Constructing a yew bow in the Tudor style.

David Pim

Introduction.

Prior to the Norman invasion of 1066, the history of post-Roman Britain was more tightly linked with that of Scandinavia and northern Germany than with the rest of Europe. In a period lacking any sense of nationality, cultural links were considered more important than geographical location and this can be seen very clearly in the inheritance of military tradition. This was a period, more than 4 centuries, of minimal technological change, and the English archery tradition, as with the rest of north-western Europe, barely changed from the early medieval period through to the 14th century – simple wooden bows constructed with various timber species, for the most part almost identical to those of pre-viking and viking cultures. Some examples of these kinds of bows have been found in Scandinavian and other European sites, (1.) but almost none in England, despite the historical importance of archery in England and its tactical use and effectiveness, when used in sufficient numbers, throughout the medieval period in European warfare and considering the enormous amount of yew staves imported and the huge number of bows constructed. This consequent lack of primary archaeological evidence prevents us from being completely certain of the construction and performance of these bows, and the arrows shot from them, although images from medieval manuscripts give us some idea. It is not until the raising of the Tudor warship Mary Rose and the discovery of the hoard of longbows and arrows found within, that any real idea of what late medieval bows actually were, came to light.

Archery practices during the reign of Henry VIII can be divided into three parts: military, hunting and as exemplified by Roger Ascham (2.), sports archery and Tudor military bows were at the apex of wooden self-bow technology. Records show that bows of the medieval period through to the Tudor were constructed of a variety of timbers, but those aboard the Mary Rose were all made of imported Yew, save one in Elm. They were bows of mostly very high draw-weight, designed to inflict maximum damage in battle, whether on land or on sea.

I have researched the construction and shooting of Tudor military longbows – more recently termed 'warbows', for more than 15 years, with help and advice from what is now a growing network of English and other European bowyers and based on multiple visits to the Mary Rose museum, as well as the Mary Rose trust, to examine some of the original bows kept in storage (photos below). I have learnt through hard work and experience, following my own road to constructing bows within the limitations I place upon myself with available space and preferred choice of tools. Other bowyers may have acquired a different set of methods and philosophy and consequently, this article should not be considered a definitive guide to constructing a yew bow, since in essence, nothing teaches better than hands-on experience.

Choosing the timber for constructing a bow.

Simple self-bows from the early medieval through to the Tudor period were constructed using a variety of different timbers and the characteristics of each type of timber determine the form of the bow. For example, generally speaking, bows made of elm or hazel have a rather flatter cross-section when compared to those made of yew. Yew, *Taxus Baccata*, is generally considered the finest European timber for bow-making due to the tensile strength and elasticity of the sapwood and the ability of the heartwood to cope with compression – particularly important when constructing high draw-weight bows with a deep cross-section. English yew may have been used but records show that the majority of yew was imported, over many centuries, initially from Baltic regions via Hanseatic merchants and subsequently from southern Europe (Spain, Portugal, Italy) with Venetian merchants. Whilst it is possible to construct a yew bow from freshly cut, unseasoned timber, no English military bow was ever constructed this way. Medieval records show unequivocally that yew was imported as cut staves, meaning that trunks were felled and then sawn or split at source, possibly even stored in warehouses before transporting to a port for transit to England. Certainly, it would have been many months before harvested timber arrived in England and it would have been at least partially seasoned at arrival. Timber seasoned and dried slowly over 2 or more years is always best. Some bowyers with extensive experience with working yew believe that the longer the timber is seasoned, the better the performance of a finished bow.

Taxus Baccata is a tree species highly protected across most parts of Europe and suppliers of cut and seasoned staves are increasingly difficult to find as a consequence. Some limited cropping however, is possible on private land with the permission of the owners. The very best yew comes from zones where the trees grow slowly and very straight, frequently at high elevation, most probably due to limited access to sunlight rather than water or nutrients. Figure 1. shows a typical area of woodland in the Trentino region of Northern Italy, at an elevation of around 400m above sea level. What is noticeable about the woodland is that all the trees, not just yew, grow particularly straight. I discovered that traditionally, in years gone by, yew from this area was used to construct rot-resistant supports for the grape-vines growing on the hillsides and the owners of the woodland would habitually cut side-shoots off the growing yew saplings to keep them as straight as possible. Given that this habit may stem back as far as Roman times, the resulting growth of particularly straight yew trees may have also attracted the attention of bowyers in medieval times.

Given permission from the owner of the woodland, I selected and cut several trunks of around 2m length and around 17cm diameter. These were then sawn in half lengthwise and left to season slowly for two and a half years in a cool dark area with a moisture level that remained more or less constant, but not too dry, so that the timber itself dried very slowly. The typical quality of the timber, in particular the tightness of the growth-rings within the heartwood, can be seen from the cross-section shown in Figure 2.

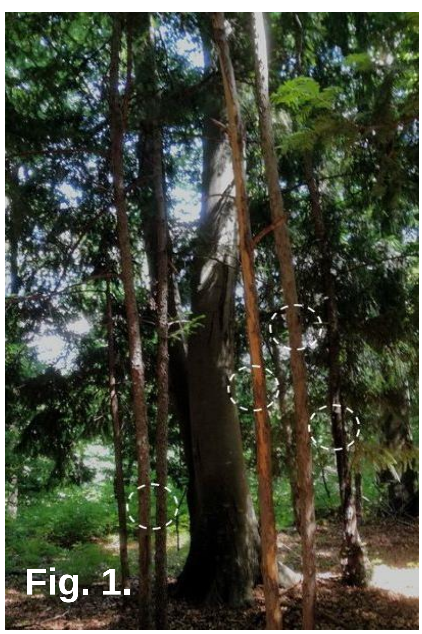


Fig. 1.


Fig.2.

Choosing a tool set for working a bow.

Tool use is a highly personal choice and many bowyers will work differently from me. Halved or quartered trunks of yew will need a great deal of timber removal to shape the stave and many traditional bowyers, will use a hatchet and/or small adze at this stage. Others with extensive workshops may use a bandsaw, whereas I use an electric plane. Once a basic stave is produced, other than a small set of woodworking saws, my preferred tools are shown below. Although it is unlikely that original bowyers of the Tudor period were concerned with accurately measuring the draw-weights of their bows, a weighing balance is a useful item when constructing bows for customers who want specific draw-weights.

1. Draw-knife
2. Spokeshave
3. Farrier's rasp
4. Various files
5. Cabinet scraper
6. Tile saw
7. Weighing scales.
8. Drill point for horn nocks

The cabinet scraper shown is modified from a commercial one by grinding a flat edge to give a slightly curved one with rounded corners. This is essential to give the scraper a set of variable curves for working down the sapwood. The drill point for horn nocks will be described in more detail later on.

A traditional tool known to bowyers of the past, a 'bowyers flote', a tool that resembled a small plane with a series of blades is almost unavailable today except by bespoke order, no original examples appear to exist. Two interpretations are shown below. I also note that many bowyers also use small planes for shaping the bow; I have managed to get along without one.

Bowyer's Flote 1.
(Courtesy of Hugo Harbridge).

Bowyer's Flote 2.
(Courtesy of John Oneill, Waterford)).

Starting work.

