CHAPTER 1
INTRODUCTION

This book covers the construction of the four common sizes of ukulele: soprano, concert, tenor and baritone. Differing construction techniques are used for the four instruments, with the idea that the book offers a 'cookbook' of different ways to build ukuleles which can be mixed and matched as required. This does mean that there is no simple linear description of building one ukulele, rather a series of chapters on fabricating the various parts; necks, soundboards, fretboards etc, followed by other chapters explaining how those parts are assembled into a finished instrument. This also means that a fair amount of pre-planing is required to determine what kind of ukulele is to be built, and how it is to be put together. Read through the book first and get an idea of what will be required in materials and tools as well as the various procedures to make a ukulele.

At its simplest, a ukulele can be assembled over a long weekend. At its most complex, the time necessary will be comparable to that needed for a fine classical or steel string guitar. Ukuleles are only limited by imagination.

One thing to remember is that there is not very much string tension on even the largest of ukuleles. As a comparison, a full sized classical guitar has a tension of over 38kg/86lb and a steel string guitar around 74kg/160lb. The soprano, concert and tenor all use the same re-entrant tuning G4-C4-E4-A4 (the famous My Dog Has Fleas) where the lowest note is the C4 at 261hz on the third string and the top A4 string at 440hz. During the first ukulele craze in the 19-teens and 20s the standard or soprano ukulele was often tuned a full tone higher to A4-D4-F#4-B4 with the strings at higher tension.

It is common on tenor size instruments for the G string to be tuned an octave lower - 'low G tuning' - and most of the string makers make sets to suit. The baritone tuning is D3-G3-B3-E4, the same as the top four strings of a guitar. The standard ukulele tuning keeps the same intervals between the strings (notwithstanding that the G4 string is an octave higher) as a guitar so the same chord shapes can be used, just transposed up a fourth.

UKULELE SIZES

This a table of general measurements for the four sizes of ukulele. These are not absolute and any of the measurements can vary by a couple of cm or an inch or so.

Size	String length	String tension	Overall length	Body length	Body width
Soprano	34cm/13.5"	10kg/22lb	53cm/21"	23cm/9"	17.5cm/7"
Concert	58cm/15"	15kg/33lb	55cm/22"	28cm/11"	20cm/8"
Tenor	43cm/17"	18kg/40lb	66cm/26"	30cm/12"	22cm/8.5"
Baritone	50cm/20"	24kg/53lb	76cm/30"	35cm/14"	25cm/10"

THE TYPES OF UKULELE

1. OLD ISLAND STYLE UKULELE

The earliest Hawaiian made ukuleles were tiny little instruments, made entirely of koa (*Acacia koa*). The frets were inset directly into the neck surface which was in the same plane as the soundboard. The tight waisted body shape was inherited from the Madieran machete and the construction methodology documented in a short film made in 1917 by the Ford Motor Company. This instrument is based on that film and made with Australian blackwood (*Acacia melanoxylon*), a close relative of koa. It uses a 34cm/13½" scale or string length.

2. THE SOPRANO UKULELE

The soprano ukulele is based on a Regal design which was made by the thousands in the 1920s and sold under a variety of labels. It is a simple ukulele, made as lightly as possible. Three of this style of ukulele were made during the writing of this book. Pictures of all three instruments have been used at various times.

The body was made separately from the neck and joined by a shallow violin-style mortice. A thin fretboard, made from ebony, with 12 frets, sits on top of the neck and slightly overhangs the body. The bridge is simply made with four holes drilled for the strings. Small glass beads are tied to the ends of the strings which lock them under the soundboard. This ukulele also has a 34cm/13½" scale.

3. THE CONCERT UKULELE

The concert is the second smallest size of ukulele, and perhaps the least common. The string length is two frets longer than the soprano, around a 38cm/15" scale length, and according to the string manufacturers around 50% more string tension. The concert size ukulele needs more bracing on the soundboard but the body can be built with the soundboard, back and sides the same thickness as the soprano, around 1.5mm/0.060". The body is a little longer, wider and deeper, and with the added string tension the sound produced should be louder and more resonant.

The shape of this instrument is based on a enlarged Martin soprano ukulele, following the Martin length, width and depth. Unlike the 'old island style' soprano, this instrument has a separate fretboard which can either be a short 12 fret style, or can be extended to the soundhole using 19 frets. The body and neck are made from Honduras mahogany (*Swietenia macrophylla*) with a rosewood fretboard and bridge.

The ukulele is built on a workboard or 'solera' in the manner of traditional classical guitar making. Using a flat workboard does simplify construction. The neck is glued to the soundboard with the sides let into slots cut into the end of the neck. The soundboard braces are flat, rather than arched as they might be on a guitar, with the neck in the same plane as the soundboard. The back is arched over braces and the sides shaped to a section of a spherical dome matching the curvature of the braces. This sounds complex, but is easily done with a dished workboard lined with sandpaper which both shapes the braces and sands the sides to the required profile.

Although the solera workboard method is only used for the concert and baritone ukuleles in this book, it is adaptable to any size ukulele. Because the workboards themselves are quite small it is simple and cheap enough to make one for each size of instrument. The moveable dowels which establish the body shape allow for variation in the body outline.

A soprano ukulele in a Martin or Regal body design (as included in the plans) could be made on a slightly smaller solera workboard.

With this method of construction the actual assembly of the instrument takes very little time, but only after the constituent parts - neck, soundboard, back and sides - have been prepared.

4. THE TENOR UKULELES

The tenor ukulele has become very popular in recent years as a solo instrument. The longer 43cm/17" scale means higher string tension with standard G4-C4-E4-A4 tuning. This should lead to a louder and more responsive instrument. Many players alternatively use a low G3 string which adds extra range to the instrument. The body design for the two tenor ukuleles built for this book is based on a Gibson L-00 guitar from the 1930s. For the first one the body and neck are made with mahogany and the soundboard is Californian redwood (*Sequoia sempervirens*), recycled from an old stair tread a century or more old. This ukulele is made with 12 frets to the neck/body join.

The body and neck are made separately and bolted together using a small threaded insert in the neck heel and a short M4 thread bolt. The back of the neck heel has a 18mm/¾" wide tenon that extends 10mm/⅜" into a mortice in the neck block which provides vertical alignment of the neck. The section of the fretboard over the body is supported by an extension of the neck the same width as the tenon.

The second instrument has 14 frets to the body with the body made from Australian red cedar (*Toona australis*), recycled from a piece of century old skirting board, with the neck from mahogany. This instrument uses a simpler bolt-on neck. A 14 fret to the body neck means that bridge position is closer to the soundhole and the soundboard bracing is adjusted slightly.

The bodies are constructed in a solid mould using solid rather than kerfed linings. There is a double layer of linings for the soundboard and a single lining strip for the back.

5. THE BARITONE UKULELE

The baritone ukulele is edging closer to a guitar, with a longer 50cm/20" string length with a usual tuning of D3-G3-B3-E4. That is the same as the top four strings on a guitar, albeit with a lower string tension due to the shorter scale. The assembly of this instrument is again done on a solera workboard in the Spanish style.

There is more bracing on the larger soundboard and back, with five fan braces on the soundboard and three transverse back braces. The lower transverse brace on the soundboard is slightly arched, around .75mm/ 0.030" drop from the centre to the edges. The slight arch on the lower part of the soundboard allows the larger baritone sized soundboard to move a little with humidity changes.

The soundboard is Sitka spruce (*Picea sitchensis*), the back and sides are tamarind (*Tamarindus indica)* and the neck Queensland maple (*Flindersia brayleyana*). The fretboard and bridge are made from Indian rosewood (*Dalbergia latifolia*).

ALOHA OE

FAREWELL TO THEE

Composed by

H. M. Queen
Liliuokalani

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CHAPTER 3
MATERIALS & TOOLS

WOOD

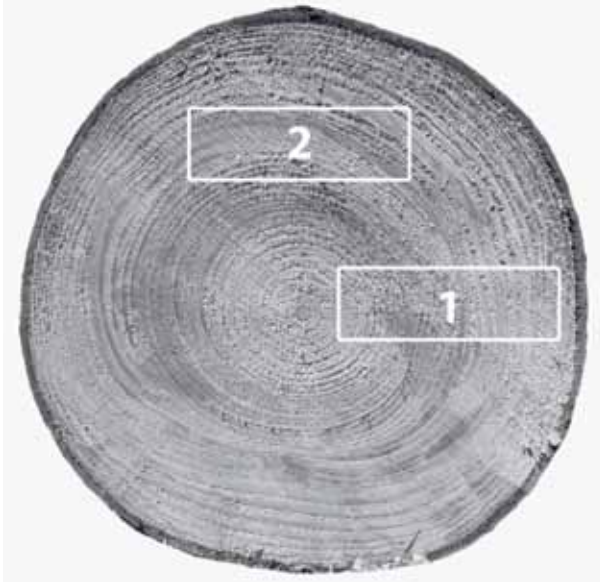
Ukuleles can be made from the same timbers as other stringed instruments, such as guitars or violins. Unlike guitars and violins many ukuleles use hardwood soundboards, usually the same timber as the rest of the body and neck. This was traditionally Hawaiian koa (*Acacia koa*), a medium-weight timber native to Hawaii. Over-use of this wood in the past century has meant there is not much high-quality koa left. Supplies are limited and expensive.

