SETTING THE NECK

Objectives

The precise location of the neck is the most complex operation in the making of a new violin, with some of the most restrictive parameters, and is even more complex on older instruments, because of their asymmetry. Both tonal qualities and much of the player's physical relationship with the instrument are influenced by the neck. All of the various parameters for setting the neck are precise, and all must come together simultaneously at the end.

The basic objectives are

- 130mm neck length from the upper end of the board to the edge of the top, next to the heel, on the E string side
- no lateral tilt of the board relative to the plane of the top
- 6mm between the underside of the board and the crest of the top, at the heel
- 27mm height for the projection of the center of the top of the board at the bridge position
- perfect centering of the centerline of the board to the centerline of the instrument and f-holes
- an angle of the D string over the bridge of 158mm in the final set up (which will probably involve compromising the previous two measurements)
- perfect alignment of the center of board to the center of bridge
- a good fit and glue joint at all glued surfaces, including a perfect joint between the neck heel and the button of the back.

Variations

All of these measurements are influenced by every cut that is made when fitting the neck into the mortise, so it's very possible to be working well towards a perfect neck set and have one or more variables wander off specification at the last moment if one is not paying attention to all of them, all of the time.

Additionally, no violin body is likely to be perfect in all respects, so there is always an amount of adjustment to be made to achieve a well-set neck.

Top arching can be asymmetrical, either because of the original shaping of the top, or as a result over time of pressure from the bass bar or soundpost (both should always be in place when setting the neck). It's traditional to set the neck by visually checking it's alignment towards a dummy bridge placed on the top, but if the top is not symmetrical, this will throw the top of the bridge to one side, resulting in a misaligned neck. It is desirable to do this check, but in order for it to work, the dummy bridge used in the setting process has to be cut to cancel out such misalignment. String pressure can collapse the bass bar side slightly more than the treble, especially on a cello, but this should be compensated for when cutting the final bridge so that the centering of the neck is not compromised.

Neck length may need to vary slightly from 130mm, depending on the exact size of the body, the actual length of the stop (edge to bridge center) if it varies from the ideal of 195mm, and the maker's objective in meeting an individual player's requirements. For instance, on some Guarneri del Gesu violins the stop may measure somewhere between 190 and 195mm. The maker of such a model needs to consider whether to keep the normally-expected stop-to-neck length ratio of 3:2, or the normal string length resulting from the 195mm stop plus 130mm neck length. There are choices to be made in such a situation: should one lengthen the neck by the amount lost in the stop (at the extreme, making a 190mm stop with a 135mm neck, which would probably defeat the reason for making a smaller violin model) or split the difference in some way (putting a normal 130mm neck on a violin with a 193mm stop is not unusual)? What should be avoided is a short neck relative to stop, for instance a 130mm neck with a 198mm stop as found on some larger Stradivari models, because this moves the higher positions towards the bridge, making them more inaccessible to the player. The most common way of getting around this is to move the bridge so that the back of the bridge is aligned with the inner nicks of the f-hole, and working from that measurement.

This brings up the question of which f-hole's nicks to use, the one on the G side, where the player usually looks when aligning and straightening the bridge, on the E side, where the player's left hand works (stop and neck length are crucial for the player's identification of the location of third position), or perhaps neither, as above, or splitting the difference. All of this needs to be calculated before starting to set the neck. For a violin which is planned as a normal violin, probably it's best to keep to the 195mm and 130mm measurements, as much as practical.

Precise centering of the string path down the center of the instrument, without any dog-leg in the string path, is essential and difficult to achieve on a device which has traditionally been constructed without much regard for symmetry. The center glue seam of the top and back can't be counted on to be equally distant from the purfling at the

widest points of the upper and lower bouts; the c-bouts may not be centered relative to either the top seam or the bouts; the f-holes may not be centered relative to any of those, and one of these may be tilted relative to the other, so that the centerline of the instrument can't be placed relative to both the upper and lower eyes and the nicks all at once. For most purposes, a nominal centerline should be determined first by the nicks of the f-holes, and then made parallel to the center of both the upper and lower bouts. That is, the neck may be located running to one side of the bouts' centerline, but shouldn't appear to run diagonally to the overall appearance of the body, when viewed from the front.

