NORTH CUMBRIA ORCHARD GROUP

BUILDING AN APPLE PRESS

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BASED ON A TALK GIVEN TO SOUTH LAKES ORCHARD GROUP, DECEMBER 6TH, 2011

Topics covered:

- Why build your own press?
- Design considerations
- Stress calculations
- Materials
- Construction
- Finishing
- Accessories
- Costs and Suppliers

WHY BUILD YOUR OWN PRESS?

COST

Vigo rack and screw cloth press costs £695. This takes 40kg apples in one pressing. My press is a similar capacity and costs about £250 - £350 (plus time).

CUSTOMISABILITY

You can make your own press to suit you requirements. E.g add castors, make it “knock-down” for transportability, etc.

MAINTENANCE

If you built it you know how to fix it if it breaks. Also you can add extra bells and whistles later.

SATISFACTION

DESIGN CONSIDERATIONS

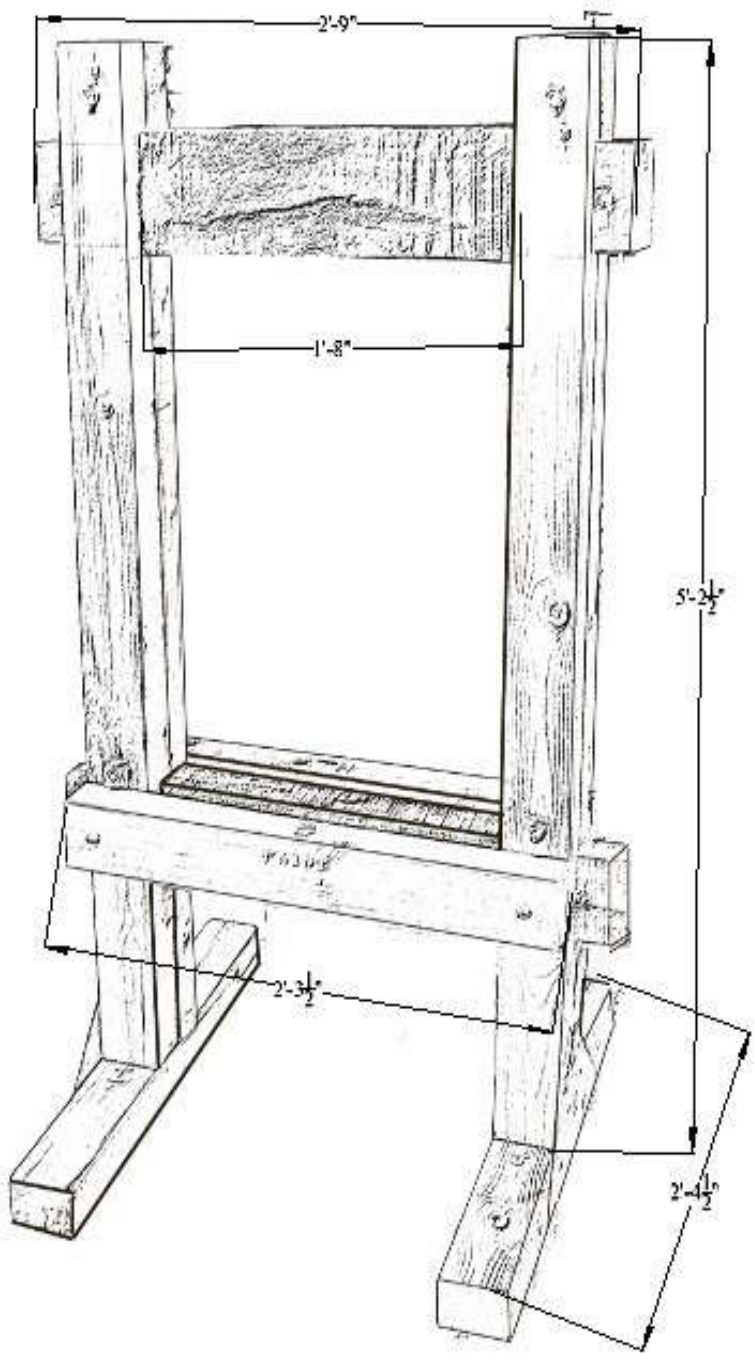
SIZE

Doesn’t make sense to make a small one – larger doesn’t cost much more. If you want a smaller one (than about 40kg) then a basket-type press may make more sense that a rack and cloth press. Vigo 20L cross-beam press is a good example at £345. Harder to make than a rack and cloth press.