The early 20th century alternative to koa was Central-American or Honduran mahogany (*Swietenia macrophylla*) but the same fate has befallen that timber and the sale of raw timber from Central American is restricted under the CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) treaty. Mahogany is plantation grown in Asia and some Pacific islands, so supplies are available and ukulele sized pieces should not be too hard to find.

There are other temperate and tropical hardwoods that can be used, such as monkeypod, mango, walnut and Australian blackwood (a close relative of koa). Specialist tonewood suppliers such as Luthiers Mercantile or Allied Lutherie have a bewildering array of timber available, and the relatively small sizes of the pieces needed for a ukulele can mean that even the most exotic can be purchased fairly inexpensively. This can also mean that interesting small pieces can often be found in a timberyard aimed at the furniture trade. A 14" bandsaw, the size commonly found in a lutherie workshop, is adequate to re-saw all the wood needed for a ukulele.

The early Hawaiian makers used koa because it was both available and highly valued in Hawaiian society. There has been, in recent years, an increased use of softwoods such as spruce for soundboards and both hardwood and softwood soundboards are equally acceptable.

The most important factor to consider when buying the timber needed for a ukulele is how it was sawn out of the log in the first place. Preferable is quarter-sawn timber, with the annular growth rings as close as possible to being perpendicular to the widest face of the board and the lengthways cuts following the grain of the wood. Wood can be imagined as a bundle of straws held together by the bark, and it is preferable for the sawing to take place as much as possible following the line of those straws. This isn't always practical or even possible as trees bend and twist as they grow and sawmillers will often have to compromise between end yield and the practicalities



A newly cut softwood log. The section marked 1 is quarter-sawn, the section marked 2 is back- or slab-sawn.

of sawing. Quarter-sawing a log is the least efficient way of cutting it up, both in terms of the effort to do it and the amount of lumber produced at the end, but quarter-sawn timber is the most dimensionally stable as the timber is dried, and many, but not all, timbers show the most interesting figure in the wood on the quarter-sawn face.

The specialist tonewood suppliers will try to oversee the entire processing of the log, so what they sell is optimally cut for instrument use. Softwoods for the soundboard are often cut to appropriate lengths in the forest as the tree is felled and then the log sections are split into manageable billets and dried before being sliced into soundboards. The splitting means that it is easier to then do the final cutting with minimal 'runout'. On a perfect soundboard a sliver pulled off one corner would run the entire length of the soundboard. Most of the time little twists and irregularities in the tree means this won't happen, but a sliver should run several inches along an edge before tapering away to nothing. Less runout means that it will be easier to plane the soundboard, as bookmatched flat soundboard halves will have the runout going in opposite directions and planing across the centre join can get tricky.

Hardwoods would be more typically cut into 50mm-100mm/2-4" planks and dried before being re-sawn into thinner slices for backs and sides or blocks for neck stock. If the wood is being air dried, the general rule is a year per 25mm/1" of thickness, though kiln drying will accelerate this process. The difference between air- and kiln-dried wood is one of ongoing discussion in the stringed instrument world, but most people will admit that properly kiln dried timber is perfectly acceptable. The important thing is that it is dry and stable.

Wood purchased from a specialist tonewood supplier will usually be dry to a stable point where almost all the free moisture in the wood has gone, but the wood will still absorb and loose moisture depending on the local humidity levels. It is advisable to have any timber to be used in the workshop environment for a few weeks at least, so it matches the conditions in the workshop.

HUMIDITY CONTROL

Humidity, or at least the extremes of it, is the great enemy of stringed instruments. Wood absorbs and loses moisture continuously as the relative humidity changes and changes size as it does so. A thin, flat piece of wood, such as used for a soundboard or back will noticeably change in width going from the extremes of humidity. While this doesn't matter when it is just a flat piece of timber, once other bits of wood such as internal bracing are glued across the grain, the plate cannot contract and expand in the same way. The plate will still absorb and lose moisture, as will the braces, but the constriction of the bracing will mean that the plate will dome up as humidity increases, and flatten out as it decreases.

The small size of a ukulele means that the inbuilt soundboard doming is not as important as it might be on a guitar and the soprano, concert and tenor sizes can be made with flat soundboard braces. A 15' radius curve for the back braces is suggested. This curve is both practical and aesthetic. It means that even if the humidity falls to very low levels the plate won't go entirely concave and in very high humidity the dome is accentuated a little more.

A relative humidity of 40% is strongly suggested for all gluing of braces on flat soundboards and backs and for gluing the fingerboard to the neck. Cheap electronic humidity/temperature meters can be purchased at electronic suppliers which are accurate enough for this application and can be combined with a dial hygrometer and checking on-line weather reports. It is guaranteed that gluing soundboard or back braces in times of high humidity will be regretted.

What is most damaging to stringed instruments is sudden large changes in humidity and temperature. Gradual changes from one extreme to another can be coped with but rapid changes can be catastrophic with soundboards or backs literally cracking apart in extremely low humidity levels.

GLUES

Several different types of glue are used at various times in these instruments. For most gluing a PVA glue is used, either Franklin Titebond (the original formula, not the II or III version) or Luthiers Mercantile's Yellow Instrument Glue. Both of these set up much harder than the ordinary white PVA woodworkers glue commonly available in numerous brands. Titebond is an Aliphatic Resin Emulsion and of a yellowish colour, rather than the white colour of most PVAs, and has been the standard glue in the guitar building industry for many years. One thing to be careful about using these glues is that they don't work if the temperature is below 10°C/50°F. They dry to a white chalky consistency which is not very adhesive. Cleanup of any squeeze-out is important as residual dried glue can sit on the surface and be visible under a finish.

At the same time there are instrument makers who will only use hot hide glue. This glue has been used for centuries and is the standard glue of violin makers. It is a gelatine made from animal skins and requires dissolving in water and heating before use. While its adhesive qualities are excellent it is trickier to use than PVA with a relatively short 'open' time - the time available to get the two surfaces to be glued together and clamps applied. It is an excellent glue for gluing tentallones in place when assembled an integral neck ukulele. Cleanup can be simply done with a cloth and warm water.

Epoxy can be used for gluing the fretboard to the neck. One advantage of epoxy for this joint is that it does not add any moisture to the join, which can lead to a backbow to the fretboard. Cleanup must be done with acetone before the epoxy has cured. Both Stewart MacDonald and Luthiers Mercantile sell epoxies suitable for woodworking, and there are others available such as West Systems, Z-Poxy, Bob Smith, Devcon and NHP. A 30 minute cure time is suggested. Hobby shops specialising in radio controlled model aircraft are a useful source of these epoxies. Cheaper, hardware store or supermarket 5-minute cure epoxies are useful for gluing inlays into the head of an instrument, and can be coloured with wood dust to match the colour.

Cyanoacrylate glue, often called super glue or CA, is useful for gluing in fretboard markers or side position dots as well as repairs in ebony and rosewood when mixed with a little sanding dust. This glue comes in a variety of viscosities for different uses, but the cheap varieties available in supermarkets are fine for the uses mentioned above.

MEASUREMENTS

Most dimensions in the book are given in both metric and Imperial forms. Metric lengths are in centimetres or millimetres (*cm* and *mm*) and Imperial in fractions or decimal inches. Thin plates, such as soundboards, are usually given in decimal inches, eg. 0.060" rather than 1/16", which is almost, but not quite 0.060". (1mm is very close to 0.040") Sometimes only Inch fractions are used where there is a convention for that usage, such as saddle widths or drill sizes. A table of conversions is included in the Appendix.

MATERIALS REQUIRED

OLD STYLE ISLAND SOPRANO

What You Need

Soundboard: One piece of hardwood 25cm/10" long, 15cm/6" wide, 3-5mm thick that will be reduced to 1.5mm/0.060" thick.

Back: One piece of hardwood 27cm/10½" long, 15cm/6" wide, 3-5mm thick that will be reduced to 1.5mm/0.060" thick. The extra length allows for the button glued to the base of the heel.

Sides: 2 pieces 50cm/20" long, 6cm/2⅜" wide, 1.5mm/0.060" thick.

Neck: One piece 6.5cm/2½" x 6.5cm/2½" x 35cm/14" for a neck cut out of a solid or laminated block. One piece 6.5cm x 2cm x 45cm/2½" x ¾" 18" for a built-up, scarf-joint neck.

Braces: 6 pieces 5mm x 10mm by 15cm/3/16" x 3/8" x 6" spruce.

