Imp – A 7 ¼ inch Gauge 'Minimal' Locomotive

Introduction

Thanks to having been sent to a school where it seemed to be a matter of pride that nothing of any practical use whatsoever was taught, I never had even a most basic introduction to any engineering or craft skills. Over time a few bodge-it DIY techniques have been picked up by trial and (mostly) error, but my skill level is still such that an engineer acquaintance once described me as having two left hands. I thus felt truly qualified to enter the Minimal Gauge Railways Facebook Group loco building competition! You can find details about the competition here:
https://www.facebook.com/groups/MinimalGaugeRailways/permalink/1040142009371113/

I decided my locomotive would be of approximately the same dimensions as Colin Edmondson's 'Scamp', possibly using some of the same components. That way there was a chance it would be reasonably stable, possibly portable and probably fit into my car for transport to other railways. At least I would have a few parts towards building a Scamp if all else failed.

I imagined a wooden chassis with no suspension, a lawnmower engine for power, and a simple friction mechanism to give forward and reverse. In fact more of a 'Skimp' than 'Scamp', which led to the naming of my wee beastie as 'Imp'. In a twist on the story I read about someone naming their loco 'Sherpa' because they had the badge from an old van handy, I might acquire an old Hillman 'Imp' badge sometime.

A parts list and details about how I constructed the locomotive follow. I have to confess that as it stands it is really a 'work in progress' because I am still testing to find materials for the friction drive that are easily fixed in place, reliable and long lasting. I have been encouraged by tests so far and you can see a short video of the locomotive in action at https://youtu.be/O-3Em6lWZeU More experimentation with different friction materials and how to fix them in place is ongoing. The ease of driving and jumping on and off this engine has inspired me to look at where to add more sidings to the railway for some shunting fun!

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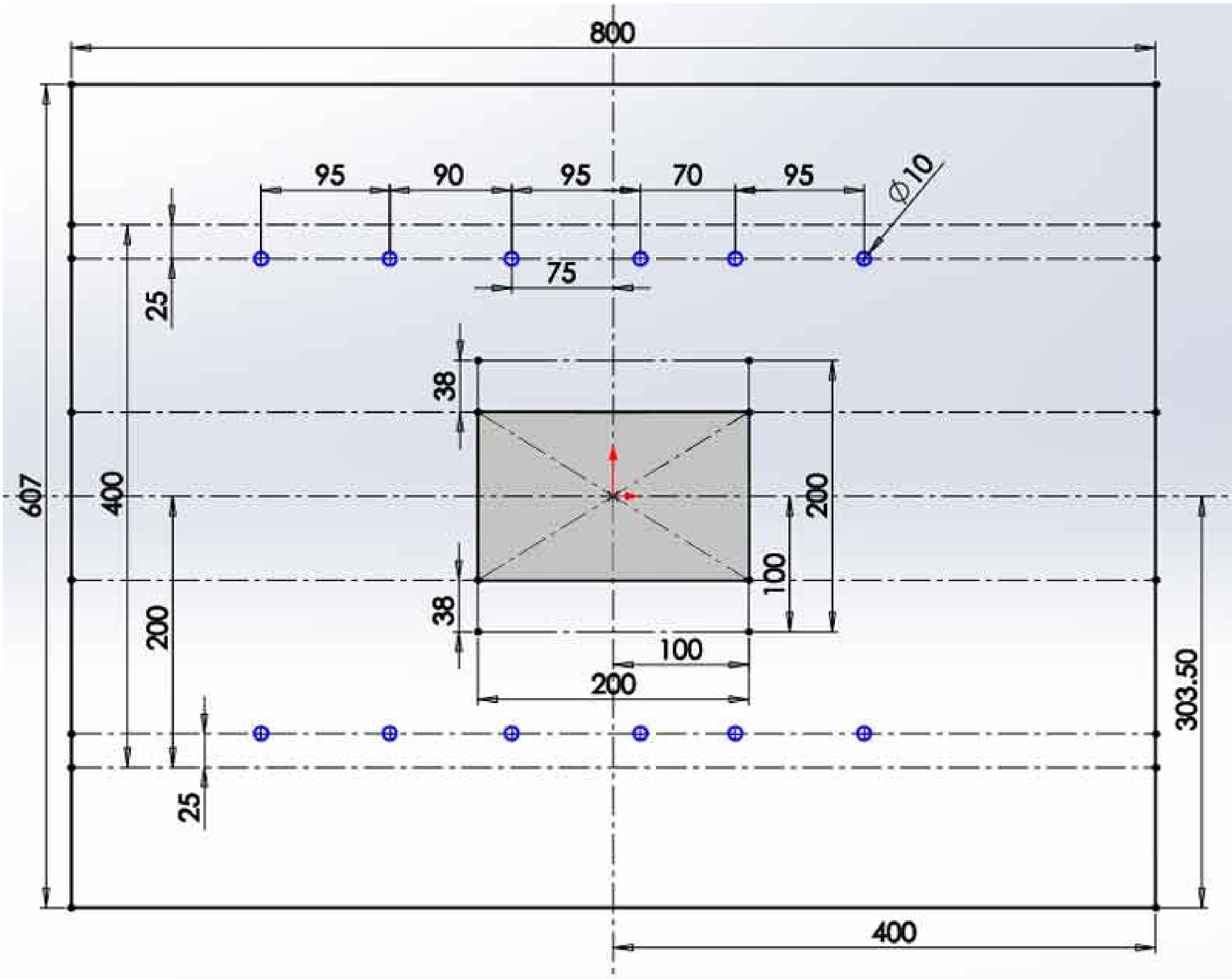
Construction