The original Mary Rose bows had lengths varying from around 1.8m to more than 2m, with an average length of around 1.95m (3.) so it is best to start with a stave of 2m if possible, reducing its length as need be. Figure 3., shows an example of a half-trunk before starting. The first stage is to remove excess timber (heartwood only!) with hatchet, bandsaw, plane or draw-knife to produce the basic shape of the stave, (Figutre 4.), at around 7-8cm depth and width at the centre, perhaps tapering gently to 4-5 cm at the tips (Figure 5.), leaving the stave slightly deeper than wider, considering that you will be removing bark and some sapwood. Many bowyers mark out the stave with a centre line from one end to the other before starting, as a guide to even removal of the timber when working down the dimensions of the stave. I personally don't bother, but it is essential to pay attention to the flow of the grain of the timber, especially if there is a lateral bend in the stave, which you will need to remove using heat, as explained further on. Often enough the pith-line in the centre of the stave is visible, (Figure 6.), especially if the stave is derived from a narrow trunk and this can be used as a guide to the flow of the grain along the stave. A stave presenting serious problems is shown in Figure 7., where it can be seen that, not only is the stave bent sideways, but the pith-line within it is even more seriously bent; making any sort of bow from a stave with these problems would be extremely challenging! After reduction of the stave's dimensions, the bark is removed using a drawknife, being careful not to cut deeply into the sapwood beneath, as shown in Figure 5.

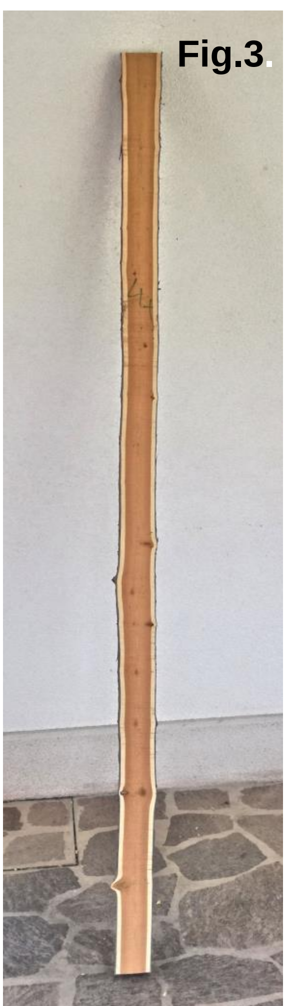


Fig.3.


Fig.4.


Fig.5.


Fig.6.


Fig.7.

After reduction of the stave's dimensions, the bark is removed using a drawknife, being careful not to cut deeply into the sapwood beneath, as shown in Figure 8. The resulting stave with the bark removed is ready to start shaping (Figure 9.). Although one may have started with a 2m length of wood, few original bows were this long, so one needs to cut one end to give the desired length, which will be dependent on the draw-weight of the bow and the draw-length of the archer. The higher the draw-weight of a bow, the deeper the cross-section will be and consequently the more compression the heartwood of the belly will suffer during use. If the draw-length of the archer is long, the bow needs to be made longer so as to reduce compressive strain on the belly of the bow. One might consider 76" (1.93m) a good average length to start with; the bow can always be shortened further if needed. Always measure the length and mark the geometric centre of the bow.


Fig.8.

Shortening the stave will also allow one to avoid some knots, awkward bends or other faults towards the end of a stave. If for instance there are knots in the side of the stave, towards the tip, they may be partly or completely removed in the finished bow if they were moved closer to the tip by removing that end of the stave when cutting to length. However, if there is a knot in the centre of the sapwood towards one tip, the reverse is true; you need to ensure there is more timber around it, so you should shorten the stave from the other end.


Fig.9.

Straightening bent staves.

Slight lateral bends in a stave, or regions with a deflex, can often be straightened using steam; you can make a workable bow from a deflexed stave, or one with a lateral bend around a knot, but you will never make a good one. To resolve bends/deflexes, the part of the stave that needs straightening is placed over a large pan of hot water and a layer of aluminium foil is placed over the top and sealed around the edge of the pan (Figure 10.) Two more sheets of foil go across the top, overlapping the first but further out and sealed around the stave and pan edges, (Figure 11.) and the water set boiling for around 2 hours.


Fig.10.


Fig.11.

Fig.12.

At the end of 2 hours, the stave is immediately removed from above the pan and placed under pressure overnight using a cramp, as shown in Figure 12., pressing in the opposite direction to the original bend. Bearing in mind that the stave will spring back fractionally when pressure is released, the pressure of the cramp should bend the heated stave just past the point where it appears straight.

When the stave is straightened, one proceeds to reducing the thickness of the sapwood, using a scraper or combination of scraper, file and spokeshave if the surface of the sapwood is smooth enough. (Figure 13.).

Why is reduction of the sapwood necessary?

Fig.13.

Late medieval/Tudor longbows, in contrast to earlier medieval bows, had slim tips reinforced by horn sheaths to protect the bow-tips from damage by the bowstring. Mary Rose bows, for example had tips with diameters approximately 12-17mm diameter at the point where the timber enters the horn. These dimensions require a high ratio of heartwood to sapwood at the bow-tips in order to resist the force of the bow without bending or breaking. I reduce my bow-tips to 14mm and consider a good ratio as being around 10mm of heartwood to 4mm of sapwood and considering that most of a yew bow's performance is due to the heartwood rather than the sapwood, removal of some layers of sapwood is recommended if it is too thick. Some of the Mary Rose bows were made from timber of such high quality, with layers of sapwood so thin that the bowyers merely removed the bark and left the sapwood intact. Other bows show clear signs of sapwood layers having been worked down. The sapwood is worked down layer by layer, to the desired thickness, leaving an intact growth-ring layer from tip to tip of the stave if possible. When this is done one can start to shape out the stave using spokeshaves and rasps. The cross-sections of the original bows were variable, from almost round to 'D'-shaped to 'galleon' shaped according to the bowyers' habits and training. The only thing they have in common is the depth of the timber along the length of the bow. I favour a 'galleon' section; Figure 14. shows the section from an original bow, Figure 15. the end of a bow in progress. Tables 1. and 2., show the dimensions of a set of original Mary Rose bows as a guide to the correct dimensions along a bow in progress.

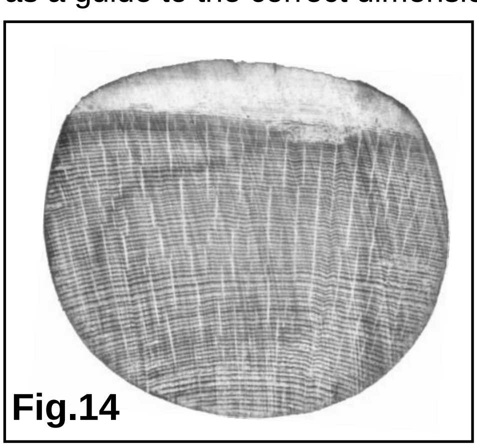


Fig.14

Fig.15.

Dealing with knots.

Most Mary Rose bows were made with very fine quality yew, almost totally lacking knots, but the occasional bow can be found with them and it is clear that although today many bowyers leave areas around knots ‘proud’ of the surface, the original Tudor bowyers often cut across knots in the side and belly of the bow, level with the remaining wood, confident that the timber around them would survive under tension. In fact, yew is a timber that can be worked well enough even with a series of knots, provided care is taken.

Knots come in 2 varieties, ‘dead’ and ‘live’. Live knots are derived from small side-branches that were alive when the tree was cut. ‘Dead’ knots are derived from side branches that were already dead when the tree was cut and these normally fall out of the stave during construction and will need plugging by gluing in a spare piece of timber if the hole they leave is large, (Figure 16.). Live knots will generally stay stable in the stave but will need working carefully around them, bearing in mind that their grain runs at right-angles to the rest of the stave and they will not flex with the fibres that run around them. Figure 17. shows two sides of a stave with knots and how the sapwood has been worked down to flow above and around these.