Kerfed Linings: 4 pieces 5mm x 7mm x 50cm/3/16" x 9/32" x 20" ***or*** 6 x solid linings 2.5 x 7mm/3/32" x 9/32".

Tailblock: 6.5cm x 5cm x 15mm/2⅜" x 2" x 5/8") laminated or solid softwood.

Bridge: 6cm x 1.5cm x 8mm/2⅜" x 5/8" x 5/16" hardwood, an off-cut from the neck can be used.

For the body and neck any light/medium timber used by guitar builders is suitable, including koa as well as mahogany, Australian blackwood, mango, monkeypod or other relatively light-weight and resonant hardwood.

CHICAGO STYLE SOPRANO

What You Need

Soundboard: One piece of hardwood 25cm/10"long, 17cm/6¾" wide 3-5mm thick that will be reduced to 1.5mm/0.060" thick. Two narrower book-matched pieces of timber could also be used for the soundboard and back.

Back: One piece of hardwood 25cm/10"long, 17cm/6¾" wide thicknessed to 1.5mm/0.060" thick (add 1.5cm/⅝" if an integrated neck is used to allow for the heel cap).

Sides: 2 bookmatched pieces 50cm/20" long, 6cm/2⅜" wide, 1.5mm/0.060" thick.

Neck: One piece of hardwood 6.5cm x 6.5cm x 35cm/2½" x 2½" x14" for a neck cut out of a solid or laminated block or one piece 6.5cm x 2cm x 45cm/2½"x ¾" x 18" for a built-up, scarf-joint neck.

Fretboard: 30cm/12" long x 5cm/2" wide x 4mm/0.160" thick hardwood. Ebony or rosewood are often used on more expensive instruments.

Braces: 6 pieces 5mm x 10mm x 15cm/3⁄16" x ⅜" x 6" spruce.

Kerfed Linings: 4 pieces 5mm x 7mm x 50cm/3⁄16" x 9⁄32" x 20"long ***or*** 6 x solid linings 2.5 x 7mm/3⁄32" x 9⁄32".

Neckblock: 5cm x 5cm x 18mm/2" x 2" x ¾".

Tailblock: 6cm x 5cm x 12mm/2¾" x 2" x ½" laminated or solid softwood.

Bridge: 6cm x 1.5cm x 8mm/2⅜" x ⅝" x 5⁄16" hardwood, an offcut from the neck can be used.

Most soprano ukuleles were originally made entirely from light/medium density hardwoods such as koa (*acacia koa*, a native Hawaiian hardwood) or mahogany. More recently other timbers such as Australian blackwood, mango or monkeypod have been used. Alternatively a softwood, such as spruce, Western Red cedar or redwood may be used for soundboards. The softwoods should be used a little thicker than a hardwood, perhaps 1.75mm/0.070" for spruce and 2mm/0.080" for cedar or redwood.

CONCERT

What You Need

Soundboard: 2 bookmatched pieces 32cm/13" long, 10cm/4" wide, 3-5mm thick (or one piece 20cm/8" wide thicknessed to 1.5mm/0.060").

Back: 2 bookmatched pieces 32cm/13" long, 10cm/4" wide, 3-5mm thick (or one piece 20cm/8" wide thicknessed to 1.5mm/0.060").

Sides: 2 bookmatched pieces 50cm/20" long, 7cm/2⅝" wide, 1.5mm/0.060" thick.

Neck: One piece of hardwood 6.5cm x 6.5cm x 35cm/2½" x 2½" x 14" or a piece 6.5cm x 2cm x 45cm/2½"x ¾" x 18" for a built-up, scarf-joint nec.

Fretboard: 30cm/12" long by 5cm/2" wide by 4mm/0.160" thick hardwood (ebony or rosewood suggested).

Braces: 6 pieces 5mm x 10mm by 15cm/3⁄16" x ⅜" x 6" spruce.

Kerfed Linings: 4 pieces 5mm x 7mm x 50cm/3⁄16" x 9⁄32" x 20" long ***or*** 6 x solid linings 2.5 x 7mm/3⁄32" x 9⁄32".

Tailblock: 6.5cm x 5cm x 12mm/2⅜" x 2" x ½" laminated softwood.

Bridge: 6cm x 1.5cm x 8mm/2⅜" x ⅝" x 5⁄16" hardwood, an offcut from the neck.

Many concert size ukuleles are made with hardwood soundboards in the usual manner of a soprano. Alternatively a softwood, such as spruce, Western Red cedar or redwood may be used. The softwoods should be used a little thicker than a hardwood, perhaps 1.75mm/0.070" for spruce and 2mm/0.080" for cedar or redwood. For the body and neck many timbers used by guitar builders are suitable, including koa, mahogany, Australian blackwood, mango, monkeypod or other relatively light-weight and resonant hardwood.

TENOR

What You Need

Soundboard: 2 bookmatched pieces 35cm/14" long, 12.5cm/5" wide, 3-5mm thick (for ease of joining), with a final thickness of 1.75mm/0.070".

Back: 2 bookmatched pieces 35cm/14" long, 12.5cm/5" wide, 3-5mm thick, final thickness 1.75mm/0.070".

Sides: 2 bookmatched pieces 52cm/21" long, 7.5cm/3" wide, 1.5-2mm/0.060-0.080" thick.

Neck: A piece of hardwood 6.5cm x 6.5cm x 40cm/2½" x 2½" x 16" if cut from a solid block or a piece 6.5cm x 2cm x 57cm/2½"x ¾" x 22½" for a built-up scarf-joint neck.

Fretboard: 35cm/14" long by 5cm/2" wide by 4mm/0.160" thick hardwood (ebony or rosewood suggested).

Braces: 7 pieces 5mm x 10mm by 20cm/3⁄16" x 3⁄8" x 8") spruce.

Kerfed Linings: 4 pieces 5mm x 7mm x 57cm/3⁄16" x 9⁄32" x 22½" long ***or*** 6 x solid linings 2.5 x 7mm/3⁄32" x 9⁄32".

Neckblock: 25mm deep x 62mm high x 50mm wide/1" x 2½" x 2" mahogany (or similar) with the grain in the same direction as the sides. This is for a separate bolt-on neck.

Tailblock: 7cm x 5cm x 15mm/2¾" x 2" x 5⁄8" laminated or solid softwood.

Bridge: 10cm x 2.5cm x 10mm/4" x 1" x 3⁄8" hardwood, often rosewood or ebony.

Like concert size ukuleles, tenor and baritone size instruments can made with hardwood soundboards in the same manner as smaller instruments or a softwood, such as spruce, Western Red cedar or redwood may be used. The softwoods should be used a little thicker again than a hardwood, perhaps 2mm/0.080" for spruce and 2.25mm/0.090" for cedar or redwood. For the body and neck just about any timber used by guitar builders is suitable.

BARITONE

What You Need

Soundboard: 2 book matched pieces 40cm/16" long, 15cm/6" wide, 3-5mm thick, to be reduced a final thickness of 2mm/0.080".

Back: 2 bookmatched pieces 40cm/13" long, 15cm/4" wide, 3-5mm thick to be reduced a final thickness of 2mm/0.080".

Sides: 2 bookmatched pieces 58cm/23" long, 10cm/4" wide, 1.5-2mm/0.060-0.080 thick.

Neck: One piece (solid or laminated) hardwood 6.5cm x 8cm x 45cm /2½" x 3¼" x 18" or a piece 6.5cm x 2cm x 60cm /2½"x ¾" x 24" for a built-up scarf-joint neck.

Fretboard: 40cm/16" long by 5cm/2" wide by 4mm/0.160" thick hardwood (ebony or rosewood suggested).

Braces: 10 pieces 5mm x 10mm by 30cm/3⁄16" x 3⁄8" x 12" spruce.

Kerfed Linings: 4 pieces 5mm x 7mm x 58cm/3⁄16" x 9⁄32" x 23" long ***or*** 6 x solid linings 2.5 x 7mm/3⁄32" x 9⁄32".

Tailblock: 9cm x 5cm x 15mm/3⅝" x 2" x 5⁄8" laminated or solid softwood.

Bridge: 10cm x 2.5cm x 10mm/4" x 1" x 3⁄8" hardwood, often rosewood or ebony.

NOTE: For all sizes of ukulele wherever possible all timber should be quarter sawn. Kerfed linings, in larger size for guitars or smaller for ukuleles, are available from most lutherie supply shops.

TOOLS

Most of the tools listed below will be standard in a woodworker's workshop, but there will be some specialised instrument building tools as well.

STATIONARY POWER TOOLS

Bandsaw - a 14" saw will allow the preparation of parts for just about any ukulele. A ¼" wide, 6 tooth per inch is a good general purpose blade with wider blades commonly used for resawing.
Drill press - a mid-size bench mounted model with a ½" chuck and a selection of standard twist, brad point and Forstner bits. A useful addition is a Safe-T-Planer (originally made by Wagner, but now by Stewart MacDonald) which is useful for thicknessing pegheads.
Disk sander - a 8-12" disk sander.
1HP+ router mounted on a dedicated router table.
Wide belt drum sander - for ukuleles a small model with a 10" wide drum could be used, but larger sizes can be more versatile.
Useful but not essential...
Oscillating spindle sander
Thickness planer - such as a 12" Delta or similar
Jointer - a 6-8" model with a reasonably long bed
Small table saw with a .023" kerf fret slotting blade.

