There is a fair bit of variation to be found in the archings of various classical violins, and there is no need to idealise the description of these forms unnecessarily -- though for the mathematically inclined, it can be an interesting study. When I look at the arching, I am more interested in trying to come to a more intuitive understanding (of course based on years of experience where I was more interested in copying outer models). I try to imagine myself into the material -- get a sense of the static loads required, the pressure of the soundpost, the twisting of the body with the pull of the strings. I am aiming for a simple, efficient, and restful strength where all parts share the load equally, but yet will be sensitive to the subtlest of vibrations. The sense of judgment in these things develops with experience -- or least the confidence that allows the freedom to work in this manner.

Arching guides or templates made from existing instruments (or mathematically generated) can be of help, but I find that the best tool for this long back arch is a flexible 12 ruler that can be used as a spline -- when bent to the surface it will easily show up any irregularities and provide a smooth, fair, and efficient curve. Still, the ends of the arch should be judiciously recurved to allow for greater freedom and flexibility.
After the long arch has been finished to my satisfaction, I turn now to the transverse arching, which so far has been left rough and full. The traditional arching guides (or “quinte”) are a set of 5 templates that are placed across the plate -- at the widest parts of the upper and lower bouts, the narrowest part of the waist and in the hollows of the transition from the bouts into the corners. Any number of these are available from books, drawings, plans, or existing instruments. Again for the mathematically minded, there is an interesting construction for these curves that has been getting attention in recent years: the “curtate cycloid”, which is a mathematical curve that is drawn by tracing a point within a circle as that circle rolls along a straight line. If the circumference of the circle is the length of the desired arch, and the distance of the point from the centre is half the height of the desired arch, then the curves traced are a remarkably close fit to those seen in many classic violins (that is, as long as the proper adjustments are made to the end recurves, and a bit of allowance is made for normal discrepancies and distortions).

These are all valuable ways of looking at the shape of violin’s arching -- but again, it is probably best not to rely too much on idealized conceptions; violins are remarkably varied and each is unique. There is no single truth or outward formula that will guarantee a “perfect” violin. Ultimately, I think that the slow crystallization of one’s knowledge and experience into a personal vision and sense of judgment is what can elevate the craft of violinmaking to an art. There was only one Stradivari, but there should also be a place in this world for each of us.

Keeping all this in mind, the arching planes are used to finish arching -- always checking for symmetry, smooth and efficient curves, and the proportioning of concavity and convexity in a manner that I hope will bring out a good balance of strength and responsiveness.
These little guys visited my workshop again last night. I think that it’s their babies that are responsible for eating the holes through the outer layers of the nice spruce logs I had stashed in the barn -- now I know to make sure that all the bark is removed! They are cute, though.....

The back is scraped to a clean surface of smooth, efficient curves. I keep in mind that the final scooping of the perimeter that will complete the arching will wait until near the end -- for now, the outer edges stay flat at around 4mm. I like to do the final scraping of the arches at night, working with a single strong light, using the shadows to throw into relief any irregularities in the curves of the surface. Strong direct sunlight will work for this, too.
Graduating the Back

The thicknessing of the plates is another major consideration for the tone of the instrument, and should be done within the context of the quality of the wood, the character of the arching, and the overall tonal objectives. Too thick, and the plates will not be able to respond quickly and efficiently -- the tone will be hard, bright, and confined. But too thin and the violin will become hollow, boomy, uneven and wolfy (as well as endanger the longevity of the instrument). The construction in general should be strong but light, again balancing the need for both flexibility and stiffness -- a strong solid tone that is free, light and responsive. Violin makers tend to obsess over the graduations of the plates -- probably because it is easier to quantify than the description of the complexities of the arching. Standard plans of the classic instruments give measurements, but dimensional measurement is just one way of looking at it. The same measurements will have different weights or densities in different pieces of wood. Tap tones are another tool that many makers rely on to adjust the thicknesses, since the frequency of the tones is a function of the density and stiffness. But there is no simple rule for any of this -- they are all valuable ways of getting to know your materials and designs, but it is the judgement of the violinmaker that balances one factor against another and tries to bring a proper harmony into the complexities that make up the violin. Real violins can be quite varied in all of this, and the numbers tend to be just averages.