Any drawings are the ones I worked from. They assume timber is the same size as its nominal size. The actual size is normally smaller. If you familiarise yourself with the drawings and pictures before marking or cutting anything out, you should be able to see how things go together and be able to compensate accordingly. I often mark out by holding a bit of timber in position, rather than relying on marking a theoretically correct measurement. I usually find this technique is more accurate for me and can help avoid confusion.

Footplate
Made from 18mm thick exterior ply. I bought a piece 1829mm x 607mm (roughly 6' x 2') from our local B&Q. A couple of cuts of sheet materials are included in the price. One cut was used to give me a footplate measuring 800mm x 607mm, meaning that at least I would be building on something cut straight and truly 'square'.

A small rectangle in the middle (shaded grey) was cut out, and 12 holes (coloured blue) drilled.



Plan of the footplate

Below the footplate
The UCP 204 bearings for the lay shaft can be bolted straight onto the footplate via the centre two holes on each side. Similar bearings for the main axles are fixed through the other holes using some 50x50mm timber as spacers to position the axles far enough away from the footplate to fit the wheels in place, as shown in the photo below (on next page).

Axles positioned

Originally I had thought that that might constitute an adequate chassis. Later I added extra timber to form 'buffer beams' and 'side frames'. This was partly for aesthetic reasons, partly to add more low down weight, and also because it prevents the footplate flexing too much.
The 100x50mm 'side frames' run the length of the footplate fixed outside the spacers so that their inner surfaces are 400mm (the length of the axles) apart. The 150x50mm 'buffer beams' are the same width as the footplate, screwed to more 50x50mm timber bolted across the front and back of the footplate. The bottom edge of the 'buffer beams' are aligned with the bottom edge of the 'side frames' to complete the woodwork that makes up the 'chassis'.

Complete assembly below the footplate

The other 'below the footplate' items can be added at this point, or later if more convenient.
The rail wheels are welded onto the axles, but I understand that gluing with 'Loctite' will suffice for light duty use. The large pulley (SPZ 150) and 17 tooth sprocket on the lay shaft are fixed using taper lock bushes, so their exact positions are easily adjusted. Positioning the 27 tooth sprocket outside the rear wheels allows it to be changed if you feel the need to experiment with different gear ratios. Driving just the rear axle works perfectly well and is the simplest and cheapest option.
Exactly where the brake is fixed will depend upon the brake you have sourced. I needed a small block of wood (approx 12mm thick) as a spacer to align the brake correctly relative to the pulley it acts on. To allow for neat cable routing I swapped over the cable adjuster and end crimp from their usual positions when used on a bicycle.
The (optional) 12mm threaded bar runs along the centre line as close as possible to the footplate, through the buffer beams (and 50x50mm timber they are fixed to) and into M12 tapped holes in the angle iron used as couplings. The thinking behind this was to ensure that the buffer beams could not be pulled off. A simpler solution would be to use triangles of plywood (approx 6 inch sides) to reinforce the join between the bottom edges of the buffer beams and the frame sides. Bolting through the buffer beams would then suffice to hold the couplings in place.