SMALL POWER TOOLS

Electric drill, mains powered.
Drill/driver, battery powered.
Laminate trimmer for binding jig.
Orbital sander, for backs and soundboards.
Dremel, or similar, with various accessories.

HAND TOOLS AND OTHER USEFUL THINGS

Hygrometer and possibly, depending on your climate, a humidifier or de-humidifier
(target is 40% relative humidity)
Clamps - you can never have too many
- 6-8 small cam clamps
- 4 large cam clamps
- an assortment of G and F clamps or you might know them as C and bar clamps
- several dozen spring clamps for kerfing (wooden clothes pegs or small plastic type)
- spool clamps made from threaded ¼" metal rod (or bolts) with discs of wood or polypropylene cutting board material. The clamping surfaces of wood discs should be covered in thin cork sheet.

Bench vice - preferably a Versa-Vice or Parrot vice which can rotate
Chisels - a range from ⅛" - 1"
Planes - a long shooting plane for joining plates, a smoothing plane, a block plane (a Veritas apron plane is a useful one)
Cabinet scrapers: straight and curved
Sharpening stones and honing guide
Cork sanding blocks
Machinist's square
Sliding bevel
Screwdrivers
Bradawl
Plastic compass for determining angles
Saws - razor saw, fretting saw, jewellers saw (for inlay)
Exacto knife or violin makers knives
Files: smooth mill file for fret levelling
Fretting hammer
Wood rasp, Surform or Microplane rasp, spokeshave for neck carving
Rulers - 6", 12" and a longer one, preferably in both imperial and metric that will allow measurements of 1/100" and 1/10 mm for fret placement
Dial calliper for measuring thickness of sounds, back and sides
Fret cutters (flat-head nippers)

A shop-made spool clamp from a 3" x ¼" bolt with the discs cut from a polyethylene chopping board with a 1½" hole cutter.

LUTHERIE SPECIFIC TOOLS

Purfling cutter for binding ledges such as the Ibex Purfling Cutter or the Schneider gramil
Fret crowning file
Nut slotting files
Violin peg reamer (1:30 taper)

CONSUMABLES

Glues

wood glue (Titebond or LMI yellow glue) and/or hot hide glue
cyanoacrylate (superglue)
Weldbond 16 (or similar solvent based cement) glue for plastic binding
epoxy: a good quality 30 minute epoxy for fretboard gluing, a finishing resin for sealing/grain filling and a hardware store '5 minute' for inlays

Masking tape for binding
Sandpapers: 80, 120, 180, 240-grit aluminium oxide and 400-grit up to as fine as you want wet & dry paper for frets and finishing
Finishing and buffing materials (see the chapter on finishing for options)
Offcuts of plywood, acrylic sheet, cork sheet, leather and wood for clamping cauls

Three different purfling/binding cutters. A Schneider gramil, an Ibex purfling cutter and a shop made version from scrap maple and an old chisel blade.

BUILDING FORMS

The ukuleles in this book are built on a variety of forms which are described in each chapter. The 'old island style' soprano ukulele uses an inside form on a base plate with rope and wedges holding everything in place. This is a now almost forgotten methodology documented in a 1917 film made by the Ford Motor Co. Modern soprano ukuleles are more often built using either of the two building forms described below.

The concert and baritone size instruments use a workboard in the style of a classical guitar solera, where the instrument is assembled face down on the workboard with the sides glued into slots cut into the neck itself. Workboards for soprano and tenor models can be made in the same way, adjusting the size as required.

CONCERT

The workboard starts off as a piece of 18mm/¾" plywood 51cm/21" long and 26cm/10½" wide. This is long enough for the body, the clamping caul for the tailblock and ending a few mm before the nut. Draw a centreline and trace the body outline, with the tail end of the body starting 35mm/1½" from the end. Trace a line around the outline that is 35mm/1½" outside it. Mark the neck support, from the end of the body, 5cm/2" wide and cut out the shape. The neck

A solera workboard for a concert size ukulele.

support extension should end 1cm/½" or so before the nut. Sand the cut end smooth and mark the centreline on the sanded face. This is used to align the neck when it is glued to the soundboard.

A tailblock clamping caul can be made from plywood or solid timber. It is 5cm/2" wide, 6cm/2⅜" high and thick enough that two ¼" hanger bolts can be inserted in the bottom to hold it firmly to the workboard with wing-nuts. The hanger bolts should be fixed at 2.5-3cm/1-1¼" centres and two slots cut from the end of the workboard to match. One side needs to be shaped to the curve of the tail and a notch cut in the bottom to clear the overhang of the soundboard.

To hold the sides to the planned shape, 6cm/2⅜" lengths of 3cm/1¼" dowel are also clamped to the workboard with hanger bolts and wing-nuts. At least three on each side are needed, but five can give more control over the final shape. Individually shaped blocks could be used, but the large dowels can be used anywhere around the perimeter, just touching the side at one point. Again, a notch is taken out on one side at the bottom, to clear the soundboard overhang.

A 15mm/⅝"hole is drilled is drilled on the centreline of the workboard in the middle of where the soundhole will be. It is that diameter to take a short length of metal curtain rod which acts as an axle for a sandpaper lined dished workboard that will be used to shape the sides to the body taper and the arched back braces. The axle and relevant hole can of course be whatever size and material is convenient and available.

Two pieces of timber (5 x 2.5cm/ 2"x1" pine is fine) are attached to the underneath of the workboard. These support the workboard off the surface of a workbench or allow the workboard to be clamped in a vice. One piece is placed lengthways and secured by two countersunk screws from the top. It needs to be short enough to clear the wing-nuts for the tailblock caul and stop halfway along the neck. The second is notched over the top of the first across the widest part of the body and similarly screwed into place.

A ¼" or M6 thread T-nut can be fitted into the lengthways piece of timber in the centre of the hole drilled for the sanding disk axle. The photo of a workboard on the previous page shows an alternative approach with the T-nut hole in front of the axle hole and the T-nut mounted in the underside of the workboard itself. A bolt fitted to the T-nut can hold down the soundboard firmly to the workboard using a simple clamping system across the two transverse braces. The bottom photo on page 83 shows such a clamping system. It MUST be removed before the back is glued in place.

An optional addition is to fix a number of wood screws around the edge that can act as anchors for large rubber bands which can be used to clamp the back in place for gluing.

BARITONE

The solera workboard for the baritone ukulele is 60cm/24" long and 32cm/12½" wide. The tailblock caul is 8.5cm/3⅜" high and 5cm/2" wide. There are six other slots on each side for dowel side supports.

BODY MOULDS

The bodies of the tenor and the Chicago style soprano ukulele are constructed separately from the neck in an outside mould in the way commonly used for constructing steel string guitars. The neck is then attached to the body using a small bolt and a threaded insert fitted to the neck heel or set into a mortice in the neck block.

The mould is constructed in two halves and bolted together at each end. Two blocks are made by glue- laminating three or four pieces of plywood or MDF (or a combination of the two). The blocks need to be about 6cm/2⅜" thick - the height of the neck block. This might depend on the thickness of the materials available, the one used here was made from layers of 15mm plywood on the outside sandwiching two layers of 16mm MDF. The blocks are as long as the ukulele body plus 5cm/2" on each end and half the total body width plus 2.5cm/1" wide. For the tenor ukulele the initial size of the blocks was 14cm/5½" x 40cm/16". The corners are cut away to facilitate clamps that might be needed to hold the shoulders of the body outline firmly into the mould shape.

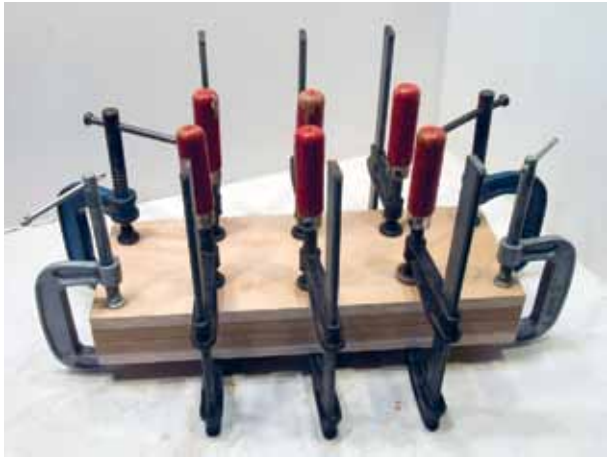
A 'spreader' at the waist is made from two layers of the plywood which are cut to the inside line of the waist. Two short pieces of threaded rod and four wing-nuts keep the spreader blocks in contact with the mould. The rectangular extensions at each end are cut squarely to allow a hole for a ¼" bolt to be drilled. These extensions are also a solid clamping caul for gluing the neck and tail blocks.