Design will scale up fairly well, but need to use appropriate scaling factors (they're not all linear). Probably would benefit from making the whole thing a bit wider.

OVERALL DESIGN

See diagram below. A key feature is that the sides are used to ensure that the cheeses get built vertically.



TRAY SIZE

The tray size is what determines the span of the top beam. Bear in mind that you need to leave at least 2 inches all the way round the cheeses, to the inside edge of the tray so that juice drips into the tray not on the

floor. If you are buying the tray rather than making it, it would be sensible to do this before finalizing the size of your press.

JACK SIZE

Jacks come in a variety of sizes, exercising from 2 to 40 tons of force. Larger jacks will give better performance (approx 5% for each doubling, up to a point) but need the frame to be more sturdily built. 8 tons is a good size for a 16" cheese – beyond that and the additional cost is not justified by the additional yield.

MATERIALS

Main choice is between wood and steel. Both will work. Mine is from wood, because I can work wood. It's also easier for the novice to make. However, stainless steel for the tray is best if you can get it.

TOP BEAM

This is the most critical item as it takes a lot of strain. Main risks are snapping in the middle, bending sideways and tearing at the joints. Stress calculations and joint construction are critical.

STRESS CALCULATIONS

So we need to calculate the size of the top beam (in wood). First, some definitions:

F= the allowable fibre stress (i.e. how strong the wood is)
b= the width of the beam
d= the depth of the beam
l= the span of the beam (between the supports)

Now some sums

Max load at the centre of the beam = $P = {Fbd^2}/{kl}$
where k is a constant which depends on the units used. For imperial units, $k = 1.5$

Observe that the max load goes up with the square of the depth of the beam. So, if you double the length, then you only need to increase the depth by about 50% to sustain the same load.

However, also need to consider the deflection of the beam, which depends on the "modulus of elasticity" of the wood, rather than its strength. If E= the modulus of elasticity, then:

Deflection of the beam = y $= K \frac{P}{E} \frac{l^3}{bd^3}$ (where K is another constant: 0.25 for imperial units))

Now observe that the deflection goes up with the cube of the span and down with the cube of the depth, so if we double the span but only increase the depth by 50%, the deflection will increase by $({2}/{1.5})^3 = 2.37$ i.e. more than twice the deflection. Whether or not this matters depends on the absolute numbers involved, but it is also worth noting that sideways deflection may also be important. If the beam is too narrow, then any off-centre deflection of the jack will apply a sideways load which may bend the beam: the sideways load will then increase and risk snapping the beam sideways (or permanently bending a metal beam).

So much for the theory, what about some actual numbers?

Wood	Fibre stress propn'l limit (psi)	Modulus of rupture (psi)	Modulus of elasticity (psi * 10^6)
Oak	8000	14000	1.60
Ash	8900	15400	1.77
Pine	6500	9800	1.34

The FSPL is the limit beyond which damage will occur, although it won't actually break until the pressure reaches the modulus of rupture. From this it is clear that ash is the best wood, being both stronger and more elastic. This is why it was used in longbows. Oak is good, but it is important to make sure that the grain is reasonably straight and free of big knots. Pine is a poorer choice, particularly if it has knots which will reduce the strength: it will therefore need to be larger than an ash or oak beam. We will use the FSPL in our calculations.

A typical 6 inch beam (the size of mine in oak) should support almost 13 tons, if it is free of defects and has a straight grain. I use an 8 ton jack, so that sounds more than enough, but my beam is not straight or knot-free. To make the ash and pine beams to the same strength, we would adjust the depths as follows:

Wood	Beam 1			
	Span (in)	Depth (in)	Width (in)	Max load (ton)
Oak	20	6	3	12.9
Ash	20	5.7	3	12.9
Pine	20	6.7	3	12.9

The deflection for each of these would be:

Wood	Beam 1			
	Span (in)	Depth (in)	Width (in)	Deflection (in)
Oak	20	6	3	0.06
Ash	20	5.7	3	0.06
Pine	20	6.7	3	0.05

As can be seen, the deflection in all cases is fairly low.