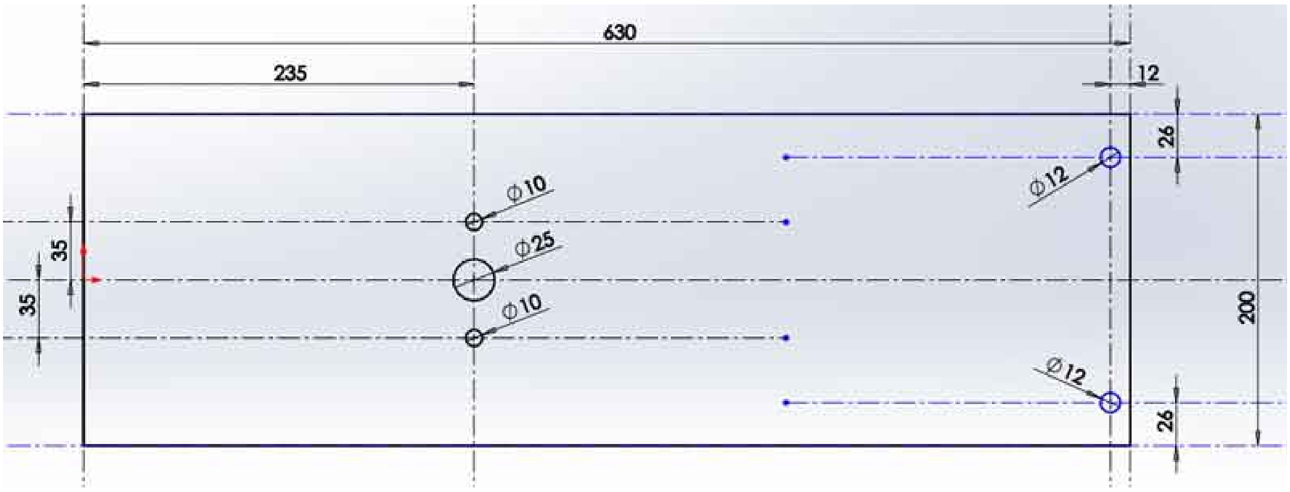
The Seat

The basic structure of the seat is simple, as can be seen in the photo (below) with one side removed. The seat top and vertical supports are made from 200x47mm timber and the plywood sides are 530mm x 280mm. The rear vertical support (and thus the back of the seat) is aligned with the back edge of the footplate.

The seat assembly

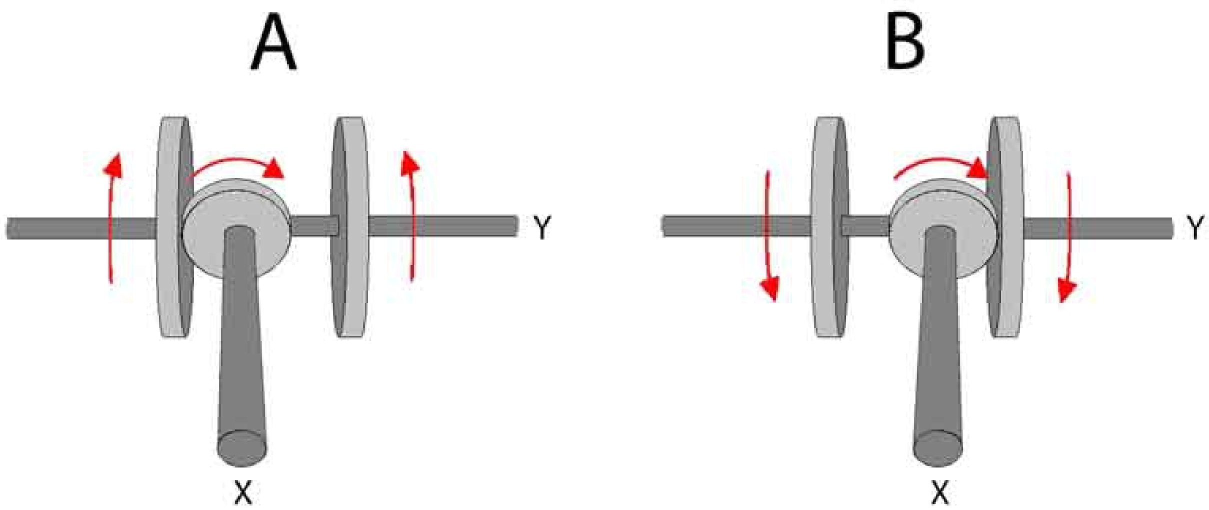
The seat is fixed to the footplate by bolting it to two pieces of 38x50mm timber. These are 170mm long, fixed with the 38mm side in contact with the footplate alongside the central hole as shown in the above photo.
The precise position of the UCF 204 bearing will depend upon the length and height of your chosen engine's drive shaft. The aim is to fit the 'friction drive' axle (described in the next section) so that it is at roughly the same height as the engine drive shaft once the engine is fixed on the mounting