For the smaller soprano ukulele the two laminated blocks started out 10cm x 33cm/4" x 13" and 4.5cm/1⅞" thick.

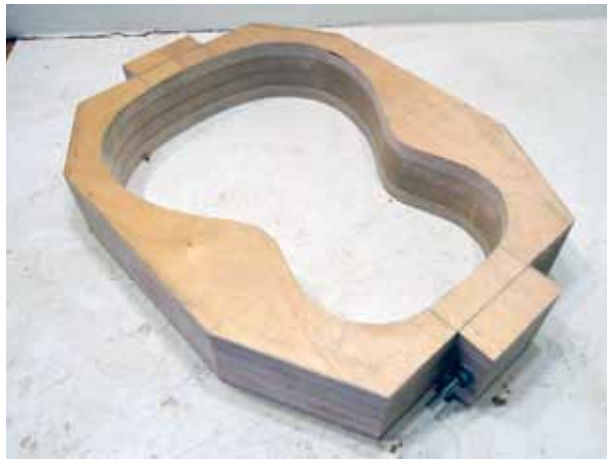
The external shape should be cut and the two blocks bolted together before the body outline is marked on the top surface. The halves can then be un-bolted and the inside waste cut out on a bandsaw. The shape can be refined with sanding drums or a spindle sander making sure to keep the inside shape square to the top surface.

Of course, any of the four sizes of ukulele can be made with any of these approaches, though the small size of a soprano instrument makes the bolt-on neck a little more fiddly to accomplish.

If a radiused sanding dish is used (as described on the next page) with a solid mould, a base plate will be needed to hold the mould and provide a location for an axle for the dish to rotate around. A piece of MDF is all that is needed with a couple of bolts to secure the mould and a hole drilled on the centreline for the axle. The Auxiliary Workboard described on page 25 can be used for this and other uses.



Laminating layers of plywood and MDF for a body mould.



The finished mould with the two halves held together with ¼" bolts.

Cutting the body shape out of a mould half.

A mould for a soprano ukulele with waist spreader blocks fitted.

RADIUSED DISHED WORKBOARDS.

These workboards are used for both gluing the back braces to a ukulele back and, when lined with coarse sandpaper, to shape the sides and blocks into a small section of a sphere. These are available commercially in a number of different radii, usually designed for guitar building use, but it is a simple and cheap device to build. A 15' radius is suggested for the back of a ukulele, but a tighter, 12', radius could also be used. Materials needed are two pieces of MDF or plywood 50cm/18" square, one 18mm/¾" thick and the other 3mm/⅛" thick as well as twelve pieces of dressed 50x25mm/2x1" pine that are around 21.5cm/8½" long.

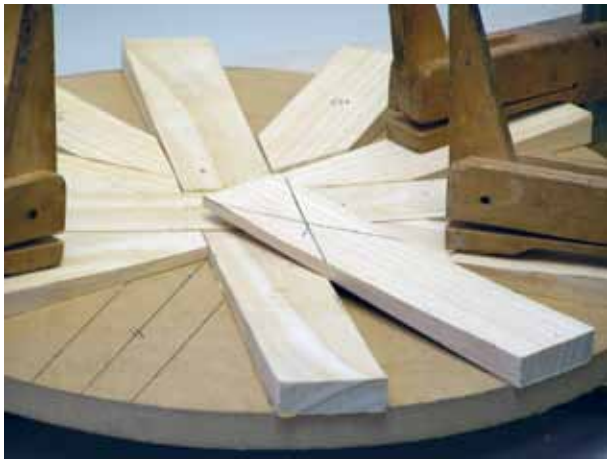
Drill a ¼" hole in the middle of both pieces of the MDF/ply and cut a 45cm/18" diameter circle. A piece of wood with a ¼" hole at one end and another 22.5cm/9" away to take a pencil makes a simple compass. Using the 15' radius pattern in the plans at the back of the book, cut curved strips from the lengths of 2"x1" pine. The pieces should end up 5mm/3⁄16" thick at one end and 10mm/⅜" thick at the other. Glue the first two so they butt together in the middle, and add the others, shortening them as required. Once all are in place sand any unevenness out and glue on the piece of 3mm MDF/ply, using a short length of ¼" dowel as an alignment pin through the centres. The best way to apply pressure is with go-bars in a go-bar cabinet. This is simply a rigid structure with a floor and ceiling and lengths of dowel the same length as the distance between floor and ceiling. Suppliers offer wood or fibreglass bars 24" in length, though longer ones are not a problem. Those shown are 105cm/42" in length and made from 10mm/⅜" dowel.

The hole in the centre should be enlarged to whatever size dowel or metal tubing there is available to use as an axle. In this case a short length of 15mm/⅝" metal curtain rod was used. The inside surface can be covered with strips of 60- or 80-grit sandpaper glued in place with contact cement. A knob or handle can be fixed to the back to help rotate the dish. It could also be mounted on a more

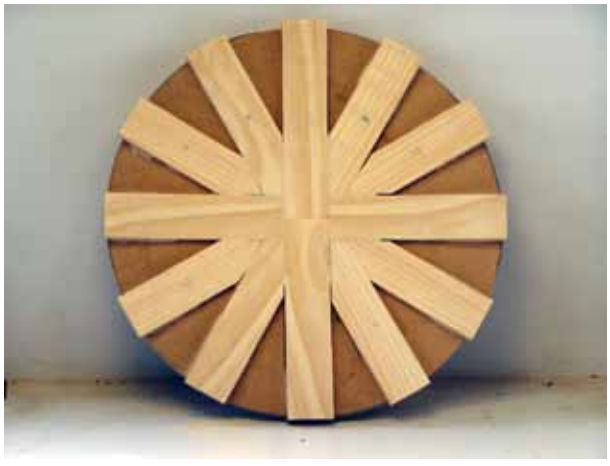
Gluing the first two curved strips.

Gluing strips three and four. These are trimmed shorter to meet the first two strips.

Gluing strips five to eight. These have been shaped to fit between the first four.



Marking the final four strips to fit.



All twelve strips glued in place.

The 3mm/⅛" MDF top plate glued into place in a go-bar deck.

permanent axle with the sandpaper side facing up and rotated by an electric motor in the manner of a potter's wheel.

AUXILIARY WORKBOARD

A useful addition is a workboard that can be mounted in a vice, especially one that rotates, and used for jobs such as brace carving where it is good to be able to get at the work from several angles. Holes can be drilled in the workboard for specific tools like circle cutters and radiused sanding disks. The one used here is 35cm/14" x 50cm/19" and made from a piece of 18mm/¾" marine ply screwed to a length of 10cm/4"x 5cm/2" hardwood 50cm/19" long, but they can be made to any convenient size.

Other pieces of plywood or melamine coated MDF can be used as flat sanding boards. A sanding board cut to the size of half a sheet of sandpaper (cut lengthwise) is useful for many jobs and a larger sanding board, the size of up to four sheets of sandpaper can be used for flattening neck blanks or levelling linings on the inside of the ukulele body.

HAWAIIAN SONG

FAREWELL
MY LOVE
(ALOHA OE)

AS SUNG BY THE ORIGINAL
TOOTS PAKA

CHAS. H. ROTH
MUSIC CO.
1777 BROADWAY, N.Y.

E. Pfeiffer N.Y.

CHAPTER 9
AN OLD ISLAND STYLE SOPRANO

The original Hawaiian instruments had smaller and more tightly waisted bodies than later instruments. C.F. Martin & Co introduced a line of ukuleles in 1916 that used a slightly larger and rounder shape that is still a standard and the Chicago factories made similar, if not as refined, instruments by the tens of thousands.

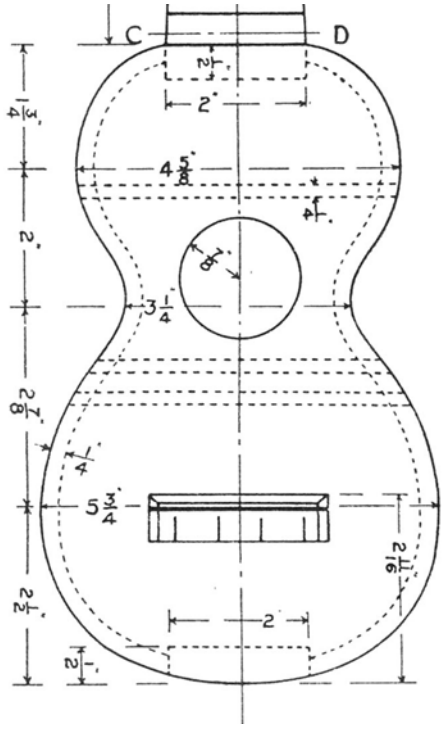
This soprano ukulele follows (more or less) an older methodology that was depicted in a short 1917 film produced by the Ford Motor Company. The person putting the instrument together was probably an employee of Manuel Nunes (who appears briefly) and the film shows a now almost forgotten approach to ukulele construction. It uses an inside mould sitting on a T base. The longer arm of the T holds the neck with a Spanish heel style of integral neck block, while the cross pieces support shaped cauls which are wedged to clamp the sides to the mould at the waist.