Some further calculations along these lines show that if using pine 1 inch thick, you would need a depth of 10.6 inches. If the load started to go sideways on this beam, then it would soon deflect sideways and exceed the sideways load of 1 ton.

For all of these reasons 6 x 3 is a reasonable size for a 20 inch beam, but is the bare minimum if using (good quality) pine and an 8 ton jack.

Note that if the press is made larger (say an extra 4 inches width), then the rack size will increase by 4inches from 16 inches to 20 inches. The area of the cheeses will increase by the square of the increase in width from 256 sq in to 400 sq in – a factor of 1.5625. To maintain the same pressure, a 12.5 ton jack will be needed. To cope with this and the longer beam, at the same safety margin a depth of 8.5 in. is needed (assuming still 3 in. wide). So a 20% increase in beam span requires a 25% increase in depth, assuming the same jack pressure is

required. However, if the width of the beam is also increased, then a 20% increase all round works. This is because the pressure in the press (Q) is equal to the force (P) divided by the area (A). i.e. $Q = {}^{P}/_{A}$. Assuming the width of the cheeses is proportional to the span of the beam (say about ¾ of the span), then $A = (0.75l)^2$ so $Q = {}^{P}/_{(0.75l)^2}$. So, double the span requires 4 x the force. 4 x the force requires the beam to be twice as deep and doubling the span can be offset by doubling the thickness, so everything multiplies up by two except for the force which goes up by 4 times.

All of these calculations are a bit approximate. The intention is to illustrate the complexity of getting the stress calculation right, particularly if departing significantly from the usual size for this type of press. For a significantly larger press a different design (e.g. twin screw) is probably more appropriate, since otherwise the top beam size and jack size get unwieldly.

JACK SIZING

I have found that an 8 ton jack with a 15" cheese width gives a good level of juice yield (about 70%), using a good mill, such as a Fruit Shark. This accords with the experience of others (see "Craft Cider Making" by Andrew Lea). Doubling the pressure might increase yield by about 5%. A 2 ton jack will give about 60%.

Jack (tons)	Cheese (in)	Pressure (psi)	Yield
2	16	18	60%
8	16	70	70%
20	24	78	71%

MATERIALS

FRAME

Wood construction, but ideally ash for the top beam. The rest of the frame can be softwood. The bottom beam can be sized a bit less than the top beam since the load is spread evenly, however, mine is the same size.

PLATFORM

The platform under the tray needs to resist bending – worktop cut-offs are good, else several layers of ply or MDF.

TRAY

Mine is stainless steel, fabricated to measure. My first one was just wooden – need to seal the corners well.

PRESS PLATE

Built up from 3 pieces of 12mm ply.

RACKS

Don't need to be fancy like the Vigo ones – can just be of plain plywood, or (better) HDPE. If thick enough, can be grooved, but I'm not convinced it improves performance.

FORMER

Plain timber construction

CLOTHS

Net curtain or debris netting is cheapest.

SUNDRIES

Steel strike plate. Coach bolts - 4 of M12x150mm (ideally stainless steel, but galvanized will work). Coach screws – 4 of 100mm. Glue. Varnish.

CONSTRUCTION

The overall construction is fairly obvious from looking at it. Key features are:

- Other than the top beam, the frame uses 4”x3” softwood (this is the nominal size – the finished planed size is about 95mm x 70mm). A piece of 6” x 3” (finshed size) oak or ash is assumed for the top beam in these construction notes. Otherwise, glue and cramp together two pieces of 4” x 3” (nominal) softwood to make a piece 7 ½ “ x 2 ¾ “; the tenons can be the same as for the oak/ash version, so the construction details are otherwise similar.
- It is essential to use a mortice and tenon construction for the to beam. Do not use bolts, as is often seen, as this may cause the wood at the end of the beam to shear under tension. A mortice and tenon joint will place (almost) the whole depth of the beam under compression which is much stronger.
- The uprights are two pieces of 4”x3” bolted together with four 150mm M12 coach bolts. This gives a stable structure, provides a guide for the cheese former and makes for easy construction of a strong mortice.
- The central bottom beam is also a mortice and tenon construction. The additional bottom beams are principally to keep the tray level and can be bolted or screwed on.
- The uprights are simply fixed to the base with dowels, then a triangle of ply screwed on. Bed bolts would be another option.
- Mine has castors, which makes it easy to move, but only work on a level floor.