plate and drawer runners, and in such a position that the drive disc can make sufficient (about 5mm) contact with the friction discs. You may also need to make a small cut out in one of the seat sides to clear the exhaust pipe.
To complete the seat you will need to drill two 12mm holes through the seat top for the control levers and (optionally) others if you decide to add a tractor seat. I kept the centre of the tractor seat forward of the rear axle.



Plan of the seat top

Friction Drive
This form of drive is the simplest way I could think of for giving forward/neutral/reverse. Two fixed discs are mounted on what I have termed the 'friction drive' axle. One or other of these discs can be driven by another disc at right angles to them which is mounted on the output shaft from the engine. Moving the driving axle/disc (in fact the whole engine mounted on drawer runners) a small distance between these two discs gives forward and reverse.



The friction drive in principle

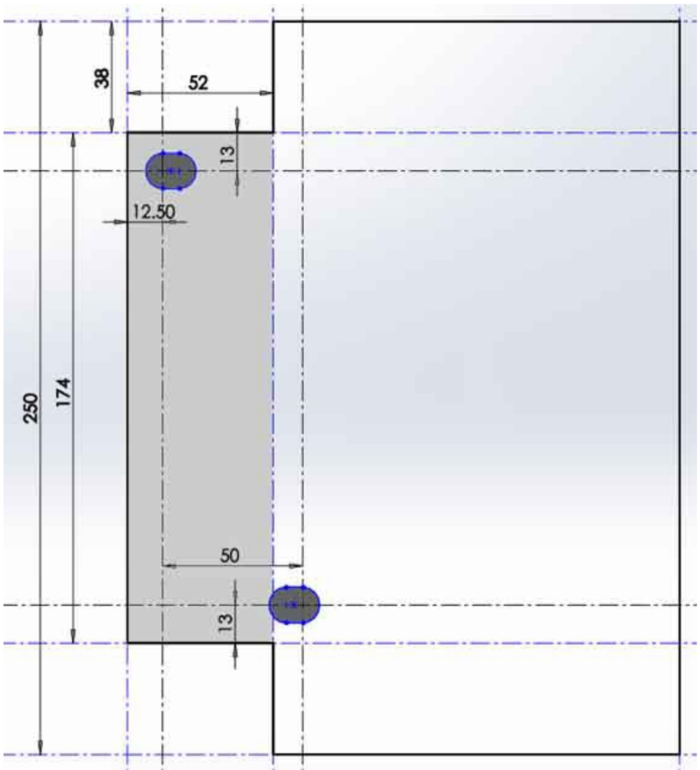
With the driving axle (X) in position A the 'friction drive' axle (Y) will be driven in one direction. With the driving axle in position B the 'friction drive' axle will rotate in the opposite direction. Obviously when the driving disc is between positions A and B and not in contact with either of the driven discs, you are in neutral or can coast.
The drive disc is a SPZ 50 pulley fixed to the drive shaft of the engine via a suitable bore taper lock bearing. The engine shaft will probably be 19mm, 18mm or 3/4inch diameter. The 'friction drive'

axle is nominally 200mm long, but is likely to be a few millimetres shorter as it should be the same length as the actual width of the seat top. The driven SPZ 118 'friction discs' are fitted equidistant from the ends of the axle so that their inner faces are about 70mm apart. There is a small (SPZ 60) pulley between them, offset from the centre of the axle to line up with and drive (via a V belt) the large pulley on the lay shaft. You will need to add some sort of friction material, ideally both around the SPZ 50 'drive disc' and on the inner faces of the SPZ 118 'friction discs' that it makes contact with. To date I have had most success using leather (rough side as the friction Surface) fixed on with 'Evostick' contact adhesive. Two 2” leather washers fit neatly on the 'drive disc' pulley if you first partially fill the groove with a thin strip of leather. Wrap the leather strip around a few times to match the inner diameter of the washers, gluing it in place as you go.