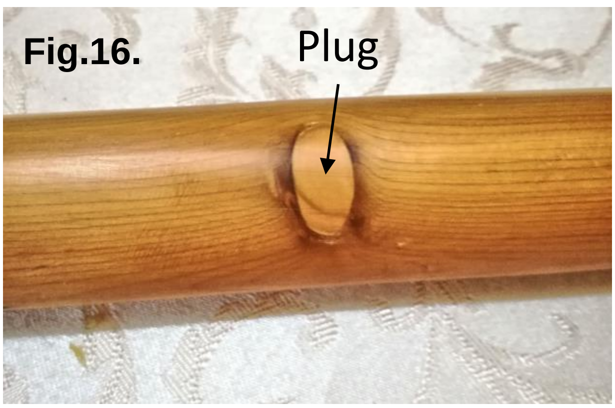


Fig.16.

Fig.17.

Fig.18.

Fig.19.

Figures 18. and 19. show views of a large knot before starting work and on the finished bow (low draw-weight). Large knots, or plugs in the back of the bow do need careful attention and it is wise to leave sapwood proud around them as shown in Figure 20.

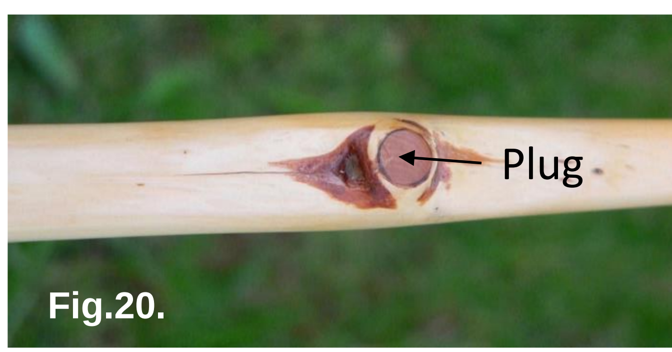


Fig.20.

Other problems in the stave.

Yew is a fairly rot-resistant timber, but both in cut staves and in the living tree, signs of infections – mostly fungal – can be observed, usually as a layer or layers of grey between the sapwood and heartwood. Sometimes it makes no difference at all, other times one can feel that the tensile strength and elasticity of the sapwood has become compromised and a bow built from that stave will be risky. Occasionally stored timber attracts woodworm and again sometimes if there is only the occasional hole, it won't be a problem. At times one may observe longitudinal cracks within the heartwood that are filled with a whitish substance, which I suspect is a fungus and this can seriously compromise the bows performance and longevity. Two seriously awkward problems occur for which I have found no real solution. The first is 'Wynd' also called 'axial' or 'propellor twist'. As this suggests, the stave is twisted along its longitudinal axis so that the surface of the sapwood at one end of the bow is lying askew relative to the other end of the bow. This means that when drawn, the direction of force does not lie perpendicular to the sapwood (Figure 21) so that some of the heartwood is taking up a degree of stretch and there is a risk of breakage. For lighter draw-weight bows, this may not be a problem, but it is not recommended for heavy draw-weights.

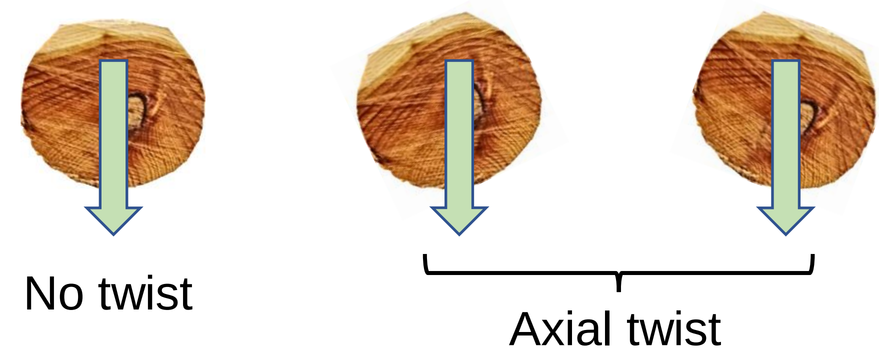


Fig.21.

The second serious problem is voids within the timber of a stave. These sometimes become apparent during the tillering or shooting of a completed bow, visible as lifts in stretches of timber when the heartwood is under compression; underneath these there are voids where the timber layers were disconnected during growth. In extreme cases these occur in the centre of the stave and separate with disastrous results. On one occasion I found a small side knot that had started growing within a void in the timber. This seems to occur when two slim trunks of yew from the same original trunk have fused together, the bark and outer layers between them becoming absorbed, so that what appears to be a single trunk and staves derived from it, are in fact two separate stretches of timber. Figure 22., below, shows an example of a long void that opened up for around 60 cm along the length of a partially tillered bow. The polished looking surfaces show that the two halves grew separately.

Fig.22.

Working the stave down to the desired dimensions, especially towards the bow-tips, will produce a pattern of the wood-grain on the belly similar to that shown in Figure 23. if it has been done correctly. One can then start to tiller the bow. Use a tile-saw to cut tillering nocks in the sides of the bow-tip as shown in Figures 24. and 25.


Fig.23.


Fig.24.


Fig.25.

Many bowyers constructing warbows use a wall-mounted pulley system for bending the stave and checking the tiller of the bow. I prefer using a basic tiller bar (Figures 26. and 257) mounted vertically in the vice of a workbench.


Fig.26.


Fig.27.

The advantage of such a system is that it allows you to check the bending of the limbs from end-on and control any tendency to bend sideways at an early stage of the tiller, (Figure 28.). However, the clear disadvantage of this system is that it limits the bowyer to tillering lower draw-weight bows; I could only reach a maximum draw-weight of 130 lbs this way. At this stage, having cut tillering nocks as shown above, one can attach a long cord, mount the centre of the bow on the tillering bar and begin to carefully bend the bow round, checking the even curvature of the timber.


Fig.28.

Figure 29. shows a bow at an early stage of tiller, where it can be seen that the bow is too stiff halfway along each limb relative to the centre, where there is too much bend. This requires removal of timber, with file or scraper, from the belly of the bow in these areas, to produce a more even bend. One can decide to complete the tillering at this stage, with the temporary nocks or to add horn nocks before finishing, which is my preferred method.

Fig.29.

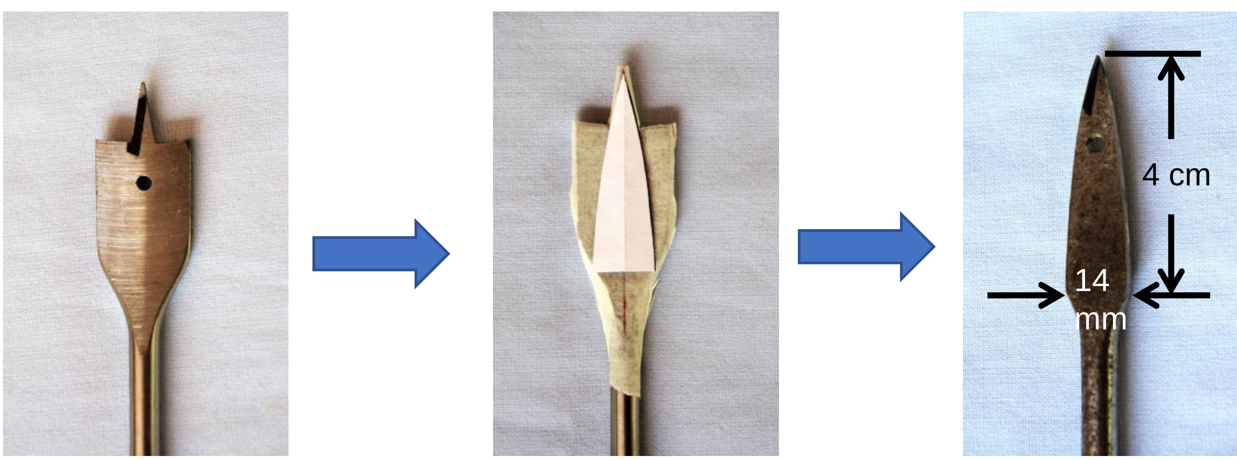
The construction of horn nocks.