The first step is to rough out the wood on the inside of the plate. Using a drill press with a depth stop, the plate is peppered with holes -- in the central area between the inner bouts, I start with about 6mm and 4mm in the upper and lower “lungs”. Then, I quickly chop out the excess with a gouge until I come close to the bottoms of the holes. The early classical makers would not have had a drill press, but a graduation marker consisting of a frame with a lever equipped with a marking awl that could be adjusted for different thicknesses.

The gouge is followed by the arching planes. After the initial planning I will recheck the thicknesses with the caliper and drill a new set of guide holes, this time coming a little bit closer to my expected finished thickness. A good average measurement for this would be around 4.5mm in the centre, and about 2.5 in the upper and lower areas, a bit thicker around the edges (I’ll plan to leave some extra thickness around the edges for a final outside graduation after the instrument is assembled.
I go back and forth a number of times between the marking holes and the planes, slowly approaching the final graduations. As I thin the plates I will pay more attention to not only the measurements, but also the weight and the tap tone (by holding the upper bout a little ways in from the edge and tapping in the centre, the strongly resonant “mode 5” tone can be isolated). The general idea is to lower the weight (a good final weight for the finished back might be around 110 grams) but keep the tone up (around an F is usually good) while keeping close to the usual thicknesses. Normally, none of these factors will be too far off, but every piece of wood is a little different and it’s good to be aware of all these aspects -- balancing one against another, and aiming for strength, yet flexibility and response. None of the measurements are to be taken as the final word on any of this -- many famous violins are found to vary quite a bit from the “standard” measurements -- but these are the tools and materials that the violin maker has to work with in making the decisions along the way that will determine the character and voice of the finished instrument.

I’ll finish with the scrapers to smooth out the plane marks, using my fingers to look for any irregularities in the graduations, keeping the curves and graduations smooth and continuous. Because I like to finalize the graduations of the plates afterwards, from the outside, I will plan ahead and leave things just a bit heavier than I expect them to finish. Rather than finish each part as I go, I prefer to work the instrument as a whole as much as possible, and do the finalizing only after I have brought all the parts together.

Removing the Mold

Now it’s time to take the ribs off the mold. A sharp crack with the chisel and the corner blocks are split free. The end blocks are separated from the mold and the whole rib assembly can be stretched to allow the linings to clear the mold for removal.
The insides of the rib assembly is cleaned up: excess glue is scraped off, the insides of the blocks are shaped, and the linings are trimmed to a triangular profile. The aim is to lighten it up, removing whatever material is unnecessary to the structure. The finished rib assembly should weigh no more than 50 grams.

The ribs are then aligned and clamped to the back. Glue is worked in one section at a time, excess is cleaned up, and then the entire assembly is set aside to dry.
**Purfling**

Before starting the purfling on the back, the outline is finalized -- I even out the overhanging edge, gently rounding the underside, and making sure all the curves flow smoothly, and with no irregularities. I pay special attention to the shaping of the corners -- much of the sculptural character of the carving is in the corners and edges, and this will determine how the purfling finishes out to it’s characteristic “beestin”. I don’t rely too much here on measurements or templates. I hold it at arm’s length, and use my eye to tell me if all the corners look like they belong together -- are they the same size? do they point outward at the same angle? do the curves flow outward to the tip in expectation of opening out?

Once the outline is finished, I mark the purfling lines with a two bladed purfling marker, being careful to keep it steady, upright, and snug against the edge of the plate. The lines are marked, then excavated with a sharp knife and chisel (made from a dental pick). Many makers will adapt a small router to cut the purfling channel -- it’s not as pleasant or peaceful but can be made to work well. I’d rather put on some nice music and forget about time.

The channel for the decorative “knot” is carefully drawn out and incised freehand with the knife and chisel.
The purfling strips themselves are sandwiched together from maple veneer and ebony shavings. First I take some shavings from a straight grained piece of ebony, using a very sharp plane.