The friction drive shaft (no friction material shown)

Engine Mounting

The engine is fixed to a plywood mounting plate attached to a pair of drawer runners on the footplate.



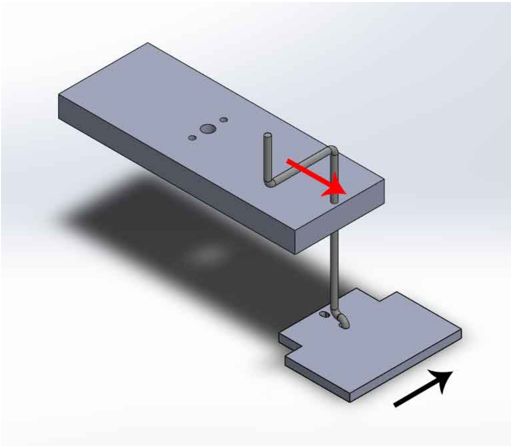
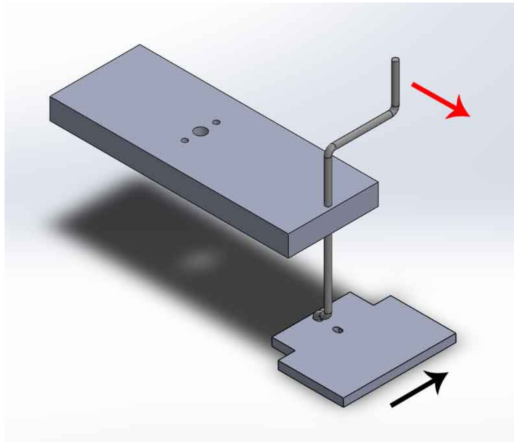
Plan of engine mounting plate

The size of the engine mounting plate may vary according to the engine you are using, but the width of the 'tongue' (shaded grey) needs to be such that it will allow enough movement (about 26mm) for the drive disc to make contact with the friction discs. The 'tongue' fits between the seat sides when the mounting plate is positioned.
The slots (shaded dark grey) are the same distance apart as the holes you drilled in the seat top for the control rod. I made these slots by drilling two 10mm diameter holes as close as I could to each other and sanding them to shape.
The engine is mounted on this plate using 8mm nuts and bolts, making sure that the drive shaft is exactly midway across the 'tongue' and the front of the engine is clear of the slots that the control levers will fit into.
The mounting plate is fitted to the footplate via the drawer runners using M6 machine screws and nyloc nuts. The drawer runners can be fitted in any convenient position, but may require some minor modification. There is a useful article 'using drawer slides as linear guides' at https://woodgears.ca/pantorouter/glides.html I simply shortened mine to suit the mounting plate, (plus a bit extra to allow the amount of movement I required on the footplate side) and drilled some extra holes to make fitting them easier. Beware that if you cut the runners down you will probably cut off any end stop that prevents the runners completely separating, and you will have to be careful not to lose the ball bearings.
Having fitted the engine you might need to mount a petrol tank. You will probably have your own ingenious solution for whatever petrol tank you have or acquire. My solution was made from wood and angle iron, using the angle formed by the original lawn mower handle as a template for the piece of ply that the tank was fixed to.

Friction drive and engine in place

Control Levers

Both control levers are identical. They were originally designed with the intention of having one centrally placed lever that produced movement matching the direction the lever was pushed. This lever could be repositioned according to the direction the driver was facing. Movement in the appropriate direction would be accomplished by means of the cranked shape and the location of the lever in one of two holes provided in the engine mounting plate. The engine mounting plate is mounted on drawer runners and so is constrained into only being able to move left or right thus engaging the engine's drive shaft with one or other of the friction discs.