The tips of the original Mary Rose bows were ‘piked off’ to slim points as shown in Figure 30. The marks left by the original horn nocks where they were glued in place are clearly visible, telling us the diameter of the bow-tips where they enter the horn, the length of bow-tip enclosed by the horn and the position where the slot was cut through the side of the horn into the wood below to form the ‘side nock’ that typifies the Tudor bows. Horn items were rarely found aboard the wreck of the Mary Rose and the only original horn nock found is shown in Figure 31.

Fig.30.

Fig.31.

To recreate these sidenocks one needs to construct a suitable drill-bit. I started with a flat wood-bit marked off as shown below and ground with a bench-grinder to produce a spearpoint-shape, 4cm long and 14mm at its widest.



I use cow-horn points of various types or Indian Buffalo horn, which tends to be slightly tougher. However, I have experienced issues with horn being split during shooting that may be due both to the hardness of the upper loop of bowstrings made from modern materials and also deficiencies in the toughness of the horn, which is almost invariably imported from outside Europe. We cannot know what original horns were like as the species of domestic cattle during the medieval and Tudor period no longer exist, but I strongly suspect that the horn was tougher. Generally speaking, from my own personal experience, horn from modern European domestic cattle, when it was commonly available, is still stronger than imported horn. These days however, it is very difficult to get hold of.

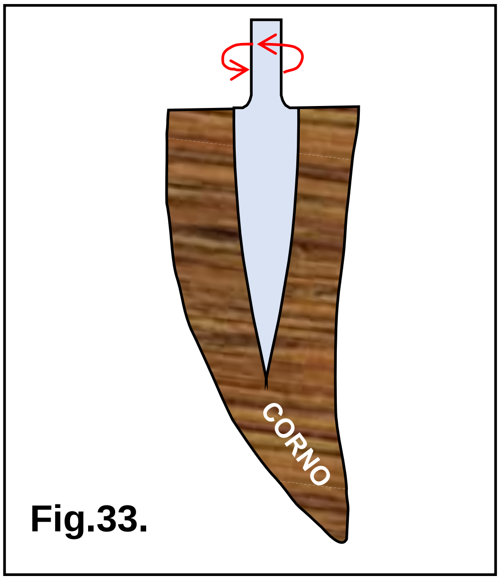


Fig.33.


Fig.32.


Fig.34.

The horn is gripped tightly in a workbench vice and drilled out, as shown in Figures 32. and 33. The horn can be partly worked at this stage by mounting it on a spare wooden dowel of suitable diameter and whose point has been worked to a similar shape as the inside of the horn. Naturally the horn can be shaped using rasps and files, but for the extra speed, I prefer to use a disc sander as shown in Figure 34., to start forming the shape. I recommend leaving the horn, especially the walls at the base, thick (2-3mm) at this stage, as it will be used for measuring the tip of the bow for tightness of fit. The bow tip now needs to be 'piked' to a pointed shape using rasps and files, principally working down the heartwood except for the last 1.5-2cm or so where the sapwood also can be tapered (Figure 35.), so that it conforms to the approximate shape of the drill-bit, (Figures 36. and 37).Try to arrange the bow so that one end is resting on a shelf and the other on a soft surface, such as a leather glove, so that the tip you are working on can be freely rotated, allowing a circular cross-section to be produced.

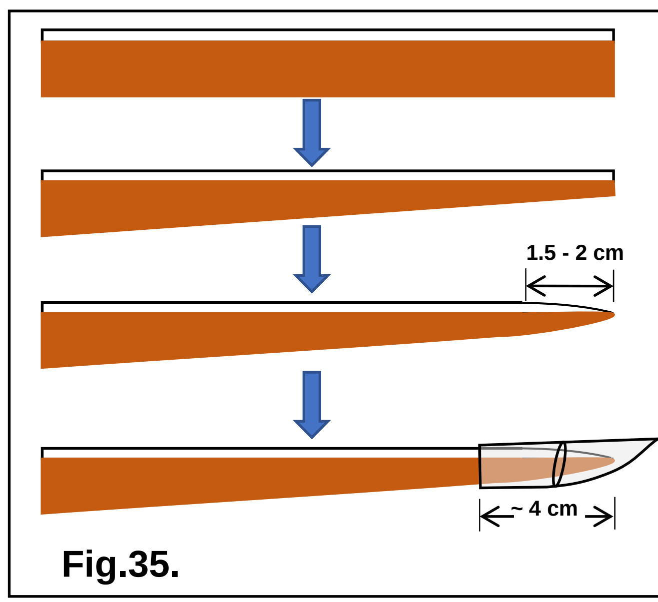


Fig.35.


Fig.36.


Fig.37.

Once the shape of the piked tip seem nearly correct, place the drilled horn firmly onto the bow-tip and rotate; this will leave a mark in the wood where the horn is rubbing and where the wood is fractionally too wide. Using a file and whilst rotating the bow-tip, work the wood across the mark, in a direction away from the tip until the mark disappears. As this process is repeated, you will notice that the mark left by the horn will move further away from the tip until bit by bit the horn rotates smoothly and leaves no mark (Figures 38. – 41.).


Fig.38.


Fig.39.


Fig.40.


Fig.41.

When the horn fits perfectly, it should be replaced on the dowel previously used for the initial shaping, in order to cut the slot using a tile saw. It is essential to make this cut in a downward rather than a horizontal direction, as shown in Figure 42., as this will create a ‘lip’ to help retain the top loop of the bowstring. The cut must go through the horn into the wood beneath and should look roughly as shown in Figure 43. This may not be the way that the original horn tips were processed, but the advantage of cutting the slots at this stage is that the horn can be pushed onto the bow tip to check for any voids between wood and horn in the region around the slot.

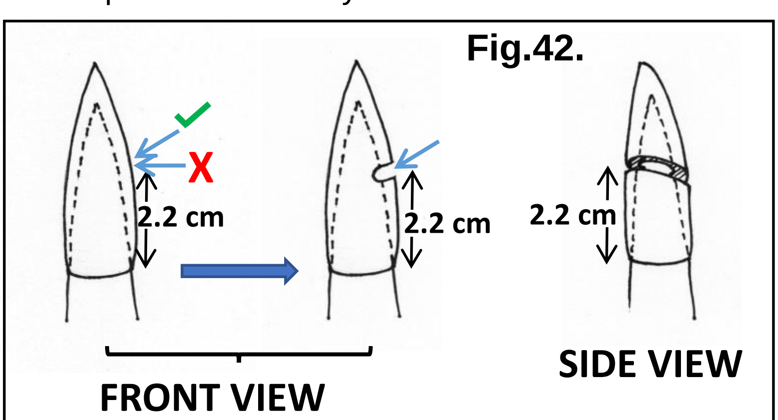


Fig.42.


Fig.43.