The curls are straightened by passing them quickly over the bending iron. The thicker white strips are sliced from a sheet of maple veneer.

They are then glued up in black-white-black strips that I slice in half and clean up with the plane. (Here I use a regular modern cabinet makers glue.... I find that it allows the finished strips to bend easier on the hot iron while still holding together.)
The purfling strips are bent to shape on the iron. I start with the upper and lower bouts, tapering the tips into a fine “bee-sting” point, then I cut the waist strips to a nice mitered fit.

The Belly

The purfling is scraped flush with the surface and it is time to turn our attention to the top. Since I will be using this nice one piece top, there is no need for the usual centre join. I will prepare it as I did the back, planing the surface flat, tracing the outline, and sawing it out on the bandsaw.
The top -- or belly -- is perhaps the single most significant factor in determining the sound of the instrument (though we should be careful not to overemphasize any single element, and keep the whole in mind). Good light weight but stiff spruce, perfectly quartered for maximum strength and efficiency is best for holding up under the long term static load from the strings bearing down through the bridge, while at the same time allowing an easy, light, and sensitive response to the vibrations.

The carving for the belly starts out much as for the back -- a quick roughing out with the gouges and plane, and the establishment of a flat ledge around the outside of the plate. Then the long arch, guided by a template at first, but then finalized by the eye, hand and judgment.

The shape of the top will differ from the back owing to its different function. Obviously, it is is a more complex structure. It is the top that first and most immediately responds to the energy from the vibrating string as passed through the bridge. The important central area of the belly -- under the bridge -- is freed from the constraint of the sides of the body by the f-holes, and the upper eyes of the f’s cut off and isolate all but a narrow “beam”, the width of the bridge, through which runs the continuous grain of the top from the tail block to the neck. Whereas the back is being stretched as the result of the pull of the strings (thus pushing upward on the sound post) the top is under compression -- squeezed from end to end while pushing down under the feet of the bridge. The post provides support under the treble foot of the bridge while transmitting the load and the vibrational energy directly to the back, while the bar under the bass foot of the bridge gives support to the top and helps transmit the vibration through the belly.
The long arch of the top will be seen to take a certain flatness through the central area, while falling a little more steeply at the ends. The steeper slope at the ends gives a bit more flexibility here (you have only to see the effect of this on some very steeply sloped Stainer copies that tend to be weak and and become distorted here). For the cross archings, I will pay special attention to the narrow part of the waist -- keeping a full strong arch there to help support the area at the ends of the f-holes, where the cross arching resumes its duty of supporting the long continuous central arch. As I start working the cross arching, I will also be guided by the way the f-holes lie. I will draw them in place to check their orientation as I shape the arching, and this will determine much of the way the curves will flow from the bouts through the waist. Looking at it from the side, I want to see that the main shaft of the f-hole lies parallel to the line of the ribs and that it lies about halfway up the slope. The upper eye of the f-hole will approach the top of the arch, while the lower eye will be dipping down just below the lower corner. Additionally, I will check for convexity with a straight-edge.... I want to keep a nice continuous dome throughout the central area of the top. As I run a ruler across the top, parallel to the f-hole, I don’t want to see any concavity until it approaches the shaft of the hole. This necessarily means that the narrow of the waist will have a broad full arch, while the upper and lower bouts are becoming low and scooped.

As I approach the final shape, I again use the shadows to look for irregularities and to check for elegance and symmetry of the curves
I finish the top arching to my satisfaction; but as in carving the back, I will leave the edges flat and thick for now -- the final shaping will wait until the whole instrument comes together.

Now I turn the belly over and start to carve out the inside. The procedure is similar to that of the back -- but again, the top has a different function, and the graduations will be different than for the back. First, a quick roughing out with the gouges and planes......