 *Control Lever*	 *Left Facing* – The lever is located in the front hole of the engine mounting plate. Pushing the lever forwards (red arrow) causes the engine mounting plate to move to the right thus engaging the right hand friction plate, which drives the loco forwards (assuming your engine rotates clockwise).	 *Right Facing* – The lever is now located in the back hole of the engine mounting plate. Pushing the lever forwards in this position also moves the engine mounting plate to the right, producing forward motion. Whichever way you are facing, pull the lever back for reverse.

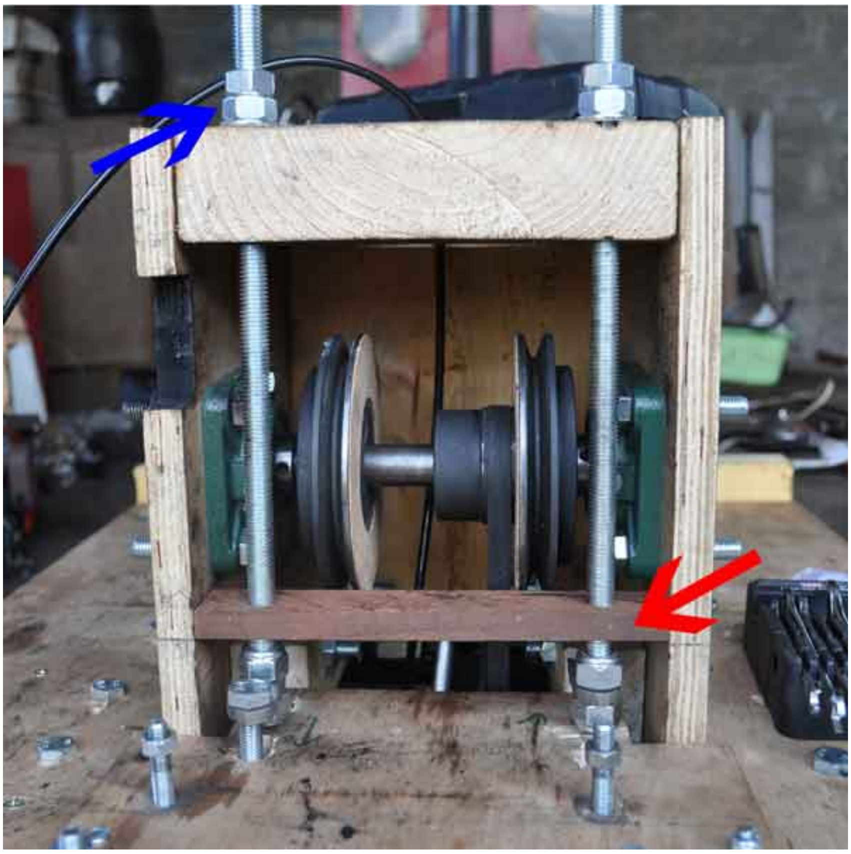
I decided to use two (identical) control levers, making it easier to work out where to position them. The (no weld) versions I made were quite bulky at the bottom crank section, making it difficult to switch between the holes in the engine mounting plate, so using two levers avoided the need to do this.

For the purposes of the competition I made the control levers using threaded bar and a bolt for the vertical sections, offcuts of flat bar for the horizontal sections (I suppose timber might work) and nyloc nuts to hold it all together. The flat bar was drilled and tapped with appropriate size holes for the threaded bar so that when the lock nuts were added everything was held in place.

A control lever as built

The centres of the M12 threaded holes in the top crank are about 225mm apart. The long length of threaded bar is 500mm long, and the shorter length is 200mm. An M10 bolt was used on the lower crank. The distance between the centres of the M12 and M10 threaded holes in the lower crank was calculated to be about an inch (25mm). In practice I had to adjust this (giving a smaller throw) by trial and error, presumably because of inaccuracies elsewhere in the build and/or because I decided to use a different engine halfway through the build.

The control levers are fitted through the holes in the seat top and held in place using a piece of 32x12mm timber (with holes drilled to match those in the seat top) fixed between the seat sides, as indicated by the red arrow in the picture below. A couple of M12 nuts and a washer on each control rod above the seat top (blue arrow) support the rods at the correct height to ensure the engine mounting plate can move freely.



Location of the control levers

Finishing Touches, Extras and Future Developments

The brake and throttle cables can be neatly routed using hooks and eyes for curtain wire. Of course every locomotive should have some sort of warning device such as a horn or bell. Something from the bicycle you 'borrowed' the brake from will do the job!