Any small voids between horn and wood that are visible in the area of the slot are generally caused by the tip not being perfectly round and will only disappear by taking a couple of millimetres off the tip and recommencing working the timber as before. Producing good horn nocks is one of the trickiest procedures of making Tudor-style bows and beginners may take some time to get it right.
The original tips of the Mary Rose bows were extremely smooth and polished. This tells us that the fit of the horn to the wood was extremely tight and the glue used very viscous, most likely an animal-based glue. I use cyanoacrylate glue for the horn, first carefully removing any dust or grease from inside the horn and the surface of the wood with acetone. I recommend using a pair of disposable gloves before proceeding. Trickle the glue into the horn and ensure all parts are lightly coated with glue, then coat the outside of the bow tip. Push the horn onto the tip with a gentle rotation to ensure everything is well coated, then rapidly push the horn into its final position and hold for a few seconds; the glue will rapidly bond tightly. Clean excess glue away from the wood with an acetone-soaked cloth, both at the base of the horn and inside the slot. Leave this a couple of hours for the glue to thoroughly dry. (Figure 44.).


Fig.44.


Fig.45.

Using the tile saw in the slot in the horn, cut 2-3 mm into the wood of the bow-tip. Smooth the slot with needle files or medium-grit abrasive paper. Finish shaping the horn by placing a couple of layers of duct-tape around the wood just below to horn to protect the timber from damage and then use fine files and abrasive paper to finish shaping the horn (Figure 45.), ensuring that the base of the horn is thinned and that there is sufficient horn at the front and the rear of the cut slot to support the pressure of the bowstring without breaking. Figures 46. and 47., show a bow tip before and after gluing and refining the shape of the horn.


Fig.46.


Fig.47.

The structure of horn nocks.

The very existence of horn side-nocks on Tudor bows used to be a highly controversial subject. Even today there are some who believe the notches in the sides of the bow-tips are the remains of tillering nocks, but the finding of a single sidenock from the wreck of the Mary Rose, together with the existence of side-nocks on later sporting longbows show them to be reality. Manuscript images that can be positively identified as side-nocks are essentially non-existent, but Figure 48., below, shows an image of a side-nock from a German bas-relief, (date unknown).

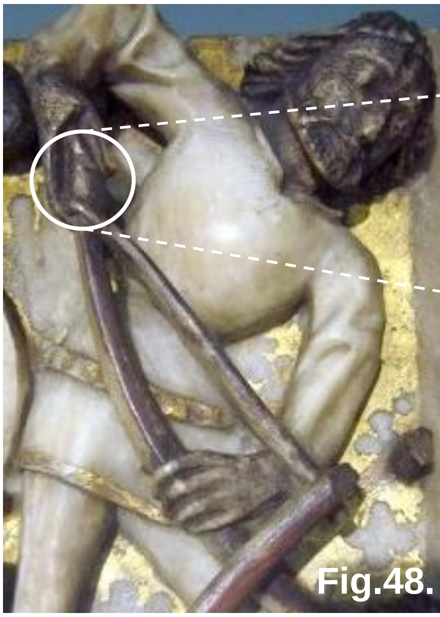



Fig.48.

It is essential to understand the form of the side-nock and how the top loop of a bowstring engages in it before finishing its shape. As previously explained, the groove cut through the horn and into the wood of the bow tip must be done in such a way as to form a lip, leaving enough horn both in front of the groove in the wood and behind., 2-3mm should be sufficient. Figures 49. and 50., below show a pair of side-nocks. And illustrate the simplicity and functionality of form. One may ask why such nocks were used, but there is no simple answer; possibly it is simply the strongly conservative attitudes of the bowyers and their guilds, but several people have noted that bracing a bow up is slightly simpler with a side-nock than with a more modern, forward-facing groove, as seen on many sporting longbows today.

Fig.49.

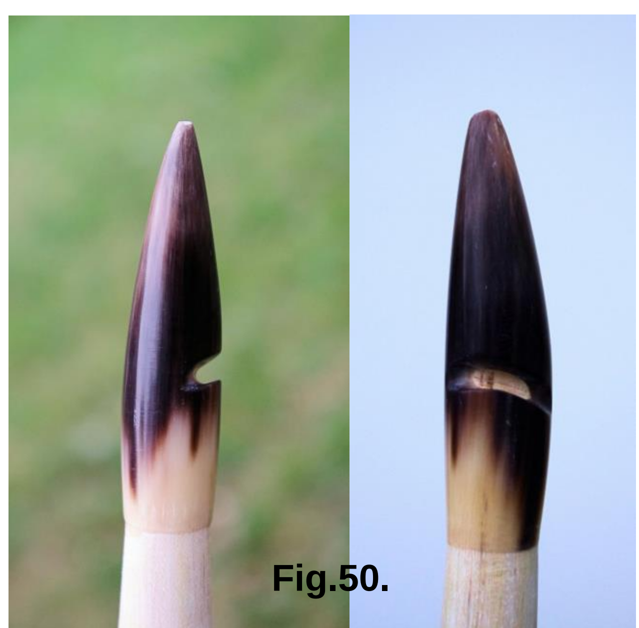


Fig.50.

When the shape of the horn is more or less as desired and before final polishing, the final shape of the bow tiller must be perfected. Military bows and probably all wooden bows of this period had a curvature designed to balance the forces on the bow evenly along their length at full-draw. This curvature is described by Roger Ascham in 'Toxophilus' as 'full-compass', which most bowyers interpret as following the circumference of a circle. An original Mary Rose bow under tension is shown in Figure 51. to demonstrate this, although the evenness of the curve has clearly been affected by 4 centuries under the mud of the Solent.

Fig.51.

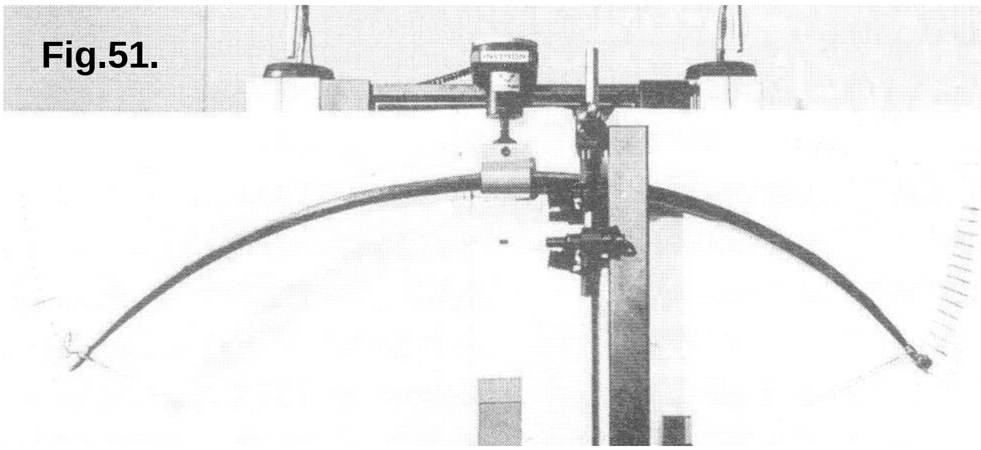


Figure 52. shows the tillering process almost finished. The bow remains too rigid in the outer limbs, as marked by red lines, relative to the centre; careful removal of wood in these areas using a scraper will allow them more bend, so relieving pressure on the middle. Figure 53., shows a bow with the tiller more or less perfected, drawn out to 32". It is worth noting, at this stage, that for a well-made and well-tillered bow, the geometric centre of the bow should correspond precisely with the centre of mass,although some exceptions to this may arise when one end of a stave has a different density as compared to the other.

Fig.52.