The top is finished off to a more uniform thickness than the back. While the back stays fairly massive through the centre to provide substance and support under the post, the top is thinner, more like a vibrating diaphragm, and designed for maximum sensitivity. It will be finished off to around 2.5 mm -- but as the finished dimensions are approached I will again check for weight, tap tone, stiffness and feel. Light weight, around 75 grams for now (I expect it to lose about another 10 g after the final scooping, edgework, neck and saddle slots, and finish scraping) and a tone around f# are expected. But all these numbers are negotiable -- depending on the character of the wood, the height and shape of the arching, the model, even the weather (and who knows -- maybe the phase of the moon?). It is the judgment of the individual violin maker -- the educated guesswork -- and the particular understanding of the kind of tone that he or she is looking for, that is what it really comes down to, and that inevitably makes every violin a personal expression and a unique individual.
The f-holes and Bass Bar

The f-holes are now laid out for the last time and cut out. As they are delineating the important central vibrating area of the top, I will pay close attention to how they are formed -- the spacing between the eyes, the distance between the shafts at the bridge line the length of the holes and placement of the holes can all play a role in influencing the instruments response. A tighter area between the holes can make for a quicker response, whereas a broader span can bring more area into vibration directly from the bridge.

The eyes are first cut through with a drill or a small gouge, then shaped with round files to their proper size and shape. Then a line is cut with a fine jewelers saw blade through the centre of the outline. A sharp knife then finishes by paring away the material to the line.

I then round off the inside edges of the holes and prepare the bass bar from a piece of good straight grained and quarter sawn spruce. This one is cut from the leftover of the billet for the top.

The bar passes directly under the bass foot of the bridge, and at a slight angle to the grain of the top. Sacconi gives this angle as following a line that connects two points measured at one seventh of the distance from the centre line to the widest parts of the upper and lower bouts. Another way to look at this is that the angle of the bass bar mimics the line of the G string.
The bar is carefully fit -- cut and try back and forth until it finally makes full continuous contact with the curving inner surface of the belly. Some makers like to “spring” the bar slightly so that there is a bit of upward tension under the foot of the bridge. This is done by fitting the bar so that either end is raised a couple of millimetres from the surface, but when pressed into place for gluing, there are no gaps or wobbles in the fit.

The bar is then cut to size. It will be about 13 mm in height under the bridge and shaped to efficiently distribute the load through the length of the top. If you measure its height at different points along the length of the bar, you will see that its height actually increases in a straight line from the ends to the bridge line -- it’s shape is just altered to follow the contours of the top. I will check to see that the tap tone of the top, which lowered considerably with the cutting of the f’s, is now back where it was.
To finish off the top, I will then glue in a small veneer of wood to protect the soft spruce from the pressure of the soundpost. It is traditional to leave a slightly thicker spot here -- I prefer to finish the central area of the belly to a uniform thinness, and add this slip of hard maple instead.

The entire inside is cleaned up for one last time, then I glue in my label and the body is closed. I will use a very thin glue here -- I want to make it easier for a future repair person to open it up. Any fiddle that hangs around for long enough will eventually need the top to come off for one reason or another.
As with the back, the edge overhang is evened out, the corners are tweaked into shape, and all the curves are gone over to smooth and complete the outline to ready it for purfling. The soft spruce is much easier to cut, but the grain likes to pull the knife, especially in the areas where it changes direction at the widest limits of the bouts. A sharp knife and gentle pressure is needed. And one must be careful not to chip the delicate corners inside the purfling line.

The Neck

With the purfling completed, it’s time to turn our attention to the neck. I will be using more of the same wood as in the back and ribs. Because this piece has an odd shape (it’s a tapered wedge that wasn’t big enough for a back), I will prepare the block by temporarily gluing some scraps to the sides that will allow me to square up the block so when I cut it on the bandsaw, the edges will all be perpendicular to the fingerboard surface.
While the neck blank is still square, I mark out the centre line and drill the pilot holes for the pegs.

The turns of the scroll are marked out, then a few initial saw cuts helps the removal of the waste.

