Equipment

The following equipment is desirable:

CNC Router or Laser or Waterjet and if not one of these then a Scrollsaw or a Bandsaw. Small Lathe, this is not absolutely essential but it would make making the clock a lot easier for all of the round parts that are needed.

Small Milling machine or **Pedestal Drill** with work holding vice. There are a lot of holes to be drilled and cleaned up after CNC machining and fabrication so the drill is pretty much essential. It may be possible to get away with an ordinary electric drill in a stand but a work holding vice is still necessary.

Drill Bits in the following sizes, Ø4mm, Ø4.1mm, Ø2.0, Ø2.1

Router Cutters Ø2, Ø3 and possibly Ø6 for cutting out the larger frames and pockets.

Hand tools; all the normal things that are used in the workshop, Files, screwdrivers, hammer, pliers etc.

If you want to save a lot of time, then look at a **Sanding disk** and a **Drum sander** but these are really nice to have.

Consumables
Sandpaper in various grades from rough to fine
Danish oil for finishing.
Gorilla Glue
PVA
Super glue
Dry Film Lubricant in a spray can for the gears after everything is finished.

MATERIALS

For all the wooden Parts

For this project use 6 mm MDF, choose board size to suit your Laser bed, the burnt finish is actually carbon and will act as a lubricant for the gears

You can, however, use a quality grade of plywood (Marine Ply) this route is a lot quicker as you can layout multiple parts on a sheet and have the whole thing cut out in a day, still need to put in the time cleaning up the parts and making all the other bits, but generally speaking the whole thing can be done a lot quicker.

You can also use Perspex with which you can create some quite colourful clocks (see clock 19). Also, you can, of course, use Brass or Steel or even Aluminium but this latter would need some post-treatment to stop the wear that can happen between two aluminium parts in rubbing contact.

Whatever you use, the flat 2D parts are all laid out for you on the Profile cuts sheet, this comes as a DXF file that is 1200mm square, you can manipulate this in your own CAD program, which you will probably need to do, to be able to feed the files into your CAM program.

For all the other parts

Ø2 Drill Rod or Silver Steel 1200 mm Long for all the shafts and numerous pins.
Ø4 mm Rod or Silver Steel 500 mm Long
Ø25 Brass or Acetal Rod 150mm long
Ø19 Brass Rod 25mm long for the balance weight
2mm Thick Plastic Sheet
Carbon Fibre tube or wooden Dowel 200mm
M6 nuts 2 required for the weight
Ø6 Threaded rod 180 mm long for the weight
Woodscrews 2 required Ø4.5 mm x 60mm
Roller Bearings – HK0406
Chain 43.5 LPF approx. 1.5meters long. https://www.cousinsuk.com/product/chain-steel

Note these are the minimum amounts of material necessary to build the clock I used more in the prototype and you may well be advised to by extra to cover those accidental losses that occur.
If I have missed anything here, you will find them in the parts list for the clock anyway.

HINTS AND TIPS

- The DXF files are spread over 4 files, the first two are for the Parts machined from 6mm MDF, the third is for all the 2 mm thick Plastic items and the fourth is for the Dial numerals.

- When fitting the gear sub-assemblies into the frame make sure the mating gears engage and run smoothly. The faces of mating gears should be aligned so they fully engage with each other, i.e. the front faces of the gears are lined up. There is some clearance built into the design so that when the gears are enclosed between Front and Back frames they are free to move without rubbing on the frames.

- The front and Back Frames are held together with two simple Wedges The wedges are fitted as shown, with one at the top and one at the bottom. The wedges are designed so that when cut they will be slightly too thick, this is to give you some material to sand off to get a proper tight fit.

- The dial on this clock was made from a Trolase material 1.6 mm thick, it has 3 layers white on the outside and black in the centre. The laser is used to burn away the white layer to expose the black layer beneath, I actually used a thicker version of the material to use a V bit cutter and cut out the dial on the router. I use Artcam Express which gives a good clean-cut edge and very fine detail without having to use extremely small diameter cutter. A free alternative to Artcam is a program called F-Engrave,

- The weight needed to drive the clock was around 2200 grams for my prototype, you may find that you can get away with something less.