The reason for this choice is so that casual viewers of the instrument will not get the impression that the neck is set crooked, and also because other shops or semi-informed players will almost invariably attempt to reposition and center the bridge on the top by measuring the distance from each foot to its adjacent f-hole, not by any other landmark you might personally choose. In former times it was common to indicate a non-standard location for the bridge by punching two pinpricks into the top on either side of the bridge, but this is no longe acceptable, for rather obvious reasons (and many old instruments have multiple sets of pinholes in their top, as each successive workman attempted to impose his own standard of bridge placement with a larger hole than any of his predecessors).

On an old violin/neckset being redone, one does generally not have the option, without some fuss, to center the board on the front of the instrument if it is not already, and then twist the heel so that it points at the button because this tilts the top of the board (by "fuss", I'm thinking about a theraputic board, mainly). If centering the button on the center seam on a new violin is important to you, you'll have to leave the neck heel slightly over-sized until you've laid out the final alignment of the neck (but before fitting it) and cut the heel asymmetrically to point at the center-seam-aligned button, if that is necessary. This may seem like a bit too much work, but it's very commonly done when fitting a new neck graft to an old violin which may have been made with no regard at all to any centering, anywhere. Planing the back of the heel, the part that rests on the button, so that it is parallel with the front (so the board is level with the top when the heel is against the button) and then placing the neck centered on the top pushed against the button at the back allows one to mark out the heel on the ribs by the button, and then figure out how the now-too-wide heel should be narrowed to aim at the center seam of the back.

The angle that the strings take as they turn over the top of the bridge is influenced by the angle of the neck relative to the body and the height of the saddle. In neck-setting terms, the angle of the neck is the result of both the amount of space between the bottom of the board and the top (called overstand), measured at the edge next to the heel, and the height of the bridge. Conventionally, specifications aim for a 27mm fingerboard projection

(resulting in a bridge that is about 33mm high in the center) on a 16mm top arch. With those measurements, a conventional saddle, and an undistorted body, a 6mm overstand will give a D string angle over the top of the bridge which is just a bit steep of the desired 158 degrees. These numbers work well for a 15mm arch, but for a 16mm one we may need to compensate by a slightly higher overstand, combined with a slightly lower bridge, and perhaps a slightly higher saddle to attain the necessary 158 degrees.

These figures assume a flat top plane (defined by the underside of the edge of the top—the gluing surface). This is the case with no rib taper from end to end (which no one does) and a constant taper from end to end (which many makers do) but it is not if the body has been thinned from the upper corners up to the upper block, as in traditional Cremonese style as explained by Roger Hargrave in STRAD magazine.. If the ribs are thinned on the back, theoretically the top remains flat, but in reality both the top and back will be bent slightly towards each other in the upper bout, because of the stiffness of the back. If the taper is taken off the front of the ribs, but the overstand remains at 6mm, the top will bend quite a bit backwards in the upper bout, and this can remove almost 2mm of effective overstand, resulting in a greatly increased string angle. Consequently, the conventional numbers work better on older violins, on which the body has become bowed forward through hundreds of years of string tension, resulting in a bridge which is lower relative to the end blocks than on a new violin by as much as 2mm.

The result of all of this is that while the usual numbers work in a general sort of way, they don't suffice for someone who wishes to have precise control over the neck angle. Perhaps it's initially better just to head for specific numbers, but in the long run it's desirable to have some way to predict what is going to happen when the violin is strung up. To do this, I use an angle gauge which is designed to anticipate the string height over the board and predict the string angle there.

The gauge stands on the top of the board, with the hinge placed right at the bridge position. The free arm of the gauge rotates down until it touches the saddle, and a built-in protractor predicts what the angle of the D string will be when the violin is strung up. During the course of setting the neck, the gauge works similarly, but needs to be held above the saddle the distance remaining to fully seat the heel before the neckset will be finished. This allows predicting the string angle very early in the neck fitting process, and keeping track of it all through the process. Near the finish of the setting, it will become apparent whether the neck can continue in the same manner, or whether adjustments will need to be made to achieve the optimum 158 degree angle by altering the target measurements for overstand and bridge projection.