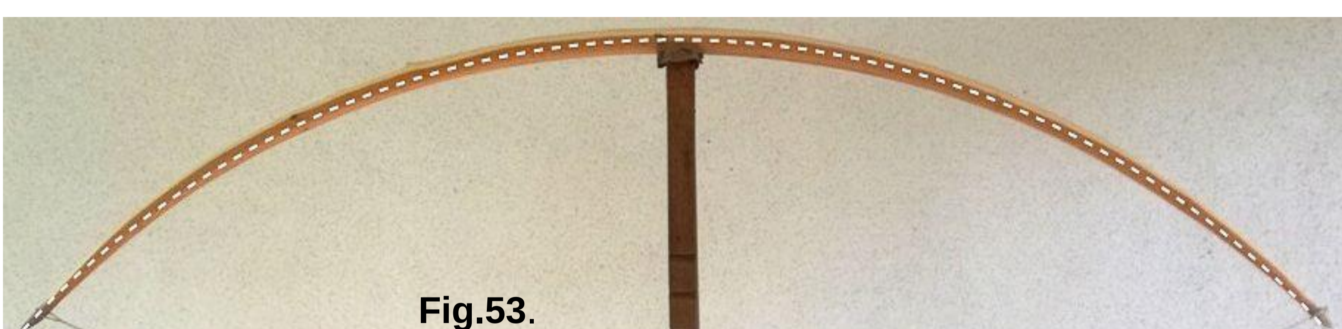


Fig.53.

As previously mentioned, we do not know whether Tudor bowyers ever bothered to measure the draw-eights of their bows in any way. Today however, to produce bows of precise draw-weights for customers we measure the draw-weight, generally at 32”, hanging a weighing scale on the string and pulling it down so as to draw the bow as shown in Figure 54.

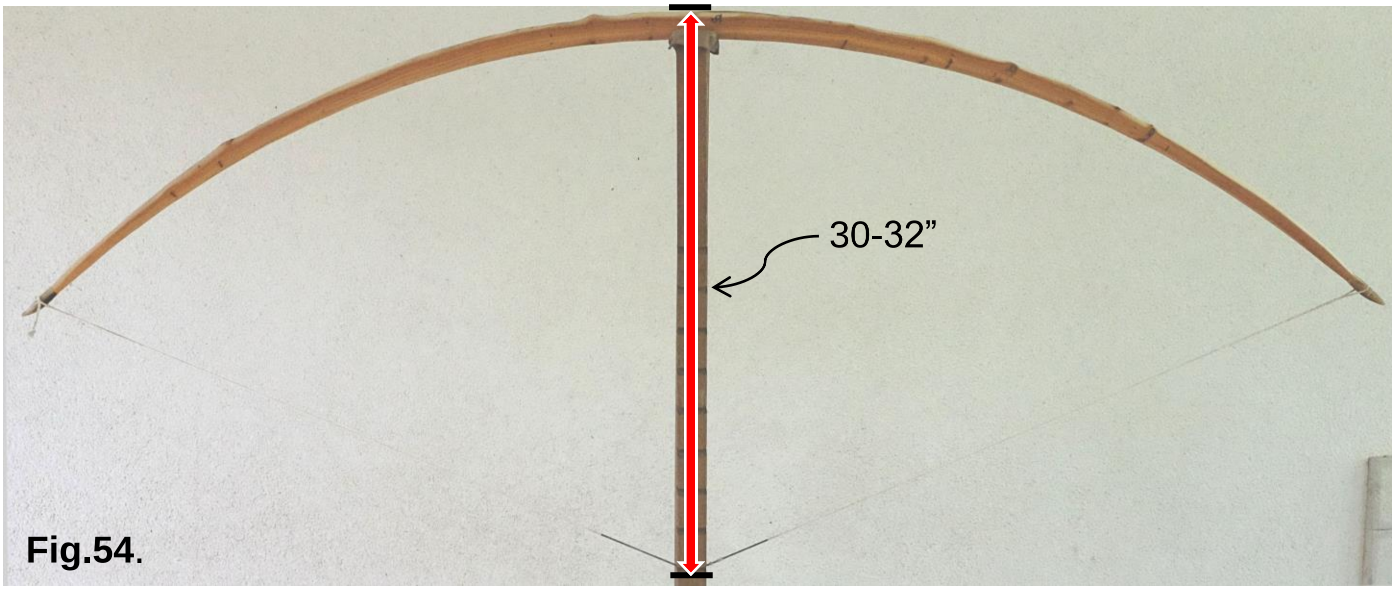


Fig.54.

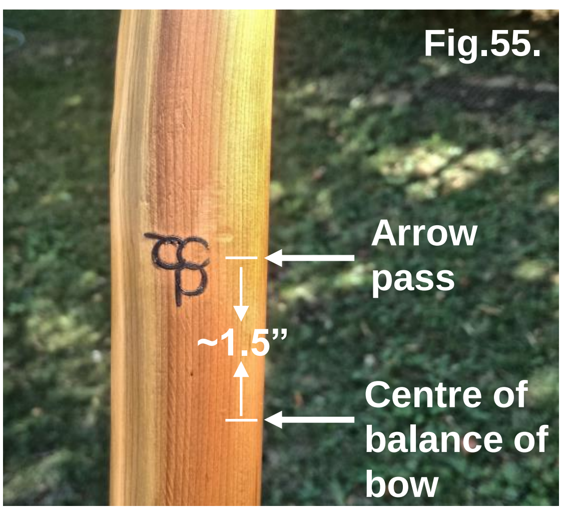


Fig.55.

Fig.56.

It is absolutely fundamental to mark the side of the bow with an arrow-pass. All the Mary Rose bows were marked with a bowyer’s mark at this point, incised or burnt into the surface, and which is around 1,5” above the centre of the bow, (Figure 55.). This allows an archer to locate his hand position without constantly balancing the bow on his finger. It is worth mentioning that the centre of the bow fits into the hand slightly above the centre of the palm (Figure 56.)– this is where the maximum pressure of the bow is taken by the hand when at full-draw. I burn my mark at the correct position and fill this with epoxy resin.

Fig.57.

Finishing the bow.

The bow can now be finished using various grades of abrasive paper, finishing perhaps with wire wool. Wrapping as before, layers of duct tape around the bow-tip just below the horn, this latter can be finished with fine abrasive paper and paste/cream for polishing car paintwork. Special care should be taken around the string groove to avoid sharp corners where the string may rub; I take a length of cord covered with polishing paste and drag it rapidly across the grooves to ensure they are completely smooth. For high draw-weight bows one can cut a second, higher slot for a bow-stringer, as shown in Figure 57.

When the horn nocks are polished and the wood of the bow smooth, it is recommended to burnish the sapwood of the bow, by rubbing firmly with a hard, smooth object such as a glass bottle or polished piece of bone (not anything metallic). This renders the sapwood highly polished and compresses the fibres. The heartwood belly of the bow does not need to be treated this way and most, if not all, of the Mary Rose bows show a slightly fluted surface where the timber was worked with scrapers or a bowyer's flote, but never smoothed afterwards.

The choice of finish for the bow is a matter of personal choice. Some bowyers use modern varnishes or lacquers, which were never traditional, but help protect the timber from knocks and scratches as well as changes in moisture content. others use various types of oiled finishes or animal fats. Roger Ascham in 'Toxophilus' recommends beeswax. I use a paste made from beeswax melted gently into raw linseed oil and with a small amount of turpentine afterwards to keep the mixture soft. This can be rubbed vigorously into the surface of the finished bow using your bare hands, left overnight then polished the next day.

Bowstrings on Tudor military bows.