The minimum tools required are:

- A good quality handsaw
- A sharp chisel and mallet
- Drill with bits 20mm, 12mm, 10mm, 8mm
- Socket spanners to fit coach bolts & screws
- Try square
- Ruler

If you have a router then the mortices and tenons can be made more quickly and accurately. I will assume you only have the basic tools.

Firstly make or buy the tray. Then make the frame to fit. Complete the process by adding the racks, platform, press plate and former.

THE TRAY

Firstly make or buy the tray. It doesn't need to be particularly strong, since it will be supported on a platform.. If making it from wood then I would suggest gluing it all with a sealing glue such as "Stixall". My tray was made in stainless steel by Packhorse Steel of Keswick for £50. I like to have a tap (as close to the bottom as you can get), but you could just have a hole in the bottom. The taps I use can be dismantled in use if there is a blockage.

THE FRAME

Next make the frame, making the span just fractionally longer than the outside width of your tray.

CUT ALL THE FRAME TIMBER TO SIZE AND ENSURE IT IS SQUARE

For my press the sizes are as follows:

Uprights – 95mm x 70mm softwood - 4 each 62 ½ in. / 1590 mm
Top and bottom beams – 150mm x 75mm (6" x 3") oak – 2 each 33 in. / 840 mm
Additional bottom beams - 95mm x 70mm softwood - 2 each 27 ½ in. / 700 mm
Base ("feet") 95mm x 70mm softwood - 2 each 28 ½ in. / 720 mm
Plywood triangles

MAKE THE MORTICE AND TENON JOINTS

The finished size will be about 2 ¼ in. x 4 ¾ in. / 60mm x 120mm. Cut the mortices first, since it is easier to make the tenons to fit the mortices, rather than the other way round. These will be cut as a "housing joint" in each piece then they will be fixed together to form a mortice. Lay the uprights side by side with the "insides" face up and mark them all together. Mark the depth at 30mm (I.e half the mortice width). Carefully cut on the waste side of each line with a handsaw, then make multiple cuts across the joint, so that chiseling out is easy. Remove the rest of the joint with a chisel (and/or a coping saw if you have one).

Mark out the tenons on the two main beams, to give the required span (20") and cut on the waste side of the marks. Test fit the tenons and chisel any excess so that they are a good tight fit.

Fit it all together, then make a mark along the centre line of each tenon 8mm away from the upright. Drill a 20mm hole through each tenon and square up with a chisel. Make pegs from the same timber as the beams, from 18mm width at one end up to 24mm at the other. These should fit into the holes and draw everything together. (NB, make sure that the tenons are long enough beyond the pegs and that the wedge is only in one direction).

COMPLETE THE FRAME

Mark the positions for the bolt holes and drill 12mm holes. Fix bolts with nuts & washers and tap in pegs to hold it all together. Mark the positions of the additional bottom beams and drill and fix with 100mm coach screws.

Place "feet" on the bottom of the uprights and drill each with two holes 12mm wide by at least 150mm deep, into the uprights. Glue two 12mm x 150mm dowels into each foot. You need an auger bit for this. If you don't have one then use an extra ply triangle and skip this stage. Provide additional strength to the base by screwing on a triangle of 4mm plywood cut from a piece 1ft square. (If not using dowels then use two pieces of plywood, on either side). Attach castors if required.

ADD THE RACKS, PLATFORM, PRESS PLATE AND FORMER

MAKE THE RACKS

These should be at least 4 inches less than the inside width of the tray, to allow 2 inches all round for drips. Mine are made to measure from HDPE, which is easy to clean, but you could use ply or make fancy acacia wood ones like Vigo's. 10 racks should be sufficient. I would also recommend having a thicker (open construction) rack to lift the bottom cheese off the base.