Fitting

The following items are required:

- a perfectly flat surface to work on
- knife
- ½" (13mm) chisel
- small (102-size) plane
- dividers (optional, but convenient)
- two metric rules
- soft (lecturer's) chalk
- fresh hide glue
- new, uncut bridge
- medium-sized clamp
- clamping caul for button
- miscellaneous other small items as needed

The body of the instrument should be completely finished in the white. If setting the neck into an old one, the hole in the block left by the previous neck will have been filled with a block of basswood or similarly soft and character-free wood. The cut out edge of the top will have been reconstructed. Both pieces of new wood need to be wet, dried, and sanded, repeated several times to assure that the grain of the wood is smooth and stable. A light sealing isn't inappropriate at this point, either.

The neck should be prepared for setting. This means that the bottom of the heel should be finished at an 87-degree angle to the face of the neck, and sealed with a coat of hide glue. The board should be in place and completely finished, and the neck completely carved with the exception of the heel, which will be carved after the neck is glued in place. The heel should be tapered so that the sides are planed parallel to and flush with the sides of the board (giving a very slight dovetail taper), and the heel tapered so that it is approximately 23mm in width 42mm from the back of the board (which represents the button's final width).

The first step is to determine where the nominal centerline should be placed on the top. This is not always straightforward. Ideally, the centerline as indicated by the outline, the centerseam, and the center between the f nicks will coincide. Often the glue seam up the middle of the top cannot be trusted to be the center. Priority should usually be given to the location of the fs, and the neck is then set to them, parallel with the actual centerline as established by the purfling at the widest points of the upper and lower bouts, which will eliminate the problem of worn edges. In any case, what we chose to do will be measured off of the upper and lower bouts, so those need to be considered first.

Place the body on its edge on a very flat surface. A machinist's surface plate, though heavy and expensive, is perfect for this. I use a sheet of marble that was chosen for its flatness. Ideally, the body will rest without any rocking between the front and the back, with the top purfling of each bout the same distance off the surface plate regardless of whether the treble or bass side is resting on the plate (the upper and lower bouts do not need to be the same as each other, but the opposite sides of the same bout do need to be equal). The plane of the top should always be square to the surface plate.

This rarely happens on its own, and making it happen is a real exercise in 3D spacial skills. I can only give a certain amount of help with this—the rest is up to you. Shims variously placed under the all of the edges make this possible. I use cardboard taped to my marble slab, making two stations, one for each side, treble or bass. It is not unusual to have shims under all four touching bouts on one side, and three on the other.

With these stations, it is now possible to measure up from the slab by using a rule, dividers, or a machinist's surface gauge, and find the precise midpoint of the upper bout, the lower bout, of the top between the f nicks, and at the bottom and top edges of the top (neck and saddle positions). Those should be marked with faint pencil marks. Ideally, those points will be in a straight line, and also on the center seam of the top if you're lucky.

Now it needs to be determined whether the f-holes are spaced equally on either side of this line, by finding the midpoint between the fs at the nicks, and seeing if it coincides with the real center of the top, as just determined. If not, some compensation needs to be made in setting the neck, and the easiest and best-looking is to move the entire center line and everything attached to it (neck, saddle, endpin) over to match the f-holes' location.

In the past, it was considered enough to have the neck pointed at the bridge, one way or another, but this no longer suffices. The problem with this approach is that it's possible for the neck to point at the bridge but not be at all in line with the center of the top. Things go well enough from the nut to the bridge, but for the best tonal results the line all of the way from the endpin to the nut needs to be straight, and how can you do that if the endpin is centered, but the string path is not? One way is to move the endpin sideways, and this is, indeed, a quick neck set on an old instrument with a neck set in the old way. But you can't do this by eye, so old crooked neck sets rarely have the endpin in the right place. Additionally, it's very easy for almost anyone to notice a crooked neck, even when the endpin is in the right place, straight in line with the strings, and this will be interpreted as a problem, even when it isn't.

The reason we're going to go through so much fuss here is to make the string path straight, and make it appear straight as well. Figuring out what to do is almost harder than

doing it.

So, if the f-holes are centered, great! If not, figure out how far off they are, and you will need to place the whole neck, and the endpin, off center in the same direction, by the same amount. Mark that newly-corrected position on both ends of the top—in the end of the top where the neck will go, and then with a permanent cut or punch mark deep enough to survive through varnishing into the end of the top where the saddle will go.