Natural plant fibres have been used for millennia for constructing bowstrings and during the early to late medieval and Tudor periods, the fibres of choice were derived from linen and hemp, although it is likely that nettle and linden-bast were at times used for lower draw-weight hunting bows. Lack of any original bow-strings prevents us from knowing how they were made, the secrets of which were confined to the guild. Modern industrially-produced fibres are much less reliable for use on warbows than the original strings would have been, produced as they were from hand-harvested and retted materials. However, there is a limited source of hand-made hemp strings produced in Japan for Yumi bows and these have shown excellent, if slightly inconsistent results on high draw-weight yew bows. Figure 58., shows a section of one such string and the component fibres.

Fig.58.

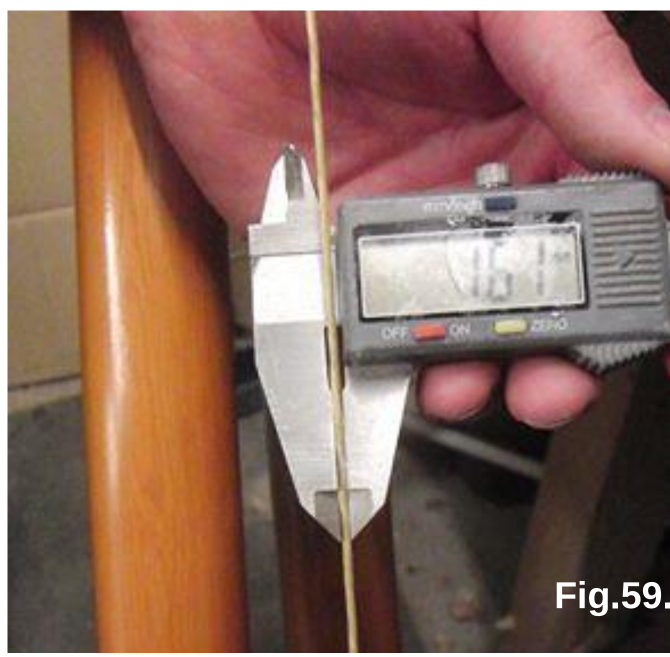


Fig.59.

Figure 59., shows a Yumi cord of 1.61mm diameter on a warbow drawing 160lbs at 32". In comparison to modern materials, the hemp string proved more rigid and capable of transmitting more energy to the arrow upon release and hence achieving greater distances during shooting. It was able to shoot more than 100 arrows before breaking. (Joe Gibbs, personal observations). Such cords have a shorter life than those made with modern string materials, but medieval records show that armies travelled with around 3 spare strings for every bow in the contingent, to accommodate this fact.

For the sake of safety and longevity of the string, I prefer to use modern synthetic materials such as ‘Fastflite’ or ‘Dyneema’. Spools of these materials are well-suited to the construction of modern, continuous-loop strings, but this design of string is not suitable for heavy draw-weight bows since the loops contain half the number of strands as compared to the main body of the string. The string therefore should be made in the traditional way, using a so-called ‘Flemish twist’ in which groups of single-strands of material are twisted around each other in one direction, then the groups united into one, twisting around each other in the opposite direction. Instructions on how to do this and how to form a loop at one end are freely available; consequently, I do not intend to cover this subject, except to point out that the string made in this way needs to have a laid in stretch of around 15cm at one end, tied with a knot and a small loop laid in at the other. Figure 60., shows how the bowstring should hang from the top sidenock of the braced-up bow. Some people also like to serve the loop, making it slightly thicker and less inclined to cut into and split the horn.


Fig.60.

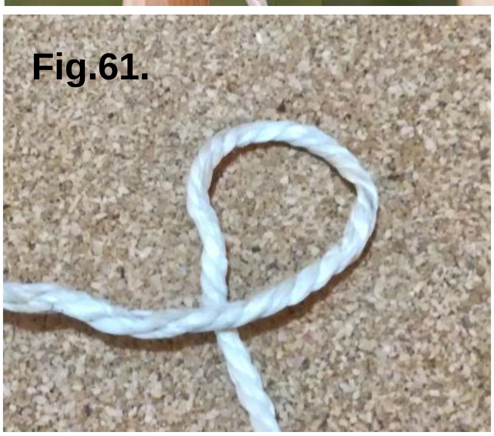


Fig.61.


Fig.62.


Fig.63.

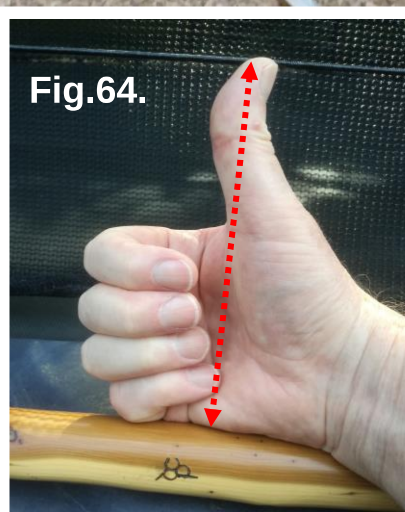


Fig.64.

The bottom end of the string is secured on the bottom nock using a ‘bowyer’s knot’ as shown in Figures 61-63. Newly-made strings will initially stretch when the bow is braced up. When it is no longer stretching, the correct brace-height of the bow (the height between the centre of the bow and the bowstring) is that of your fist with raised thumb, (Figure 64.). You initially set the correct brace-height by adjusting the bowyer’s knot, but fine adjustment is made by adding or removing twists in the total length of the string.

Note. If you have already set a nocking point on the string (see below) adding or removing twists to the string will change the brace height but not the position of the nocking point relative to the arrow pass; if you change the position of the bowyer’s knot, this <u>will</u> change the position of the nocking point and it will need to be reset.

All bowstrings need to be served tightly in the centre region, around 10cm above and 15cm below the centre, to avoid abrasion by your fingers, the arrow and any brushing against clothing. Strings should be regularly waxed to reduce fraying and it is absolutely essential to mark a nocking point on the bowstring to ensure consistent and rapid nocking of an arrow. Inconsistencies in arrow nocking lead to inaccurate shooting and frequent striking of the forefinger of the bow-hand with the arrow shaft upon release. As a result, many archers wear a glove on their bow-hand to protect against this, something that is in no way traditional or historically accurate; it is purely a consequence of lack of understanding of where to nock an arrow and poor instruction. No bow-hand glove has ever been found or shown in manuscripts illustrating longbow archery. There have been many arguments relating to speed of shooting by archers as a requirement in certain forms of 'Arkan', but these bear no relationship to the reality of military archery, particularly in the case of the Tudor 'warbow' – even the very strongest archers cannot shoot more than about 6-7 arrows per minute, considering the physical demands of arriving at full draw with bows varying from around 100 to 180lbs draw-weight, but failure to mark a nocking-point will slow this speed down even more.

How to find the correct nocking point.

As shown below, in Figure 65., the correct point is at least 2.5 cm above the horizontal and should be marked with a couple of knots, above and below, made from bowstring material (or dental floss) that is heated (carefully!) to melt into a resistant mass. It is a good idea to mark the spot temporarily using some masking-tape and checking it, before finally fixing the knots. Why is this necessary? When coming to full-draw using a standard Mediterranean loose, with two fingers below the string and one above, it can be seen that a greater length of bowstring is used up passing around the two fingers under the shaft than the single finger above (Figure 66.). This means that the nocking point on the string is pulled down to the horizontal relative to the arrow-pass when the bow is drawn, as opposed to being above it when then string is at rest.