The neck is held in position by rope and more wedges while the sides are fitted into the neck block slots and the waist cauls wedged into place. The film does not show the fitting or gluing of the sides to the tail block, but that is achieved in some way, perhaps again using rope or a single clamp and a shaped caul. The back linings and a single arched back brace are fitted before the back is glued and held on with more rope. At this point it is removed from the mould and the soundboard linings and two transverse braces are fitted. A large caul is then used to clamp the soundboard in place, probably with more rope as well as a G-clamp on the neck. This ensures that the neck and soundboard are kept in the same plane. The frets are inserted into slots cut into the neck itself before a bridge is fitted and the instrument polished.

There is a lot not shown in the film, such as the preparation of the thin pieces of wood used for the sides, the cutting of the fret slots and attaching the bridge. The film is less than three and a half minutes long, but there is enough information there to use as a basis for making a simple ukulele in what we might call an *Old Island Style*, though the methodology is probably as much Madieran as Hawaiian.

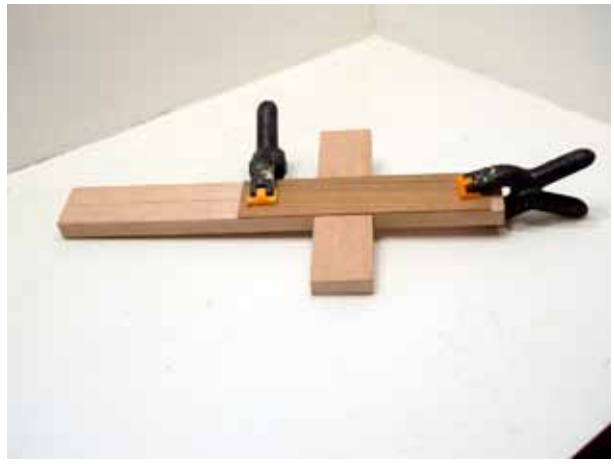
This design of this ukulele is based on an article written by a Los Angeles 'manual arts' teacher, John Bangerter, and originally published in the December 1915 edition of *The Industrial Arts Magazine*. The article included the plan of a ukulele and this instrument is a combination of the Ford company's film and Bangerter's article and plan. Ukulele historian John King republished it on his *Nalu Music* website, noting Bangerter's rather fanciful ideas about fret placement.

Many thanks to ukulele maker Ken Timms for his inspirational interpretation of the Ford film.



MAKING THE MOULD

The mould can be made from whatever stable materials there are on hand. The inside form itself has been made from two pieces of 18mm/3/4" marine ply cut out 1.5mm/.060" smaller than the outside plan of the instrument. A card template can be cut out 1.5mm/.060" smaller than the outside shape, which will also be useful when shaping the tailblock. The neck support and cross-piece are from a piece of scrap hardwood. The neck support was machined to 5cm wide, as this is the maximum width of the neck and the cross pieces to 3cm/1.25". The inside form was shimmed 1.5mm/.060" above the lengthwise neck support so that when the sides are fitted into the slots in the neck, they can be lined up with the bottom of the inside form, and leave space for the soundboard to be attached in the same plane as the neck. The thickness of the inside form has been trimmed 6mm/.25" towards the neck to allow for the body taper and the linings to be glued into place. The waist cauls are offcuts from the cutting out of the inside form and shaped to allow for the 1.5mm/.060" thickness of the sides.



Gluing the soundboard shim to the mould base.

The finished mould with the waist cauls and wedges.

Below: Cutting out the inside mould.

Below: With the waist cauls wedged into place.

THE NECK

This style of construction requires that the neck be mostly complete before the rest of the construction. The simplest approach is to cut the neck profile from a dressed 5cm/2" square quarter-sawn block of timber 35cm/14" long. The widest section of the fingerboard, where it meets the body is 5cm/2" wide and the depth of the body at the neck join is 4.5cm/1¾", so the 5cm/2" is the minimum width. If the block is a little wider that will allow more flexibility in the shape (or at least width) of the head, but that is not essential.

Cutting the fret slots into the top surface of the neck. The saw is fitted with an adjustable stop for consistent depth of the fret slots.

Any of the other neck construction methods as outlined in **Chapter 6** can be used if a suitable 5cm/2" square piece of wood cannot be obtained.

As the frets are to be inserted directly into the neck itself, it makes sense to cut the fret slots while the neck is still a square block. The 12th fret is placed where the neck joins the soundboard and there needs to be 13mm/½" of neck extending into the body. The suggested 35cm/14" length of the block allows a bit extra at either end, so mark the 12th fret position 2.5cm/1" from the end of the block and the rest along the the length of the block, adding another 3mm/⅛" past the 0 fret so a slot can be chiseled out for a nut. Cut the slots 3mm/⅛" deep. Sand the top surface to 180-grit and mark a centreline with a pencil.

As the 12th fret gets placed right on the line where the neck joins the soundboard, the slots cut into the neck to accept the sides must be straight and at right angles to the centreline. (On a classical guitar these slots are angled by a degree or two to follow the curve of the upper bout.) The slots need to be 1.5mm/.060" wide with the front of the slot on the line of the 12th fret. Cut the slots (with whatever kind of saw you want) to within 3mm/⅛" of the centreline of the top surface of the neck.

The neck profile sawn after the side and fret slots have been already cut.

The rest of the neck profile can then be cut out. On the side of the block mark a 14° line from the back of the nut slot the length of the head required, usually 10-11cm/ 4-4½". The head should be 10mm/⅜" thick at the end gradually getting a little thicker towards the nut. The neck should be 13mm/½" thick just in front of the nut and 18mm/¾" thick between the 8th and 9th frets. From that point it curves down to the heel. Cut the block to 4.5cm/1¾" down from the fretboard surface at the heel, which should extend 1cm/⅜" in front of the slots cut for the sides. There should also be 13mm/½" of block extending into the body behind the slots. Cut this off square and sand the end-grain smooth. It can be worthwhile sealing the end-grain with shellac.

Planing the top surface of the head.

Plane the top surface of the head smooth and down to the marked line. A ledge the thickness of the soundboard (1.5mm/.060") needs to be cut away from the top of the neck where it extends into the body. The top of the neck and the outside of the soundboard need to be in the same plane. This was the reason for the spacer between the base and the inside form of the mould.

Chiseling the soundboard ledge, which is the same depth as the shim on the base of the mould and the thickness of the soundboard.

The neck can now be tapered toward the nut, which is 35mm/1⅜" wide, and the shape of the head cut out. This is most easily done on a bandsaw with the fretboard surface face down on the saw table and the trim lines marked on the back of the neck. Cut 1mm/1/32" or so outside the line to allow for final shaping.

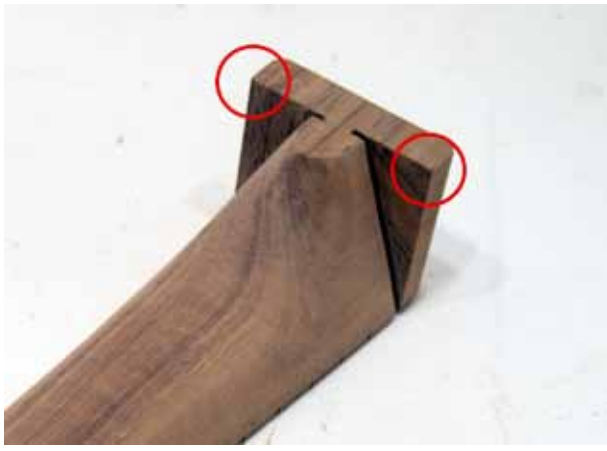
Mark and drill pilot holes for the tuners, again with the bottom surface of the head facing down on the drill-press so the holes are vertical in relation to that surface. The head tapers in thickness and if geared tuners are used it is better if the holes are perpendicular to where they are mounted.

Drilling pilot holes for the tuners. If violin style tuners are used the hole should be slightly larger than the minimum diameter of the reamer.

Using a chisel refine the shape of the neck from the 12th fret to the nut. Continue the line of the neck into the flare of the head shape and finish shaping the head outline.

The heel needs to taper from 5cm/2" wide on the top surface to 1cm/⅜" wide where it meets the back, leaving the neck extension its original size to add gluing area when attaching the back. Start the heel taper from the bottom of the fret slots. Once the basic heel taper is carved, the shaping of the neck shaft can begin, starting the cross-section curve of the neck from the bottom of the fret slots.

Carving the neck shaft.