From the new center mark at the top, mark off 16mm on each side, and put a light prick into the edge at each spot. These will be reference marks that you can use to keep the neck mortise centered all through the fitting process. Mark, with pencil, the positions of the outer edges of the bridge feet on a light line drawn between the f nicks. This will be a reference for when you glue the neck in, and can also be used during the process if you want a quick check of how your neck set is progressing without measuring, but you will certainly need to measure at the end, because the bridge position isn't totally trustworthy because of the aforementioned issue of a slightly slanted top arch. It is good enough at the beginning, though.

Next put the neck in position, center it up on the button's center seam (measure out from the seam and mark the aim point of thesides of the heel with a pencil on the inside of the button). Center it also between the reference marks you made on the top, and then trace pencil lines off the sides of the heel down to the ribs. With the neck in place, look under the board, up at the end of the neck, and see if the bottom of the board is parallel with the top. If it is not, you will need to sacrifice something to make sure it is, and that will be the centering on the heel; move the back of the heel sideways until the board is parallel with the top, and redraw your lines.

Just inside of these lines is where you will make your initial fitting cuts, with a saw, at least all the way down through the ribs, especially at the back, and almost down to the purfling at the front. If you don't make sure this cut goes through the rib, it is likely that you will tear out pieces of the rib in the next step, so use a knife to deepen the cut at the back if you need to.

If you have done everything normally up to this point, the neck will be 137mm long from the nut/board junction down to the bottom of the heel. Since we want 130mm from that junction to the nearest point of the edge of the top, that means the neck will be cut into the top about 7mm, which will be up to 1mm past the purfling. Sawing short of the purfling gives us a margin to work with in fitting the neck, similarly to what we get by sawing inside the side pencil lines.

The next thing to do is quickly hog out all the wood above the purfling, between the saw

marks, straight back to the button, with the floor of this mortise descending about 1.5mm at the back relative to the front. Next clean up the sides, out towards the pencil lines, in a slight dovetail that will match the slope of the sides of the heel. Try putting the neck in place. If it doesn't fit, widen the hole until you get enough heel in to stick. In doing this, and from now on, do not make a cut that will not make the fit of the heel in this mortise better.

Your objective is to completely eliminate gaps at all of the gluing surfaces, neck sides and the bottom of the heel, while enlarging the hole until the neck settles into the right position, as defined at the start of this section.

Cut, check, cut, recheck, until the neck fits. As the neck settles in, the back of the heel needs to be constantly planed shorter, a small amount each time, so as to gain full gluing contact with the button. At any point in the process, one should be able to glue the neck in, confident of both the fit and alignment appropriate at that point.

How to check the measurements as we go along? First there's neck length. This is measured in the normal way down the side of the neck. Be sure not to get to the right length too fast, because adjustment will need to be made along the way for precise board projection and neck tilt, and these will inevitably eat up neck length. Projection is measured in the normal way as well, with a long rule on top of the board and a short one coming upwards from the top at the bridge position Until the neck set is final, the projection will always be high, of course, but it should be exactly too high as the overstand is too high. For instance if the current projection is 40mm with a target of 27mm, that is 13mm too high, and the overstand should also be 13mm high: 6mm plus 13mm equals 19mm.

Centering is measured off the marble slab. I measure to the higher side of the board at the nut and bridge ends, but you can also put a strip of masking tape on the board below the nut and at the wide end, strike off the center, and make a pin prick to use as your center. If you use my method, the upper edge of the board top will end up about 76.5mm off the slab, and the upper edge of the board bottom wil be approximately 110-111mm off the slab. The same process will be used to locate and punch a solid starting hole for the endpin, before you disassemble your staging area.

Refer to the photos to see how all of these measurements are made. The final critical aspect is keeping the board equally high on the E and G sides, by looking under the board and comparing these sides under the board at the bottom of the heel, viewed from the end of the board. You can also opt to measure the overstands on either side of the neck, keeping them equal.

Here are some other things to keep track of.:

Don't undercut the sides of the mortise to make the rib/heel junction look good. It is helpful to use chalk on the sides of the heel to see where to cut and find places that don't touch. When necks fall out, it's not uncommon to find lots of glue in this area, indicating a bad fit, so it really does matter.