MAKE THE PLATFORM

This is best made from a worktop cut-off, but could be built up from 3 layers of 12mm ply. It should be at least a fraction bigger than the racks, but does not need to be quite as big as the tray (particularly if it has a hole in the bottom). Some strips of wood screwed to the base help to locate it accurately in between the bottom beams.

MAKE THE PRESS PLATE

This is made from three pieces of 12mm ply, each slightly smaller than the one below, to distribute the force of the jack over the whole cheese. The bottom piece can be shaped so that it slides vertically down on the uprights. Additional timbers may be required above the press plate to extend the reach of the jack.

MAKE THE FORMER

This can be constructed from hardwood or softwood. Mine is made from ½ inch thick oak with dovetailed corners, but ¾ inch softwood, glued and screwed would work just as well. The height of the former dictates how high your cheeses will be. Mine is 2 inches, but you could go higher (and have fewer racks), albeit with some risk to the stability of the cheese stack. On the two sides of the former I have added a "H" shaped construction to locate the former on the uprights, so as to keep things vertical when building the cheese. The internal dimension of the former should be just a little less than the racks, so that it sits on them and so that the cheeses don't squash outside the rack too much under pressure. Note that the internal dimension of the former needs to be slightly smaller than the racks (by say ¾ inch) so that it will sit on them.

FINISHING

All exposed wood should be finished. I used Tung Oil (food safe) but this hasn't worked too well. If I was making it again I would use yacht varnish for the main frame as it is much more easily washed down. You could use polyurethane, but I prefer yacht varnish, even though it takes longer to dry. Any timber which is in direct contact with juice should be coated with a food safe finish. I like stainless steel and plastic for these pieces as it is easier to clean.

ACCESSORIES

Press cloths: net curtain material works very well; debris netting is very cheap but not as nice in use; or you can fork out on Vigo's fancy stuff. Whatever you use the cloths need to have a minimum width a bit over the diameter of the former plus twice its depth.

With a little ingenuity, the press can be converted to cope with double pressings, so that one cheese is being pressed while the other is being built. A sliding table on sprung castors runs over the top of the platform.

COSTS AND SUPPLIERS

TIMBER

Assuming that the main beams are from hardwood, then the cost will depend on where you source from. Main were old beams from a barn so they cost nothing. Otherwise green oak or ash should cost in the region of £25 - £40; you will need to look for a local supplier. The rest of the frame can be made from four 8 foot lengths of 4x3 (95mm x 70mm finished size) at a cost of £40-£50. If you are making the beams from softwood then you will need extra softwood at a cost of about £20.

In addition, there is ply and timber for the press plate, former etc., at about £50.

Other than the oak/ash all timber should be available at your local timber merchant.

Total cost of timber is approximately £120.

TRAY

The most expensive single item, if you have a stainless steel one. Mine was made to measure for £50 by Packhorse Steel Unit 4, Goosewell Farm, Keswick, Cumbria CA12 4RN, Tel: 017687 74709.
The taps come from Hop & Grape in Darlington.

JACK

Clarke CBJ8 8-Tonne Bottle Jack from Machine Mart £22. Other sizes and costs are:

Jack (tons)	Cheese (in)	Pressure (psi)	Yield	Cost
2	16	18	60%	£10
8	16	70	70%	£22
20	24	78	71%	£42

RACKS

White (natural) HDPE sheet made to measure from www.plasticstockist.com cost £80 incl VAT & delivery for 10 sheets of 385mm x 385mm.

CLOTHS & SUNDRIES

Depending on what you use, cloths will be anything from £7.50 upwards. E.g Amazon do “White Plain Voile Net Curtain Fabric 58 Inches Wide. Sold by the metre.” At £1.75 per metre and with two cloths per width , this works out at less than £8 for 10 cloths including shipping.

Sundries include coach bolts and screws, dowelling, glue, varnish etc. In all about £30.

Should you wish to fit castors, these cost about £15 for two 100mm castoring wheels and two fixed (from Axminster Tools).

TOTAL COST

So excluding your own time and any tools you have to buy, the total cost is about £310 – less than half the price of the Vigo equivalent. If you make a wooden tray and use thin ply for the racks, it would be quite a bit cheaper. If you add castors, coffee cup holder and an iPod dock it will cost a bit more.

December 2011