The red circles mark where the neck extension should be slightly relieved so the sides can fit more neatly (see text below).

The back of the finished neck.

Carve away the front of the neck block extension as it gets revealed by the heel taper. Even though the sides need to be straight as they fit into the neck slots, if the bottom corners of the neck block are relieved by 1.5mm/1⁄16" or so, it makes a more attractive curve of the back as it reaches the neck. The bent sides should happily fit to the curve while being forced straight at the soundboard edge. The red circles in the photo above indicate the point of maximum relief on the neck block.

The plans contain cross section shapes for the neck at the 1st and 8th fret positions. The neck is a series of continuously changing curves from the heel to the flat back of the head. The neck can be held in a bench vice or mounted on a cradle that supports the head and along the centreline. It can be done with any combination of chisels, rasps, micro-planes or powered sanding drums. The important thing is that it feels comfortable in the hand when playing and the curves flow into each other when looked at from any angle. Sand to 180-grit.

The neck ready for assembly. The figure-of-eight shape for the head was commonly used on some of the early Hawaiian made instruments.

THE TAILBLOCK

A solid or laminated tailblock (See **Chapter 5**) 5cm/2" wide, 5.3cm/2⅛" high (a little longer than the sides are wide to allow trimming) and 13mm/½" thick should be made. The outside should be shaped to match the curve of the sides at the tail.

THE SIDES

The sides on this little soprano need to be 35cm/14" long, 5cm/2" wide and 1.5mm/.060"thick. It is best to allow another 2.5cm/1" at each end to make the bending easier. The sides can be bent to shape by any of the methods discussed in **Chapter 5**, keeping an overall 5cm/2" width. Consider the grain patterns of the two halves and arrange the bending so where the sides meet at the tail the grain is closest to a mirror image or book-match. Also remember that as the sides enter the neck slots that will be straight on the soundboard edge and curved slightly at the back edge.

Attach the neck to the base of the mould. In the 1917 film, this is done by lashing the neck to the mould with rope and tightening that with one or more wooden wedges tapped in underneath. The two slots for the sides should line up to the edges of the inside form. Trim the neck ends of the sides so there is 22mm/⅞" of *almost flat* section that will be inserted into the slots in the neck. The curve of the sides should start immediately outside the neckblock extension and follow the curves of the form closely. Do not worry if the rest of the curves are a little out of shape. The waist cauls and wedges will pull the sides into closer contact with the form, but the initial curve from the neck is important.

The neck lashed to the mould base, the sides held in place by the waist cauls and the tailblock clamped to the sides.

The length of the sides need to be trimmed so they meet exactly on the centreline of the tailblock, while following the curves of the inside form as closely as possible. The ends should be exactly square to the soundboard edges of the sides. It is better to have the sides a little short rather than too long and bulge out from the form. A small gap at the tailblock can easily be filled later by an offcut from the soundboard or back, but it does look good to have a tight join at the tail.

If there is a high degree of confidence that the sides are the right length, the tailblock can be glued to the sides, off the form, and then returned to the form for gluing the sides into the neck slots.

GLUING THE NECK AND SIDES

The methodology illustrated in the film for this step is simple and direct. Glue is applied to slots in the neck and the sides inserted. The waist cauls and wedges are fitted and, in some way that is not shown in the film, the sides are glued and clamped to the tailblock. The obvious way to do this is with a clamp and the shaped caul mentioned above. The important thing to remember is to line up the soundboard edge of the sides with the lower edge of the inside form, leaving the sides the thickness of the soundboard (1.5mm/0.060") above the top surface of the neck (where the frets will be inserted).

This is another of the those procedures where it is useful to go though the processes a couple of times without glue to feel how it all goes together.

TAPERING THE SIDES AND FITTING THE KERFED LININGS

The sides need to taper from 5cm at the tail to 4.5cm at the neck heel. The modern way to do this is with a concave sanding dish lined with coarse grit sandpaper. These would be typically shaped to a 4.6m/15' radius and the back braces shaped to suit. The backs of the larger tenor and baritone ukuleles are done this way, but on this very small soprano instrument the simpler old Spanish method works fine. This involves simply shaping the sides with a small plane or chisel so when viewed from the side there is a straight line from the tail to the neck heel. A half sheet sanding block covered with 80-grit paper is useful for the final touches. The important thing to keep in mind is maintaining equal height on both sides. Check at the waist and the widest points of both the upper and lower bouts.

The linings are lengths of softwood 7mm x 5mm/ 9/32" x 3/16" with slots cut into the wider edge to allow the strip to be bent around the curves of the sides in the mould. The slots can be cut with a simple fixture which is piece of 16mm/5/8" MDF the width of the bandsaw table with a slot cut which is a little less the depth of the blade. This is clamped at each end to the bandsaw table with the blade protruding enough for a 4-4.5mm/5/32" cut in the strips, leaving a 0.5-1mm/1/32" flexible web on one side. The bandsaw blade will want to move back and forth a little as the strip is fed in for one cut at a time, so it may take a

Tapering the sides with a small plane.

Below: Using a half-sheet sanding board to refine the sides as well as the neck and tail blocks.

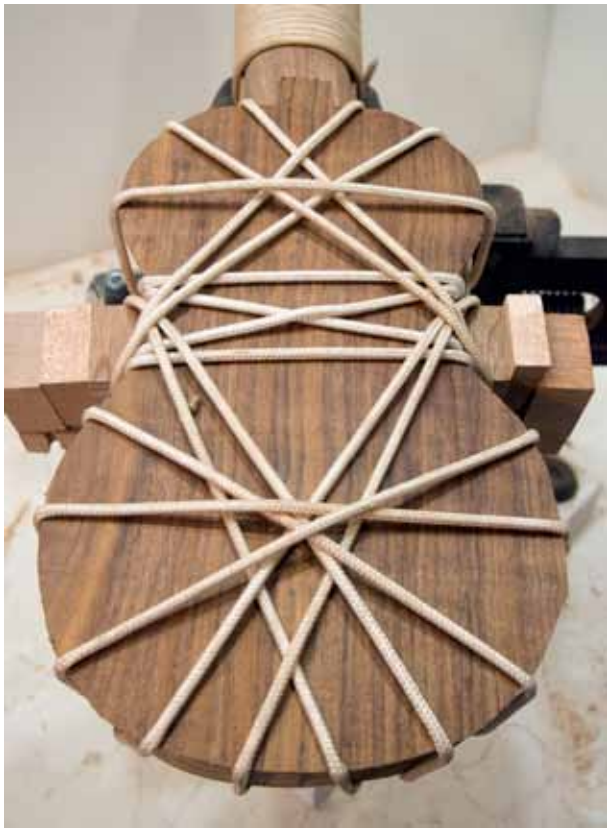
Gluing the kerfed lining for the back.

Below: Leve.ling the back linings.

little tweaking of the position of the MDF for the best results. The slots should be cut 6mm/¼" apart, and a pencil mark to one side of the blade will assist with regularity. There is a photo of the jig in **Chapter 5.**

A 30cm/12" length will be adequate for each side, so four are required. They should be flexible enough to be bent into shape around the inside of each side and fitted neatly between the neck extension and the tailblock. It should be possible to bend the lining strips without breaking at all, but they might well want to crack a little at each cut point. This is perfectly OK and will help keep the bent shape while gluing. Smear the face of each strip which is opposite the webbing with glue and clamp into place with clothes-pegs or very small spring clamps. They should be glued in place with .5mm/1/32" or so above the edge for later trimming. With the webbing on the inside of the body, rather than being glued to the side, this is known as "reverse-kerf lining".

Once the glue is dry, plane, chisel or sand the linings down to just above the level of the sides.



The back roped into place while the glue dries.

THE BACK BRACE AND GLUING THE BACK

The back on these instruments was almost always a single piece of koa around 1.5mm/0.060" thick, although some were a little thicker. They use only a single brace, 5mm/3/16" wide, on the back fitted around halfway along the body length, a little below the waist. This is notched into the linings and glued into place before the back is glued on. It should sit 4mm/5/32" into the linings and this one has 3mm/⅛" of rise to the middle, so the brace will have a total height of 7mm/9/32". Once the glue has dried, sand the slightly protruding linings and the sides to the slight bevel of the arch of the brace. This will make a cleaner join when the back is glued.

In the film the back is glued by wrapping the back and the entire mould with rope. This is an efficient and low-tech method of applying even gluing pressure, but it does need practice before doing it with glue. Up to 7-8m/25' of rope can be used and it has to be wrapped around evenly to ensure enough pressure especially at the neck, tailblock, the waist/brace and over the transverse brace.

The back needs to be only a millimetre or so larger than the outline of the sides. The thin timber can be easily split by the pressure of the rope if the overhang at the widest parts of the upper and lower bouts is any more than this.