The gouges and scrapers finish the work of carving the scroll. The lines of the traditional scroll make for a classic blend of simplicity and complexity. The eye is guided around the graceful turns, taking in the symmetry, proportion and delicacy, while the mind is directed to contemplation of the infinite contained within form.
The neck is then joined to the body of the fiddle. Unlike in Stradivari’s day when the neck was glued and nailed flat on to the ribs, the modern neck is set into a tapered mortise. Special care must be taken to fit this well, to provide strong support and to prevent settling of the neck under the tension of the strings. It must simultaneously fit the face of the mortise and the button of the back (which provides much of the strength and stability of the neck) while keeping its alignment down the centre of the body (between the f-holes) and allowing for a fingerboard projection of around 27mm at the bridge. I set it up with a “dummy” fingerboard to make the measurements and alignment easier. I’ll want a neck overstand of 6mm above the edge of the top, and a resulting string angle over the bridge of 158 degrees. It is the sharpness of this angle that determines the downward force through the bridge and to the belly.

With an arching and model of fairly standard dimensions, all these parameters should fall into place together -- with the additional correspondence that a line sighted down the edge of the back will point to the eye of the scroll and a line sighted down the edge of the top will point to the end of the fingerboard at the nut.

With the neck and heel still fairly rough, it is glued into the mortise with fresh hot glue, taking care to keep everything aligned properly. Final shaping will take place once the strings are on.
The Fingerboard

The fingerboard blank is roughed out from a piece of straight grained ebony.

The blank is cut out slightly oversize, then the top surface is shaped to a conical radius of about 42mm with the help of a straightedge and curved template.

The underside is then planed to leave an even edge of 5mm for the length of the board. The overhanging end is hollowed out to remove weight, yet leave stiffness and support for the end of the board. It is interesting to note that the end of the neck is the midpoint of the board, and after hollowing, can also become the balance point.
The fingerboard is glued in place after giving a final check of the projection height. The nut is put in place, and then the entire neck and fingerboard unit is trimmed and shaped to comfortable dimensions, so that the profile rolls nicely in the fingers and the thumbstop at the heel feels comfortable and familiar. The nut end of the fingerboard should be aligned square with the chin of the scroll and the stop length (from the bridge line to the upper end of the body) should be in a relationship of 3/2 with the remaining distance from the edge of the body to the nut.

After fitting a saddle and an old set of pegs, all that’s needed before a trial run is a bridge and soundpost. The rough bridge blank must first be worked over all its edges and surfaces. The feet are trimmed and fit to the arch of the instrument, then the curve of the top. The bridge is slightly thinned and the front surface (facing the fingerboard) is gently domed up toward the narrow top edge. The kidneys and heart opened up a bit, the lower arch is increased, and the sides are trimmed and chamfered. Makers develop a personal signature in the way they carve a bridge, but the main idea (aside from providing a proper playing action) is to lighten up the bridge, removing excess mass that might tend to mute it’s response. Nearly all the energy of the vibrating string must first pass through the bridge, so it is worth a bit of attention. It must be substantial enough not to warp under the pressure of the strings, and it acts as a filter to the incoming vibration. Too light and thin, and you might find the tone getting a bit raw and brittle, but too heavy a bridge can make it sound stiff and repressed.

The post is made of spruce cut from the waste from the belly. It is carefully fit and wedged in place just behind the treble foot of the bridge. It not only provides support for the bridge against the downward pressure of the strings, but it also serves to communicate the vibration from the bridge directly through to the back plate. In this role it also functions as a pivot for the bridge’s vibration, setting up a kind of pumping action to the other foot, situated over the bass bar. The exact location of the post -- up close to the bridge or a little further back, a bit toward the treble or bass side, a little tighter or looser fit -- can have a significant effect in the response of the instrument by altering the balance of these factors. These are adjustments that will later be made after the strings are on the instrument and it has had a chance to settle.
And now the fiddle is ready for a trial run. I put some strings on it, and pass the bow over them. It has a surprising big, full sound and a G string that is solid and strong. It’s a bit edgy, as it hasn’t any time to settle yet, and just a bit tight which is to be expected with the edges of the plates still as thick as they are. But from a first impression, I think it has great potential. It’s bright and full -- lots of snap, but rich and deep as well.