- You can make the weight from whatever you like, ideally, it should complement the aesthetic of the clock and not look bizarre or incongruous. I favour the brass weight but this is not always practical and can be quite expensive. I have used a granite block in the past on one of mine and more recently bottles of Coke or other drinks bottle.
  It is often difficult to achieve the weight that you need in a size envelope that works with the overall design. One solution to this is to construct the weight in two parts using an outer sleeve filled with lead shot. This is a really handy method for achieving the look that you want. You can find suppliers of lead shot on the Internet, the current clock uses this method

- Establishing the actual weight to use for the main clock weight, is done initially by trial and error. Each clock build is different and that has an effect on the size of weight to use. I normally use a 2 litre Coke bottle partly filled with water to start and add or remove water to get the clock running continuously.
  You would do this finally after setting assembling the clock and making sure everything is running freely and the escapement is set up correctly. Usually, a bit of back and forth here to adjust the escapement then adjust the weight.

- If you have problems getting the clock running initially it could be that the problem is usually in the gear train itself, one or more of the gears may not be meshing correctly,
  You need to test each pair of gears in turn, by mounting each meshing pair in the frames on their own and turning them by hand very slowly with little pressure. if any pair sticks or interferes with the other you should mark the teeth that are affected and carry on until you have turned the large gear around completely, then strip down and dress the teeth you have marked until they work together smoothly. Repeat this process for all the meshing pairs of gears are running freely.
  It is not sufficient to test them when the gears are mounted in the clock and then left to run continuously with the weight in place, as the free running gears will easily override any slight

interference, whereas when the gears are running in the clock with the escapement in place they never run fast and so easily feel the effects of interference.

The dial on this clock was made from a Trolase material 1.6 mm thick, it has 3 layers white on the outside and black in the centre. The laser is used to burn away the white layer to expose the black layer beneath, I actually used a thicker version of the material to use a V bit cutter and cut out the dial on the router. I use Artcam Express which gives a good clean-cut edge and very fine detail without having to use extremely small diameter cutter. A free alternative to Artcam is a program called F-Engrave,

- The weight needed to drive the clock was around 2200 grams for my prototype, you may find that you can get away with something less.

- You can make the weight from whatever you like, ideally, it should complement the aesthetic of the clock and not look bizarre or incongruous. I favour the brass weight but this is not always practical and can be quite expensive. I have used a granite block in the past on one of mine and more recently bottles of Coke or other drinks bottle.
  It is often difficult to achieve the weight that you need in a size envelope that works with the overall design. One solution to this is to construct the weight in two parts using an outer sleeve filled with lead shot. This is a really handy method for achieving the look that you want. You can find suppliers of lead shot on the Internet, the current clock uses this method

- Establishing the actual weight to use for the main clock weight, is done initially by trial and error. Each clock build is different and that has an effect on the size of weight to use. I normally use a 2 litre Coke bottle partly filled with water to start and add or remove water to get the clock running continuously.
  You would do this finally after setting assembling the clock and making sure everything is running freely and the escapement is set up correctly. Usually, a bit of back and forth here to adjust the escapement then adjust the weight.

- If you have problems getting the clock running initially it could be that the problem is usually in the gear train itself, one or more of the gears may not be meshing correctly,
  You need to test each pair of gears in turn, by mounting each meshing pair in the frames on their own and turning them by hand very slowly with little pressure. if any pair sticks or interferes with the other you should mark the teeth that are affected and carry on until you have turned the large gear around completely, then strip down and dress the teeth you have marked until they work together smoothly. Repeat this process for all the meshing pairs of gears are running freely.
  It is not sufficient to test them when the gears are mounted in the clock and then left to run continuously with the weight in place, as the free running gears will easily override any slight interference, whereas when the gears are running in the clock with the escapement in place they never run fast and so easily feel the effects of interference.