When you are finished, the back of the heel should be about 2-2.5mm deeper in the block than the front.

It's helpful to cut away the invisible bottom corner of the back of the heel, against the button at 45 degrees, since this is a difficult area to cut well.

Don't cut into the button repeatedly in fitting the neck! This will make a perfect looking joint possible. Cut the sides of the mortise from back to front with a knife as much as possible to avoid this, and that will also be cutting with the grain of the block rather than against it. A few fine cuts with a chisel towards the end are OK, if you're careful of the button.

One source of bad neck sets comes from the wood of the bottom of the mortise swelling when the glue wets it. This raises the bottom in a pillow shape, and the bottom of the heel will rock on this, making an absolutely stable joint impossible. To prevent this, I fit the bottom of the heel to the bottom of the mortise perfectly with chalk, then hollow out the mortise very slightly—maybe just .01-.02mm—so that the bottom of the neck rests on four stable corner posts. The gap is small enough to be bridged by natural swelling of the wood in the gluing process. I do most of my cutting of the mortise floor with a long pointed knife, not a chisel, because it allows me to better control individual specific spots.

Check once in a while to make sure that the mortise doesn't twist, by putting the neck in place, and then alternately pressing the neck down into the body, then the back of the heel down into the mortise, while watching the nut for any rocking; it should remain absolutely stable. This should be a regular check to make, or you may get unpleasantly surprised at the end, and not have enough room to correct the problem.

The neck fit should be quite tight, requiring definite pressure to bring home. You should feel comfortable holding the violin by the neck, without glue. Being able to swing it around your head probably indicates the fit is too tight.

Appoach all final positions together. Getting something right early on and having no room to change it later is a common beginner's mistake, especially regarding neck length.

I would rather than you need to remove the nut and saw one mm off the upper end of the board and fit a new nut than that you end up with a neck one mm too short.

Work on only one problem at once, and get them solved as early as possible, so that you can concentrate on keeping a perfect fit. I usually get the projection right first, then the left-right tilt. Both of these are determined only by the floor of the mortise. Then I go after the centering and overstand by cutting the sides of the mortise. Don't forget to check everything once in a while to make sure you're still on track, and be sure to leave a little extra neck length for unanticipated final adjustments, because there will always be some to make.

Be conservative with the numbers—a neck a couple tenths long is OK; projection a couple tenths low is OK; a half mm of extra overstand is OK—but keep precise control of the centering.

I do not set my pitch slightly high to allow for settling of the neck under tension, since I have not found it to be necessary. Be aware, though, that you may have to set the neck 0.5mm high, 27.5mm, to allow for this. Also be aware that drying varnish in a light box can result in a rise of neck pitch of almost 2mm, and that this will come back down within about two months. These are things you will have to learn to deal with (generally, I don't sell a violin before it settles, which can take several months).

Gluing

Once the neck is in its final position, check everything carefully. Make sure the neck doesn't rock in the mortise. Make a cardboard-faced clamping caul that covers the block and button and is well fit to them. At this point, with the neck in place, dry, with no clamps, measure the distance from the top of the center of the board to the top, at the bridge end. This should be around 20-20.5mm. This is your double-check for pitch, since you won't be able to measure pitch once the gluing clamp is in place. Put a bridge on the top, slide it back and forth until a visual check by sighting down both sides of the board shows that the bridge is centered on the board, then check this against your bridge marks on the top. It should be pretty close—say within a half mm. More difference probably indicates something's wrong. Note its exact position now, and this will be used to check centering with the gluing clamp in place.

Tape a piece of cardboard on the face of the board where the clamp will go, so that the clamp doesn't dent the board. Using strong glue, paint the inside of the mortise and button, and the gluing surfaces of the heel, squeeze the neck into position, pressing it firmly down into the mortise, put on the caul, then the clamp. Check the height of the

board and the centering on the bridge. If they're right, clean off the glue squeeze out, check again, put the violin in a stable position where nothing is pushing the neck out of adjustment, and walk away for 24 hours. If something is wrong, remove the neck immediately, wash off all the glue, let it all dry, then figure out later what went wrong, correct it, and try again. If things are really bad, you will need to fill the block with a piece of basswood or similar, and start over again.