I play a few jigs and reels, a Bach minuet, a waltz or two. Everything is settling and stretching -- it won’t hold its tune for long. I’ll wait until it settles down before proceeding with the fine tuning and finishing up, but I can play it and start to get to know it.

Finalizing

After a few days of settling, the violin has come into its first equilibrium. It will now stay in tune and some of the original wolfiness has gone out of the tone. The fiddle is getting used to itself. Now is the time to continue on to the final graduations and to sculpt the finishing touches before varnishing. Until now the original edges have been left flat and thick. The purfling was trimmed back flush to the surface but with none of the graceful scooping that will now finish the arching.

The tone of the instrument is largely set in the materials, the model, and the arching -- these final graduations will not significantly change the basic quality of its voice, but as the plates become thinner and more flexible, the tone noticeably becomes freer and more responsive. I don’t want to lose the sense of solidity, especially under the G string, which often seems to happen if the plates are too compliant.

As I carve away at the edges, alternating between the gouge and the bow, I feel as though I were liberating the voice that is there, but yet trying to keep it within the discipline of the overall character of the instrument. The plates do not vibrate in isolation, but only as subordinate partners to the complexity of the whole.
I do this final carving not only with ears open to the changes in tone, but also with the eye of a sculptor, finalizing and blending the curves of the arching, the shape of the corners, and the flow of edgework. Now I will return to the scroll to give a final smoothing to the surfaces and to cut the chamfered edges to the turns of the scroll. I’ll give the maple a bit of fine sanding, but I must be careful not to mush the crisp lines of the scroll and edging. The top will get only the scraper, because I want to try to leave a bit of the texture of the grain in the finished surface. Here are some photos of the white fiddle, as it stands ready for varnishing.....
Varnishing

The violin is now complete in the white, and ready to start the finishing process. There are probably as many ways to go about varnishing a violin as there are violin makers, and the varnish is certainly a signature of the individual maker. I seldom do two varnish jobs alike -- I am constantly experimenting with new methods and materials, and that must be kept in mind through the description that follows. For a slightly different procedure you can read read the account on my website “.... On Varnishing a Violin” ( www.fiddletree.com/on_varnish.htm )

To start, it is important to pay attention to the surface preparation in the light of what one desires for the finished look. In this case I am going to treat the spruce of the belly somewhat differently from the maple of the rest of the instrument. It is a very different kind of material both visually and how it takes the varnish, so it’s good to keep that in mind as one proceeds. The maple has a lot of visual interest in the flame or figure of the grain which can be accentuated to advantage by exploiting the different angles of end and side grain that result from the orientation of the grain in curling waves. On the other hand, the main visual interest of the top is in the lines of the grain itself, which will be the feature I want to emphasize there. I will go for a smoother and more polished look on the maple, while trying to bring out the illusion of depth with the shifting figured grain, but I want to leave the top with a bit more surface texture to give little more character to the grain lines of the belly.

The first step will be to lightly scrape and sand the maple to remove any last irregularities that might interfere with the final rubbing and polishing. The top will get only the scraper, as the scraper will leave a more interesting texture where the reed lines are cut a bit lower than the rest of the surface (it does this by slightly compressing the softer surrounding wood as it cuts through the stiffer reeds). Then, I wipe the instrument down with a damp cloth, to raise the grain before going over it again to smooth off the surface -- this will also bring out any irregularities I might have missed. I do this twice to be sure that I won’t have the problem of raising the grain during the next procedure. At this time I also go over the spruce with some very fine sandpaper to just barely level the surface while still leaving the reed lines undercut.