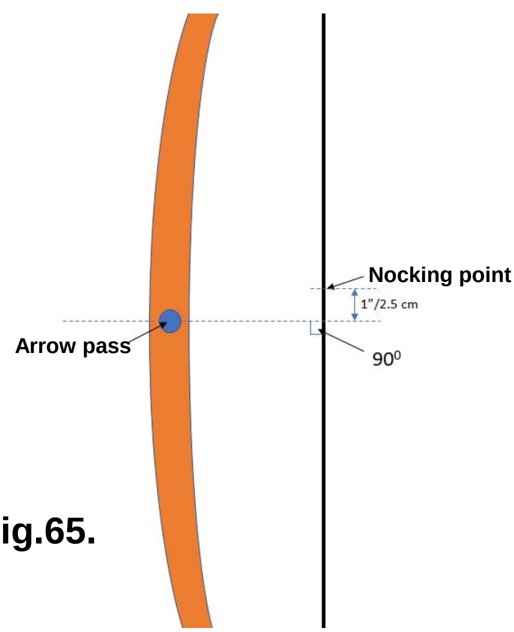


Fig.65.

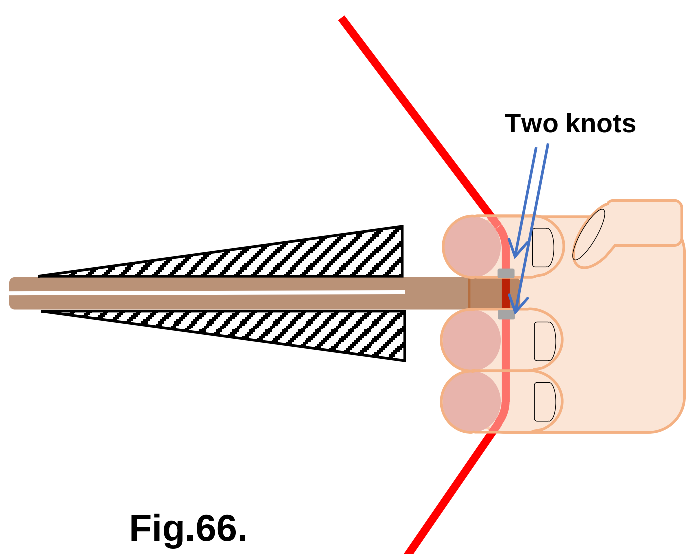


Fig.66.

Table 1. **Dimensions of 4 bows with a rounded 'D' section (Weapons of Warre)**

Bow number	1.	2.	3.	4.
Total length (mm)	2024	2029	1973	1981
Width/Depth at centre (mm)	34.6/35.9	34.7/33.0	38.4/35.2	33.6/33.7
Width/Depth of Lower limb @ distance from centre				
100 mm	34.2/31.2	34.5/31.4	38.1/34.7	32.8/31.7
200 mm	33.5/31.1	34.5/30.7	37.8/33.0	32.2/31.5
400 mm	30.6/28.5	32.0/27.4	35.7/32.3	29.6/27.2
600 mm	27.3/24.3	28.5/24.3	31.3/28.6	25.8/23.5
800 mm	21.7/24.3	21.4/19.7	23.6/22.8	19.7/18.7
900 mm	17.1/16.1	16.2/16.3	17.8/17.8	14.4/14.3
Width/Depth of Upper limb @ distance from centre				
100 mm	35.4/33.0	34.8/31.4	38.4/37.4	33.6/31.9
200 mm	33.8/32.4	34.0/30.2	37.6/32.8	32.9/30.2
400 mm	30.9/28.3	31.3/27.1	34.3/30.0	29.4/27.4
600 mm	27.5/25.4	27.3/24.6	30.2/29.0	27.2/24.5
800 mm	22.3/20.9	21.9/20.1	23.2/22.8	20.4/20.2
900 mm	17.5/16.7	17.3/16.8	17.6/17.7	15.6/12.3

Table 2. **Dimensions of 6 bows with a slab-sided section (Weapons of Warre)**

Bow number	1.	2.	3.	4.	5.	6.
Total length (mm)	2113	1968	1994	1998	2012	2005
Width/Depth at centre (mm)	38.9/35.6	37.1/31.8	33.4/32.0	37.2/36.0	35.0/32.5	36.9/33.4
Width/Depth of Lower limb @ distance from centre						
100 mm	38.8/34.4	36.0/29.5	32.9/30.9	38.8/37.0	35.7/31.5	36.9/33.4
200 mm	38.4/33.1	35.5/29.1	32.2/28.9	37.8/33.7	36.5/29.3	37.0/32.7
400 mm	36.0/31.1	33.5/29.6	29.8/26.3	35.5/30.6	33.7/28.7	34.3/29.0
600 mm	32.9/27.3	29.3/24.9	26.8/24.1	31.2/27.9	29.9/26.3	30.1/25.9
800 mm	26.8/23.8	23.6/19.7	21.1/20.4	22.6/22.9	23.7/22.6	23.4/21.8
900 mm	21.8/20.6	18.1/16.9	16.1/16.4	16.8/18.0	18.3/18.2	18.4/17.8
Width/Depth of Upper limb @ distance from centre						
100 mm	39.0/35.0	36.1/30.7	33.5/30.3	37.3/33.3	36.0/30.4	38.0/32.5
200 mm	38.1/32.7	35.0/30.0	32.2/29.5	37.3/33.2	35.6/29.8	37.2/30.9
400 mm	35.8/30.2	32.1/28.3	29.6/28.1	35.5/31.7	32.7/28.0	34.5/28.1
600 mm	32.0/27.2	27.8/23.4	25.9/23.5	30.7/28.6	30.1/24.6	30.2/25.8
800 mm	26.8/22.8	23.6/20.0	20.8/18.6	22.2/23.6	23.4/21.2	22.4/20.7
900 mm	21.6/18.8	17.9/16.0	15.9/15.5	16.2/17.9	18.1/16.3	16.8/16.1

Concluding remarks.
Constructing a yew bow, especially one with a heavy draw-weight, is a time-consuming endevour, requiring a high level of skill that can only be achieved through hard work and experience. Considering the relative scarcity and high price of yew today, I always recommend beginners to start with cheaper timbers for practice and if possible, attend a bow-making course run by a well-known bowyer. I have made good quality bows from Elm, Plum and Dogwood, but Ash, Sycamore and Hornbeam, Hazel as well as a many other timbers, will all work well. Apart from the cost, it is easier to find long pieces of other timber types lacking knots or other imperfections, allowing a beginner to concentrate on shaping the limbs and perfecting the tiller of the bow without the need to reduce the depth of the sapwood. Although the ability to use the tools available is the same, bow-making does not conform in any way to classical woodworking; you are building a wooden spring rather than a set of chairs and must understand how your bow will bend to optimize its performance and not break.

I started this article with a simple bow build-along in mind, but as I proceeded with each step, using available photographs from many bows constructed over the years, I realized that simply describing each step wasn't sufficient; an attempt to describe why you need to do things as they are done, was necessary to the beginner. As I stated at the beginning, this article is not intended as a definitive guide, it is more of a personal journey and other bowyers have found their own way just as I have. It is to be hoped that this article provides some useful information to anyone starting anew in this addictive pastime.

References and further reading.

1. "Archi Semplici Medievali" – Gionata Brovelli
2. "Toxophilus" – Roger Ascham.
3. "Weapons of Warre: The Armaments of The Mary Rose" – Ed. Alexzandra Hildred.

Recommended books for further historical information.

"Longbow: A Social and Military History" – Robert Hardy

"The Great Warbow" - Matthew Strickland e Robert Hardy

"Secrets of the English Warbow" – Hugh Soar

"Arrowstorm" – Richard Wadge

"The Beauchamp Pageant" – Ed. Alexandra Sinclair