The brake lever is fixed to a wooden handle made from approximately 1 inch diameter dowel or broom handle. By drilling a 13mm diameter hole down the centre of this dowel it can be located on whichever of the control levers the driver happens to be using. A ring (keyring in my case) can be used to lock the brake lever closed when stationary for use as a handbrake.

Brake lever can be repositioned

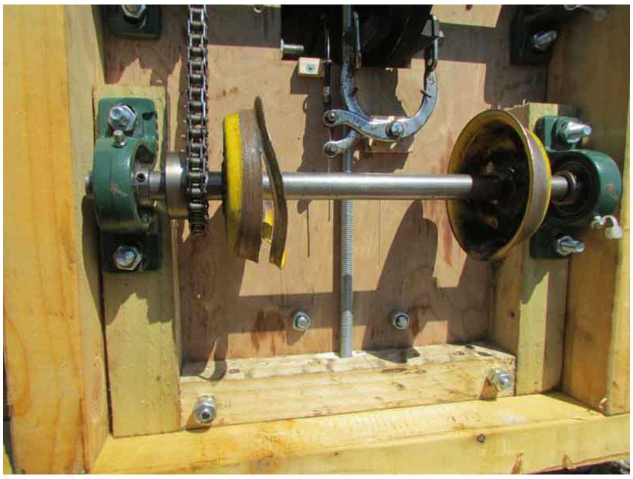
'Handbrake' On!

Although it isn't needed, I rather liked the idea of having a tractor type seat. Mine came from a 'garden cart' like the one in the picture below, bought from e-bay.

'Garden Cart' from e-bay

At the time I purchased this garden cart it was about £30, but now they seem to be about £50. You can probably get some sort of tractor seat cheaper than this but I also wanted to experiment with the wheels.



I thought the 4 split rim type wheels might provide 8 usable single flanged rail wheels. Once each wheel is split apart (by simply undoing the four nuts and bolts) you have two single flanged wheels, albeit with rather deep flanges. I 'turned' the flanges down using an angle grinder so that the wheels would run through our pointwork. The wheels with the original bearings were used on the supplied 12mm diameter axles to make an experimental rail 'skateboard', which was successful enough to convince me that such wheels and axles might be adequate for use on a lightweight wagon in the future.

I had hoped to use the remaining newly created wheels as driving wheels on the locomotive. They had central holes of 32mm diameter, which is the outside diameter of the 20mm bore solid collars available from beltingonline. These collars were used to fit the wheels to the 20mm axles. It proved difficult to weld these in place concentrically and fill the valve holes. They worked for a while (giving a slightly bumpy ride) until one of the wheels split. More R&D is needed!

At some point a form of simple suspension may be added even though experience testing the locomotive so far suggests this is not necessary. I have in mind a simple swing arm suspension using gate hinges with rubber anti vibration mounts as the dampers. To keep things simple I would consider leaving the front (under the engine) axle without suspension but making it the driven axle, only adding suspension to an undriven rear axle below the seat. Alternatively it would be possible to add swing arm suspension to both axles and make them both driven as in Patrick Henshaw's Simplex design. This would require adding some sort of chain tensioner, probably taken from the donor Suffolk Punch lawnmower.

It may be a little premature to be thinking about lights but I like the idea of battery-free directional lights. By using 2 bicycle dynamos and two sets of lights mounted in opposite directions, one could take advantage of the sliding mechanism to engage one or other of the dynamos, so that associated lights are lit according to the direction of travel.

And Finally.....

I hope anybody reading this will realise I am an unskilled hobbyist and this is a description of what has worked well enough for me. I can't guarantee my drawings are consistent or that my locomotive would work to your satisfaction. It will keep me entertained using and improving it on my railway. The focus for improvements at the moment is on the friction drive materials and the means of keeping them in place. I think I am on the right track (no pun intended) using leather, and intend to experiment further. Any constructive comments would be gratefully received.

Although the write up might make it sound as if all was plain sailing, you will see from the pictures that I drilled holes in the wrong places and made other mistakes. I thoroughly enjoyed the challenge and hope that others may be inspired to give it a go. You certainly don't have to be a skilled engineer. Use and improve upon the ideas gathered together here, or better still come up with your own and build your own unique design.

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