The next step is a light pre-staining of the wood. Most of the color in the finish will up in the varnish layer, but I like to put just a little golden yellow stain in the wood itself -- it means I can use less color in the upper layers, and it will also serve to emphasize the figure of the maple. I give it first a light wash with strong coffee to give it a light tan color. I want to be careful not to let the spruce soak up the stain unevenly as a result of way the grain orientation shifts in relation to the changing slopes of the arching, so I first wet the spruce and let it partially dry before applying the stain. This way, end grain will be already saturated and won’t tend to absorb the stain disproportionately. After the coffee, I give it an additional wash of a yellow dye made from soaking madder root in alcohol. This especially seems to have a nice effect on the maple by putting a warm and lively glow deep down in the flames.
Now it is important to seal the wood so that the richly colored varnish won’t further stain the wood. I make a mix of thickened linseed oil (raw oil that was slowly cooked in a pot over a propane torch until it had a thick honey like consistency) fine powdered mica, and a bit of turpentine to thin it. I rub this well into the wood with a brush, a piece of silk cloth, and with my fingers. The powdered mica (you can also use pumice or a variety if other fine mineral particles) packs into the pores and surface of the wood helping to seal it -- at the same time it gives a harder and more protective finish to the surface as well as providing a good ground for the subsequent layers of varnish. A coat of rosin oil finishes the sealing, but I give one more coat of rosin oil to the spruce as it is very absorbent of the first coat -- I want to see that the whole surface starts to take on a bit of a sheen indicating that it has stopped absorbing the sealer.

At this point, I like to hang it out in the sun to dry -- as with the varnish, the UV rays of the sun help to promote the polymerization of the oil -- the linking together of the molecules into a tough and durable film. Upstairs I have a cabinet equipped with UV lights, and this is great for times when the weather is bad (or the flies), but nothing beats good strong sunlight when it’s available.

When the ground coat is dry, I give it all a good buffing, rubbing it all over to make sure there is a smooth surface for the color coats to follow.
A traditional oil varnish is made from a natural resin combined with a drying oil, such as linseed or walnut oil. Trees produce resin in response to an injury in order to seal and protect the wood from infection -- hence it is an ideal substance for us to use to seal and protect the wood of our violins. The addition of a drying oil gives it more toughness and durability -- to help keep it from becoming too hard, brittle and chippy. The dark varnish for the color coats on this fiddle is made from Colombian amber and linseed (flax) oil. This South American amber is a relatively young amber, dating back to extinct forests from between one and two million years ago.

To render this fossil resin soluble for making varnish, it must first be melted, or “fused” at high heat to break the molecular bonds that keep it locked up in an inert and insoluble state. I cook it outside (it gives off plenty of noxious smoke) in a stainless steel pot over a propane torch.... and I am always prepared for fire. The high heat will darken the resin considerably, but that is part of what I am looking for. I cook it until it is thoroughly melted, and then to darken it more, I continue to reduce it until it looks like an oily tar in the bowl -- but spread out thin on the side of the pot, it will be evident that it is really a beautiful rich red-brown.

I let the resin cool down, then reheat it with the addition of an equal part of linseed oil, cooking it gently until they are dissolved together. After it cools a bit again, I will add turpentine to thin it and give it a good brushing consistency, and to make it easier to filter. I filter it while it is still hot and thin -- it will thicken up quite a bit as it cools. But I don’t want to make it too thin -- I can always add a bit more turpentine when I’m ready to apply it to the fiddle.
Once the instrument is thoroughly sealed against further staining by the colored varnish, it becomes the canvas upon which I can paint to achieve the characteristic appearance that I am looking for. The dark amber varnish alone can give a very nice rich finish, but in order to have a little more choice and control of the color, and to achieve it in a thinner varnish film, artists’ pigments may be added in very small quantities to alter its character. I give it just a touch of additional red...... and to richen and darken it -- to give it a bit of mystery and depth -- a hint of blue. One or two extremely thin pigmented coats are applied, checking and altering the color, and perhaps adding a drop of oil or turpentine to the varnish to help with the brushing.

It is important at this stage not to try to achieve the final result all at once, but to keep in mind how the subsequent coats will change, darken, and enrich the color. It is important not to let it get too dark so that the clarity of the beautifully figured wood is obscured -- the pigments should be used only to nudge the color very slightly. It is also important to look at the work in all different kinds of light -- direct and indirect sunlight, as well as under incandescent and flourescent bulbs -- as the color will vary dramatically under different lighting conditions. These initial pigmented coats are then followed by a couple of coats of just the dark varnish until I get a nice rich but mellow coloring to the instrument.