THE SOUNDBOARD BRACING

Once the glue is dry after gluing the back, the assembly may be lifted from the mould. It should just slide off, once the rope holding the neck is removed. If necessary trim the tailblock to the height of the sides and repeat the process of installing the linings, again leaving them just a little above (.5mm) of the top edges of the sides. Sand the linings level and prepare two braces 5 x 10mm/3⁄16" x 3⁄8" from spruce or the same hardwood as the soundboard. Like the brace on the back, these two braces are glued into notches in the linings and the soundboard glued on afterwards. The ends of these two braces need to be scalloped so the ends are 3mm/1⁄8" high and can be supported by the linings. The face to which the soundboard will be glued is flat, without the arching of the back brace. The half-sheet sanding block can be used to level the linings, braces and tailblock.

THE SOUNDBOARD

Like the back, the soundboard was usually a single piece of timber. The simplest early ukuleles had no soundhole rosette or edge bindings, so all that is necessary is to cut a 22mm/7⁄8" radius soundhole at the appropriate spot once the wood has been thicknessed to 1.5mm/0.060". If a rosette is to be used, this is best inlaid while the soundboard is 3-4mm/0.120"-0.160" thick and the final thicknessing completed afterwards. The rosette can then be

The neck, sides and back assembly removed from the mould, showing the position of the back brace.

inlaid while around 1.5mm thick with a final depth of around 0.75-1mm into the soundboard. This maintains enough wood behind or below the rosette for structural integrity.

The rosette can be simple strips of purfling that contrast with the soundboard timber, such as maple for a koa soundboard. 2mm x .5mm/0.080-0.020" purfling strips are available from lutherie supply houses, as well as .7mm/0.028" thick sheets of veneer in various colours from which strips can be cut.

There are various ways the rosette grooves can be cut in the soundboard. A Dremel (or similar) miniature router with a small downcut bit in a jig which cuts a circular slot is one method. Both Stewart-MacDonald and Luthiers Mercantile sell bases for the Dremel, although they may need modification for the small radius circles used on ukuleles. Small, albeit fragile, spiral downcut bits are available in sizes from 0.5mm/0.020" up. Alternatively a simple device could be made with a small blade set into a block of wood that pivots on an old drill bit, and a cuts a single pre-determined radius circle the depth of which is set by the projection of the blade. There are also several commercial versions of this tool available.

A simple rope-binding rosette.

The better quality early Hawaiian ukuleles would often have a rosette made of a strip of rope binding matching that used around the soundboard edges, with a thin strip of purfling inside and out, separated by a couple of mm. **Chapter 4** details the construction of a rope rosette.

The soundboard in the Ford film is cut close to the body size with two small wings that fit either side of the neck to locate that end of the soundboard. The join of the sides at the tail should be on the centreline of the neck and body and this can be used to position that end of the soundboard for gluing. Care should be taken that the soundhole is centred on the waist and a pencil mark made where the soundboard will meet the tail join.

Gluing the soundboard linings.

Below: The soundboard braces glued into their notches.

GLUING THE SOUNDBOARD

The Ford film uses a large and rigid flat caul that is the shape of the body and neck to align and clamp the soundboard to the rest of the ukulele. The one illustrated is made of two pieces of scrap 18mm/¾" melamine faced MDF screwed together. The neck top surface and the soundboard need to be in the same plane, so after glue is spread on the blocks, linings and braces, the soundboard is placed in position, the caul placed on top and clamped to the neck shaft. Add another clamp over the tailblock and wrap the body and caul with rope starting from the waist to ensure there is clamping pressure on the two soundboard braces.

Once dry the overhang of the soundboard can be trimmed off with a chisel and sanded smooth.

A soundboard with no rosette ready to be glued to the body.

BINDING (OPTIONAL)

If a rosette was inlaid around the soundhole, matching binding was commonly installed. **Chapter 8** describes making and installing various kinds of binding and purflings.

These small old-style ukuleles have tight radius curves in the waist and around the upper bout. Binding strips need to be bent as accurately as possible to fit the rebates cut around the body edges.

The soundboard clamping caul.

Below: The soundboard roped (and clamped) in place.

FRETTING

The frets on the original Hawaiian ukuleles would have been 'bar frets', a strip of rectangular-sectioned nickel silver or brass around 1mm x 2mm/0.040-0.080". The film shows the builder tapping the frets with a hammer to distort one edge into a 'tang' so it would grip the timber more effectively. Bar fret material can be found, though not very easily, and requires a cleanly cut 1mm x 1mm slot cut into the surface of the neck. Modern T-shaped fretwire is easier to find, and a 50cm/18"length is all that is required. Ukulele/mandolin fretwire is typically around 1.3mm/0.053" wide.

The frets are inserted directly into the top surface of the neck. It was suggested that the fret slots be cut while the neck was still a right angled block of timber, but if not it will have to be done at this point. The edges along the top of the neck should be a smooth taper from the body to the nut. A sliding bevel can be used to set a consistent angle so the fret slots are cut at 90° to the neck centreline.

Even if the fret slots were cut earlier, it is likely that the 12th fret slot at the body join has been partially filled by the side, so that slot will need to be re-cut.

Sand the top of the neck/fretboard and the soundboard to 400-grit. Once the frets are in, it will be hard to do the finish sanding between the frets. Before inserting the frets it is also useful to bevel the top of the slots slightly with a small triangular file. A shaped support can be made (or a bag of lead shot used) to support the neck under where the frets are being tapped into place with a small hammer. The frets can be cut to slightly longer than is needed and cut to length after being inserted.

The ukulele ready for fretting.

Above: The 12th fret is pre-cut to exact length before being hammered into place.

Below: A bead of hide glue is wiped into the slots before the frets are inserted and the squeezeout cleaned up with warm water.

Koa is softer than the usual fingerboard materials if rosewood or ebony and the frets can be hammered in quite easily. Hot animal glue is a useful lubricant for inserting the frets and will also help hold them in place. It can also be cleaned up simply with warm water. Modern aliphatic glues such as Titebond are harder to effectively clean up on the fretboard and can show up later under a finish. File the fret tangs flush with the sides of the neck, and file a bevel on each end of the fret itself.

THE BRIDGE

The bridge on this ukulele is made from a single piece of timber, (an offcut from the neck) 60mm x 15mm x 10mm/2⅜" x ⅝" x ⅜". The finished height of the bridge will be 8mm/⅝", and the extra thickness to start with allows for four 4mm/⅝" holes to be drilled in the back edge for the string knots. Once drilled, the base of the bridge can be sanded or cut away to expose the bottom of the holes. The first part of **Chapter 13** deals with the construction of such a bridge.

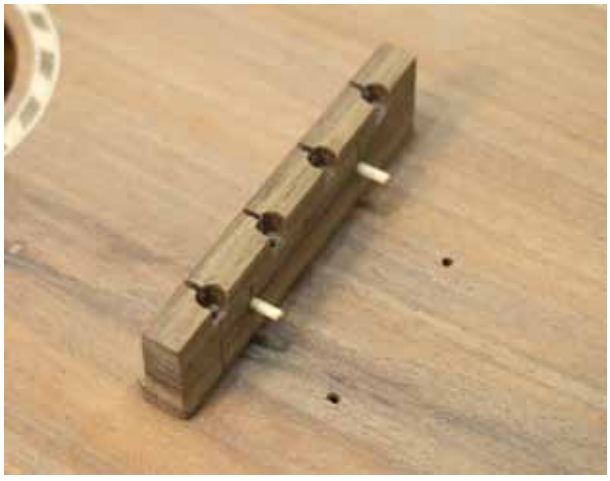
The bridge has to be located accurately and pinned into place while being glued. A pencil line was drawn on the soundboard, perpendicular to the centreline, at the calculated saddle position. Two 1/16" holes are drilled in the bottom of the bridge, only partially through. Two cut down 1/16" brass nails are inserted into the holes so only a short point extends out and the bridge accurately positioned and pushed down to mark the position of the nails. 1/16" holes are drilled and the nails replaced by wooden or plastic dowels - toothpicks are good.

The small size of the soundhole and the shallow body can make it hard to get a G-clamp the right size to fit through the soundhole and reach the bridge. An alternative is to insert a chock inside the body that will support the soundboard and back and allow the use of a couple of wooden cam clamps to be used from the outside. The chock is a short piece of softwood, slightly longer than the distance between the back and soundboard at the bridge position. The piece used was around 30mm/1¼" wide and 6mm/¼" thick and gently wedged so it sat under the bridge. A piece of scrap timber spread the pressure across the back as glue was applied and the bridge clamped into place. Hide glue is recommended for this, for strength and ease of cleanup.

FINISHING

Once the glue is dry the entire instruments can be sanded as described in **Chapter 16** and the finish of choice applied.

Below: The bridge, with toothpick locating pins, ready to be glued.



Below: The bridge clamped in place with a supporting chock between the bridge plate and the back.

NO

MY HONOLULU QUEEN

Sung by ANNA HELD in Papa's Wife

Words by Jas. O'Dea

Music by William H. Penn

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