Throughout this stage of the finishing, I like to shade the color on with highlights and shadows -- not to “antique” the instrument, but to give a little more visual interest. The richly colored varnish is beautiful, but I also want to let the beauty of the wood grain show through unhindered.
The belly has been sealed against absorbing the colored varnish, but the grain texture left on the surface allows the varnish to collect along the reed lines, emphasizing this character of the wood. I make an effort to apply only a very thin but strongly colored coat of varnish to the top to maintain the surface texture but also so as not to dampen its acoustical response. After brushing the varnish on quickly, I rub it into the grain using my fingers and the side of my hand.

After the pigmented coats, I apply several coats of the unpigmented dark amber varnish to the areas where I want the finish to appear rich and dark. The highlighted areas at this point are still bare but for the sealer coat. I give it plenty of time to dry -- many problems with varnishing can be avoided by leaving adequate drying time between coats. Patience is a must. After I have achieved the depth of color I want, I give it just a very light rubbing with fine sandpaper just to knock off any little dust nibs that have accumulated, and then I am ready for the finishing top coats. The final coats will be a light and clear varnish that will serve to protect the color coats I have built up, and will give a little more body to the thin finish so that I can give it a final smoothing and rubdown without breaking through the underlying colored layer.

Here I will use a varnish made from New Zealand Kauri resin cooked in linseed oil. This is a bit softer than the amber resin, and does not require the same high temperature to melt it. It will dissolve into the hot linseed oil without the preliminary fusing that was necessary to melt the amber, and so it will make a much lighter colored varnish for my top coat. I will use a higher proportion of oil in this varnish, observing the painter’s rule of “fat over lean”.

*Image of a violin*
While the varnish is drying, it’s time to think about making the fittings for this violin. For the trial run, it was just set up with an old set of pegs and tailpiece, but a nice instrument should be finished off with with a personal set of fittings to suit it. In this case, I will make a matched set (pegs, chinrest, tailpiece) of Brazilian rosewood.

The peg blanks are selected from some good straight grained rosewood. Temporary faces are glued onto the blanks to make for easier turning with less chatter on the lathe. The pegs are first turned, then the temporary fillers are removed and the faces shaped for a comfortable feel and grip for the thumb.
The tailpiece is made from the same Brazilian rosewood, but I’ll use a piece with a bit more figure in it for visual interest.

I will personalize it a bit with a small carving of a couple of maple leaves.

The finished tailpiece.
The chinrest is carved from the same wood as the tailpiece.

After a light buffing with wax, the fittings are finished and ready for the violin. The pips on the ends of the pegs and the fret at the leading edge of the tailpiece are made from a piece of osage orange that I found in my scrap pile.

Several coats of clear varnish have been applied to the violin, and ample time is allowed for drying. It is now rubbed down with fine pumice and olive oil to smooth over any brush marks and dust nibs, and to knock down the high gloss of the raw varnish to a softer glow. The top is just rubbed lightly with the pumice and oil using a soft toothbrush to leave as much of the surface texture as I can.
And now comes the moment that all this has been leading up to. The new pegs are fitted and the saddle glued in place..... tailpiece and chinrest.... a few minor adjustments -- and a set of strings. The bow is drawn......

The tone is bright and crisp (thanks no doubt in large part to the light stiff spruce of the belly) yet full, rich and powerful. It has a quick easy response, singing high notes and gutsy lower end. But like a newborn, it will be a little shaky on its feet until everything settles in to it’s new equilibrium. From hereon, it should just get better -- it will mature, mellow, and open up as the varnish cures, the wood ages, and the structure adapts to the new forces and stresses that it is subject to. But it’s a pleasure even now only a few hours old. Strong, mellow, biting, and sweet -- like a sip of good single malt whiskey, with which I think I will celebrate.....

Here are a few pictures of the finished instrument: