DESIGNING LONDON TRANSPORT MODELS

by Dr. Arun Sharma

One of the aims behind the formation of this Society, just about fifty years ago, was supporting furtherance of modelling LT in miniature. Then, as now, the main source of LT railway models was the Harrow Model Shop whose masters and stocks on closure were taken over by Radley Models. They continue to market them via their website and their stand at half a dozen or so exhibitions throughout the year.

This range of models had always been limited however with a discernable leaning towards the Metropolitan Railway – perhaps because of the location of the original shop in Harrow but more likely due to being able to avoid modelling some of the complex infrastructure that accompanies the deep tube lines. After all it is possible to model the MET by employing a single track, two rail system in a cutting!

Like many members of LURS, I grew up in London and started to collect train numbers whilst at school. In my case in Leytonstone at a time when the occasional ex-GER F5 2-4-2T could [just] be seen passing through the station to and from Temple Mills/Epping. The earlier [1923-27] variants of Standard Stock predominated on the Central Line together with red-painted 1935 flat-fronted experimental stock on the Woodford – Hainault shuttle.

I came to railway modelling relatively late in life. I had a job which took me around the world frequently at short notice and, quite often, for extended, unpredictable periods. That life didn't seem conducive to kit building but the [occasional] long leaves which followed back in the UK became so. When I did take up kit building, like most people, it was initially of prototypes that I had actually seen operating.

GAUGE AND SCALE

00 gauge [1/76th scale] models have never looked quite right to me. This is due to the UK model industry's historical compromise with scale. Many modellers are only dimly aware that all the rail models available from the three main 00 gauge "ready-to-run" [RTR] suppliers in the UK [Bachmann, Hornby and Dapol (and Triang and Airfix before that)] are a compromise in that the bodies of the vehicles are built to 1/76 scale whereas the track is built to 1/87 scale. This stems from a time when motors/operating mechanisms were becoming small enough to fit inside 1/87scale models of prototypes built to the continental loading gauge but not [in that scale] to those built to the [smaller] UK loading gauge. In practice, the 00 gauge track looks too narrow with the running rails 16.5mm apart whereas they should be 18.83mm. Conversely, the wheel flanges are too large compared to the prototype and this in turn distorts the geometry of points and turn-outs.

In the even-smaller loading gauges that apply to both tube and surface stock, the operating mechanism problem is compounded with 00 gauge models being redesigned to fit around one or other of a small range of Japanese off-the-shelf motor bogies. Not only that but the problem of perspective rears its head. As often as not when we look at the prototype, it is from the side or even from slightly below. When we look at a model, it is generally from above. Accordingly, in the smaller scales, there has been an understandable tendency by model designers to not worry too much about what boxes etc., exist under the solebar of LT multiple unit stock – especially if doing so would interfere with fitting one of these standard motor bogies.

Although appropriate motors have become smaller, the past and ongoing investment in 16.5mm track and vehicles by both producers and purchasers of models is such that no mainstream UK company would seriously contemplate ever moving away from the compromise. However, there are many modellers who do build their own 18.83mm track and rebuild/re-wheel a chassis to suit it. Happily, there are also modelling societies that facilitate those moving to such greater realism.

After some initial dabbling with 18.83mm track gauge, my own modelling migrated to the rather larger scale of 1/43.5 otherwise known as 0 gauge. This is a scale where until say, four/five years ago very little was available RTR and it was pre-eminently a kit or scratch builder's scale. "Scratch building" refers to manufacturing all or a significant proportion of parts of a model oneself. Fortunately, there are many kit designers as well as commercial sources for most common wheels sizes and fittings such as chimneys, brake pipes, buffers and e.g., carriage dynamos so kit assembly and scratch-

building was largely restricted to chassis and body-shells. Equally important, there are thriving 0 gauge societies.

RESEARCH AND DRAWINGS

All well and good for many BR steam engines/rolling stock and even a few LT types [H class 4-4-4T, Peckett X class 0-6-0ST, ex-GWR pannier tanks and the MET Bo-Bos spring to mind] but not for LT multiple units which would involve much more work. I decided to start with a straightforward prototype which I had occasionally seen at Acton. This was L11, the double-ended shunter built from the driving/contactor compartments of two 1931 Tube Stock driving motors. If this was a success, then much of the work in subsequently producing a 1931 Tube Stock DM would also have been done. Clearly no kit existed for L11 in 0 gauge but there were drawings. Some readers may recall the mass clearout sale of rail and road vehicle large scale engineering drawings that 55 Broadway/Griffith House undertook around 1976. At that time I bought assorted drawings including a 1/16th scale drawing of a 1931 Tube Stock DM. Additionally there were other drawings of this stock available from well-known drawing suppliers such as Skinley and Terry Russell.

I'm told that the better model makers work on a premise that if you can see detail on a decent photograph of the prototype, then that detail should be included on the model. It follows that the larger the model, the more detail that needs to be added. Thus a model can almost become a snapshot of a prototype of a particular road/rail vehicle at a particular point in time.

You might search long and hard for a drawing which showed you the prominent rivet/bolt head pattern on L11's solebar that any good photograph would show you. Additionally, any pair of scale drawings drawn by different people will have slight differences. So it was with the drawings I obtained. In fact one of them completely confused the cab/contactor compartment detail of the Acton and Ealing ends of the loco. The lesson is not only that where possible all detail should be confirmed from photographs but that you should always confirm critical measurements. The relative consistency and thickness of the lines used within a drawing and between different drawings can also vary and makes transferring measurements problematical – especially after enlarging. Often I have found myself having to completely redraw a drawing or at least having to heavily annotate it with measurements to maintain consistency. As a result, it isn't essential at the outset to have highly detailed drawings if good photographs exist. My 0 gauge model of the long-extinct L8 was designed entirely using Piers Connor's excellent schematic drawing in the December 2009 *Underground News* with added detail from photographs supplied by Brian Hardy. Other models like the 1940 Waterloo & City Line double-ended DM and trailer have been based in large part on the very useful sets of drawings and advice available from the Society's Modelling secretary, Fris Friswell.

Fortunately L11 existed and not only could detail be readily photographed from the car park at Epping Station but it also had its own website with some internal photographs. There was also a 1931 pilot motor car at the LT Museum Depot which on request was available to be photographed and measured in detail.

PATTERNS

As mentioned previously, no LT-type fittings were available commercially for this model. In practice, Z bogie axleboxes, cab front auxiliary connector boxes, brake pipes, "Deadman's Handle", front door handle, contactor compartment ventilation louvres, cab rear bulkhead fuseboxes etc., all had to be photographed and measured. After much trial and error, this was made much easier by laying a tape measure alongside the particular part and photographing it with a digital camera but eventually a scale drawing on graph paper had to be drawn for each. If the possibility of two visits to a prototype exists, then sometimes I will just take notes and digital photos on the first visit and print copies of them onto A4 sheets of paper. These are then annotated with the dimensions needed in time for the second visit and the figures written directly onto the prints.

Leaving aside wheels, motors and gears for the moment, to produce a model of L11, indeed almost any model, in brass requires two different types of components. The body work is essentially formed from $^{3}/_{8}$mm [15thou] [0.375mm] brass or Nickel-Silver [actually an alloy of brass and nickel] sheet and the fittings mentioned above from brass or white metal castings. Taking the castings first, as they are the "show stoppers", they divide into two groups. There are those that are formed of simple prismatic or geometric shapes. Straight-forward examples would include L11's shunting headlamp or square/rectangular switch- and fuse-boxes that sit on the cab rear bulkhead – these are straight-

forward to produce from tubular or box-section brass [or plastic] soldered or stuck to a base plate. Slightly more difficult would be the Westinghouse brake controllers which consist of different thicknesses of brass or copper wire with thin sheet and brass nuts soldered to them.

Rather more difficult are items like axleboxes/brake pipes/curved roof vents and collector shoes. These highly visible and intricate items need to be made accurately. At the time there seemed to be no alternative to getting some of these made by a professional pattern maker. I have to say that this was a forbiddingly expensive business. On the one hand, pattern makers are very much a dying breed and so difficult to find. Secondly, even being charged no more than the minimum national hourly rate, a one inch long Z bogie axlebox with springs will set you back £250. That is without the subsequent costs of having a mould made from the master by a jewellery foundry and then having brass copies cast. Having said that, they are beautiful examples of workmanship and the subsequent brass copies are only a pound or two each. To some extent that also dictated the choice of prototype as these components would also work on any other Standard Stock DMs and their derived ballast and pilot motor cars.

BODY – THE HARD WAY

As far as the below-roof bodywork went, essentially it was divided into two cabs, and the four sides of the two back to back contactor compartments – one pair being rather longer than the other because of the presence of part of the forward passenger compartment.

There are three ways of treating brass sheet to produce a shape that can later be folded to form a complex shape like a Standard Stock DM cab – it can be cut into shape, etched or pressed in a die. Die pressing involves making two slightly oversize interlocking steel presses which have a sheet of metal trapped in between and are then screwed together distorting the metal sheet into the required shape. For some simple shapes such as convex smokebox doors it is practical though you would need a toolmaker and his lathe to make you one. It isn't practical or economical for half a dozen complex cab fronts. Etching produces an excellent result and is useful and cheap if producing many copies. On the other hand, if just producing a couple then a piercing or fret saw will do. The way to do it is to draw the shape you want to cut onto paper and stick it firmly to the brass with e.g., a "Pritt Stick". This involves taking careful measurements from the cab drawing and remembering that it is not the perceived measurement across the front face which is important but rather the actual length of the sloping/angled cab front. Bear in mind that these cabs were not flat-fronted – the driver's [and opposite] window side of course being angled rearwards and laterally. Then just cut around the shape and finish off with fine files. Brass stretches slightly on bending but no more than the same thickness of plastic card so it is worth cutting out a few test pieces of plastic card and trying those out first. The side extensions were bent back by folding around a 2mm diameter rod to give the appropriate radius. In an ideal world, these extensions would bend back symmetrically – but when taken together with the need for the upper half of the body to also taper inwards, several attempts may be needed.

BODY – SLIGHTLY EASIER WAY

All of this was do-able but was slow and not always one hundred percent reproducible. However, for a one-off model this was no great problem and I was in no particular hurry. Then four years ago I was asked by Radley Models whether I could produce L11 as an 0 gauge set of parts that could be cast in resin and subsequently sold as kits. The castings presented no problems as they had already been produced. The problem was the sheet metal work. Most brass used in this sort of kit is around 10 to 15 thousands of an inch thick [approximately ¼ to ⅓ mm]. The polyurethane resins used by industrial casting companies need to be at least 1 or preferably, 1.5 mm thick for rigidity. Therefore the masters used for the moulds need to be the same thickness. There was no realistic possibility of thickening up the body and cab sides of the existing model or rebuilding the model in thicker material as 15 thou is pretty much the limit of readily bending sharp angles in brass.

The outline drawings for the driving cabs and body sides that would be stuck down on the brass were done in a 2D CAD package called "AutoCad" made by a company called "Autodesk". The reason for using that package is that both line thickness and length could be controlled which would solve the previous problems caused by using conventional pens and pencils. Although other vector drawing software packages such as "Corel Draw" could have been used, "AutoCad" had the advantage of far

better control of drawing line length. It isn't a simple, cheap or intuitive package to use straight out of the box however and, like many non-professional users, I attended evening classes at the local "Tech". Firstly, I discovered that "AutoCad" is excellent for drawings that will be used for producing the photographic films that are used by chemical etching companies. This suggested that body thickness could be increased by laminating identical pieces of brasswork together although it meant that each individual sheet would need the exact same curve manually bent say, around the cab front or passenger doorway. Secondly, it meant that only half of say, a cab would have to be drawn – the other half being the same, the software could attach a mirrored half to the original half.

For drawings with complex curves such as the roof section of L11, the need to only draw one half and then have the computer finish the drawing in this fashion saved a lot of time and grief. My initial plan was to cut out a series of identical roof sections in brass sheet, solder them upright and sequentially, like dominos, to a strip of brass and then fill in the gaps with something like "Polyfilla". Followed by smoothing down the sides and then when dry using that as a master to produce resin roof lengths. This would be done using one of the many readily-available room temperature cure latex moulding materials with two part rapid setting resin. Resin roof lengths could then be trimmed and applied to the vehicle body. This worked – though much finishing and fettling was required. If I was building a one-off for someone else then this process could be used but the amount of fiddling and fettling required would not be much fun for someone buying a kit who might rightly expect that these design limitations should have been sorted out by the designer and not left to the hapless purchaser to sort out.

SUBTRACTING AND ADDING

Even more useful was the discovery that "AutoCad" has a basic 3D capability. Essentially this is an "extrude" command. What this means is that any basic shape such a square, diamond, triangle, circle or indeed any 2D shape where the bounding lines didn't cross over each other could be used as a base and then pulled to whatever height required. A slice through this object at 90degrees to the axis would always give the same shape as started with. So if you had drawn a shape like the club shape from a pack of cards, and extruded it, you would end up with a mass rather akin to a very crude clerestory roof of potentially infinite length. Once the shape had been extruded you couldn't do much more with it but it was still quite a useful trick. The real trick of course would be turning that 3D computer image into a solid form. Oddly enough, something similar was possible in the woodworking business. Long sections of e.g., coving, picture rails and skirting boards had long been produced by computer-controlled milling machines and routers and some model makers had indeed produced 0-gauge carriage roofs this way. This is of course a subtractive process – you start with a long block and remove bits of it until you get the shape you're after.

As it happened, "The Tech" had another suggestion. They had just acquired an early example of additive technology in the form of a stereo-lithographic printer [SLA] and were keen to try it out. Imagine if you will, an inkjet printer which firstly, instead of ink, uses a fine instant-setting glue and secondly, instead of using paper to print on, uses a flat sheet of very fine powder on a bed that can move downwards in very small steps. The printer control software takes the [virtual] extruded roof shape and slices it into a series of hundreds of very thin horizontal slices. The printer then prints out the first of these shapes onto the powder. Once complete, the bed drops down a fraction and the glued area is covered by a thin layer of fresh powder and the next slice is "drawn" in glue. This process continues until every horizontal slice has been printed. The loose unglued powder in each layer has, all the while, been filling undercuts such as those supporting the overhanging clerestory eaves found on all later standard stock cars. The loose unglued powder is then brushed away and the 3D shape seen on the screen is now sitting on the printer bed essentially consisting of a laminate of glue and powder. Often these will require to be cured – usually with UV light. Although eminently suitable as masters for casting purposes, many types become brittle with age and are not themselves suitable as major structural parts of say, a model railway carriage. They tend also to be heat sensitive and can distort if not cared for.

Over the last few years, other additive technologies have sprung up. Most still use software to horizontally slice the drawn object into thin layers and then recreate them either by this type of printing or by firing a focused laser/other beam of light into a tank of jelly which hardens where it has been hit by the focused beam. Still others take a spool of plastic or metal wire and cause the end to be vaporized and build up an object using this condensed vapour. Whichever process is used, the

end result is what matters. In practice this is related to the resolution of the machine which in turn dictates the level of fine detail possible. Firstly the size of the vertical step between each printing pass dictates how many layers are required to build the object and in turn dictates the time taken. The more layers, the more time, the more detail, the smoother the surface and the greater the cost. Secondly the size of the "print head" dictates the smallest object that can be built. Having said that, there is no point building small rivet heads on the solebar of L11 if they just rub off when handled. In practice, that has meant that if producing a run of hexagonal nuts 0.5mm diameter and standing 0.35mm [securely] proud of the surface, the machine has to have a resolution of around 16microns. The micron is a unit of length – 1,000 microns equalling one millimetre [alt. 25,400 microns equalling one inch]. Incidentally, sixteen microns is very slightly more than twice the diameter of a red blood cell!

Understandably, these high definition prints might be considered overkill if just producing segments of carriage roof so coarser resolutions are readily available at lower prices. Essentially, you get what you pay for and you pay for what you get!

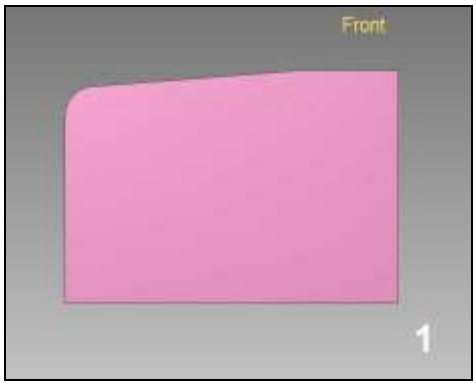
3D DRAWING

The other advice from "The Tech" was that if 3D printing was likely to be the way ahead in my modelling then I should consider a move away from "AutoCad" to a recent and more specialised product from the same manufacturer viz., "Autodesk Inventor". This is one of a series of rapidly evolving 3D drawing packages that not only extrudes an object in the same way as "AutoCad" but can then perform a very wide range, and large number, of individual cutting, revolving, joining, chamfering etc., actions on the object. Further, if need be, the part can be seamlessly fused to other similarly constructed parts to form an assembly and the composite assembly printed out by any SLA printer. In addition to this, the program also automatically produces orthographic, exploded, labelled and/or perspective drawings of each component or assembly – all very useful if having to produce instruction sheets showing someone else how to build a model. There are several similar programs available e.g., Solid Works, ARES, CATIA etc., and all have individual strengths but all are capable of this same type of activity often referred to as "Parametric" or "Solid Modelling".

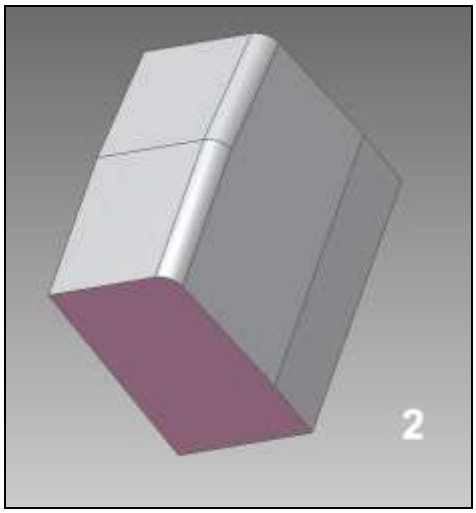
The software is simple to load [it runs under 64bit Windows 7] and used straight out of the box but once familiar with the interface, it makes sense to get some formal training as there is often more than one way of solving a problem and with practice come time-efficient shortcuts. Many colleges run short evening courses on this type of software and additionally there are hard copy manuals and DVD-based courses available. One characteristic of all of these software packages is the on-line help. The packages are so widely used that someone somewhere has had the same problem you are facing and has published the solution on the net! As is often said when referring to word-processing packages, the average user will only use a tiny percentage of the software's capabilities. The same is certainly true for this type of software. The particular software packages mentioned are industry-standard ones used to design everything from nuclear submarines to racing cars to Olympic stadiums. Not surprisingly, their price also reflects that.

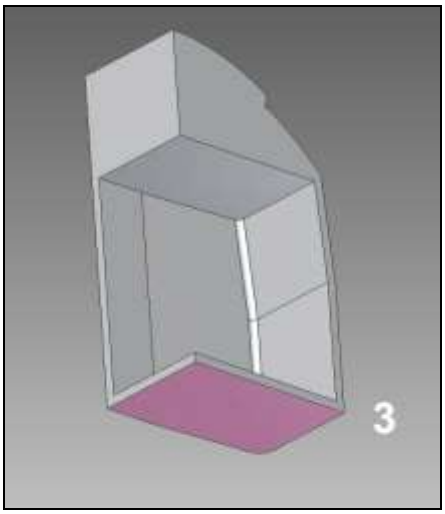
1925 CAMMELL LAIRD DRIVING MOTOR

To give an example of how straightforward [albeit with some practice] it can be to produce a model, there are a series of screen shots showing the stages of construction of a virtual 1925 Cammell Laird DM. A fuller description follows of each picture:

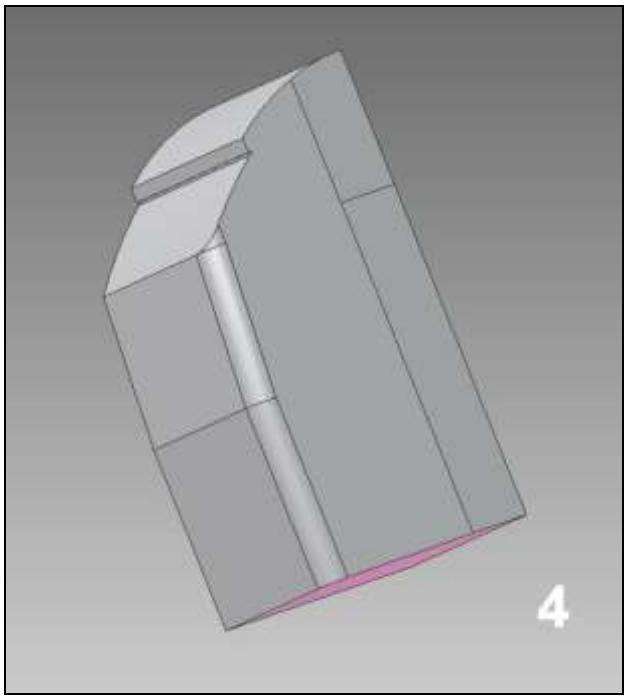


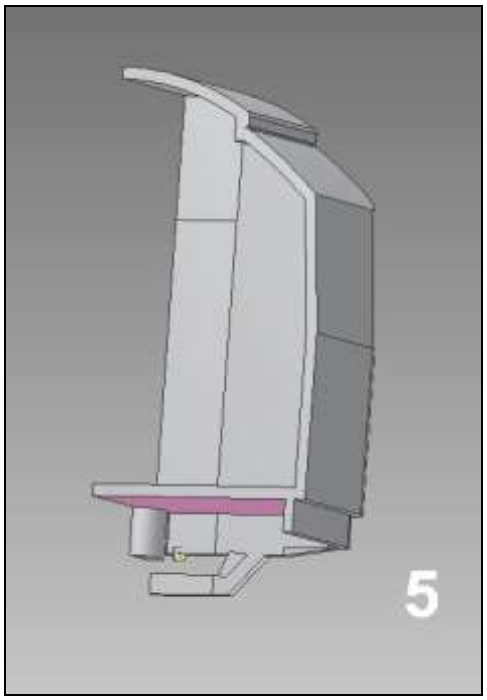
1. This is the RHS cab floor of the DM awaiting extrusion.





2. The floor plan sketch has been extruded to the level of the cantrail [roof eave] and the angled part of the body above the waistline created by slicing away an appropriate angled segment of the side. At the moment this is still a [virtual] solid block.
3. Looking from behind, the previously solid extrusion has been hollowed out ["shelled" in techno-speak] – in this case to a uniform thickness of 1.5mm. Additionally a clerestory shaped sketch has been drawn on the roof of the cab and extruded forward to the angled cab front.

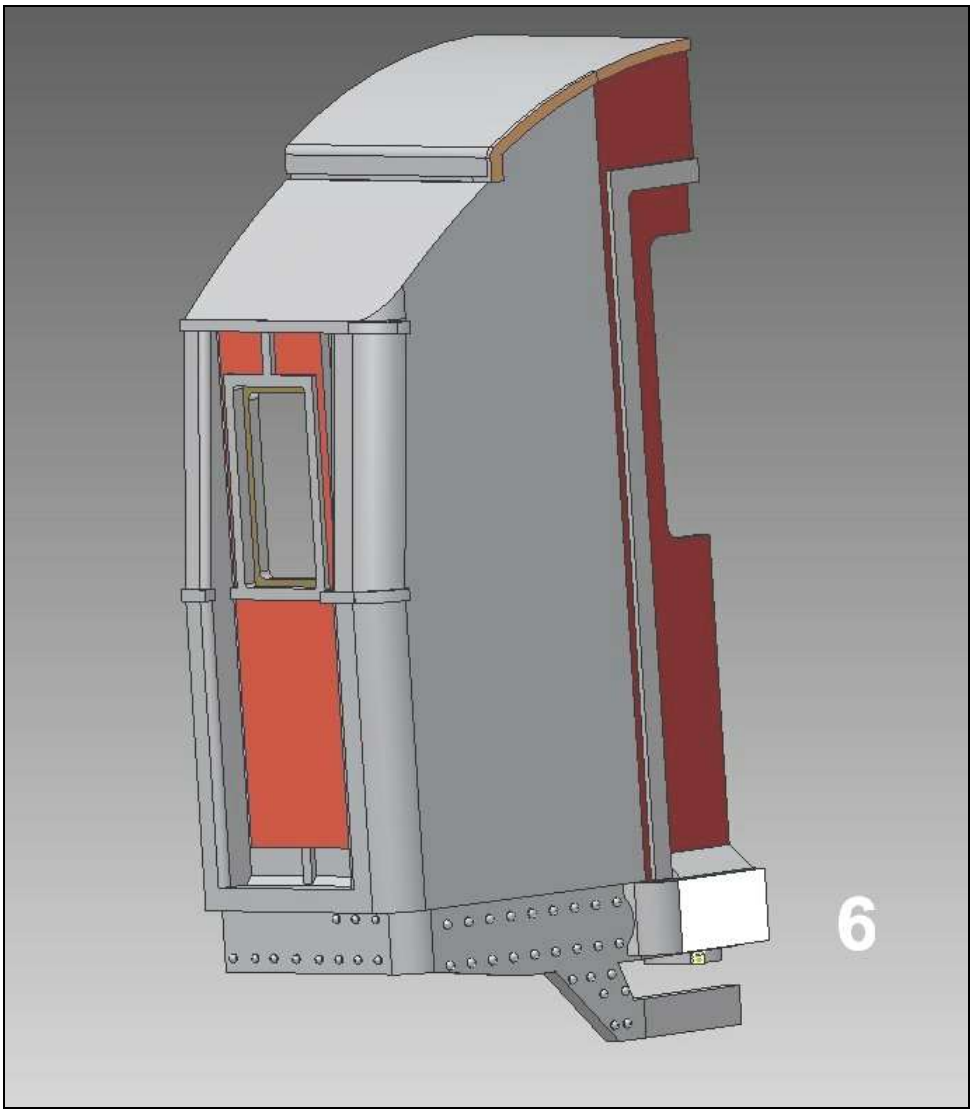




4. Looking at what will recognisably become the cab front – in fact at this point the guard's end of the car and the cab are still identical.

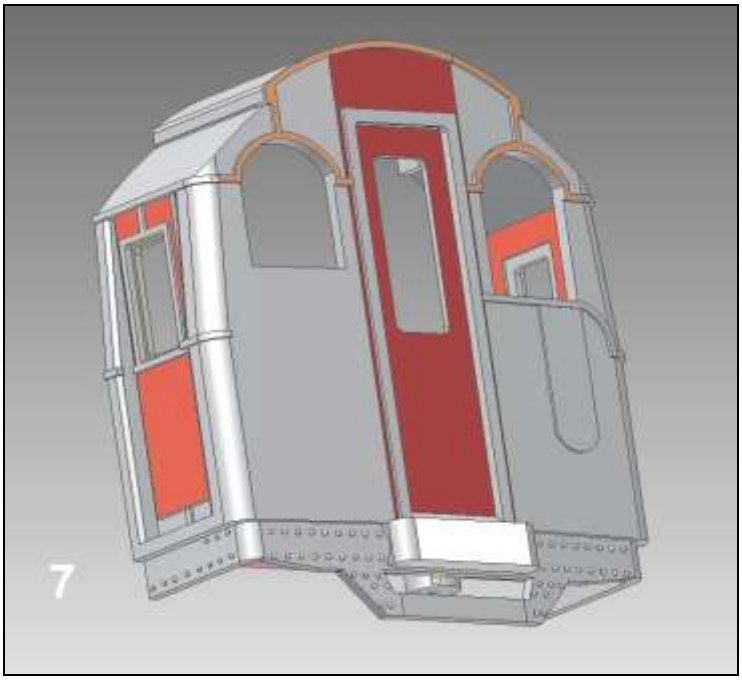
   Obviously, a copy of this stage will be the start point for the guard's end rather than starting from scratch.

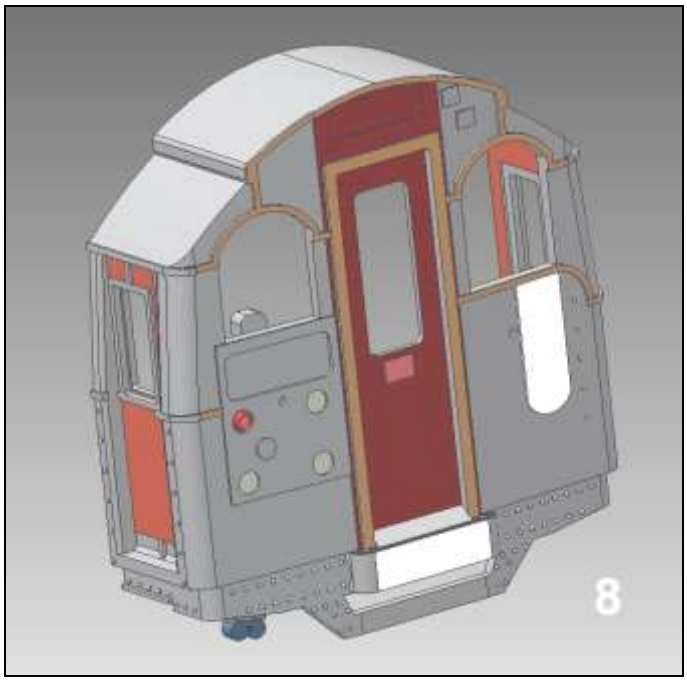
5. The clerestory has been shelled out to match the rest of the cab. This sort of task is simply a matter couple of key strokes/mouse clicks.

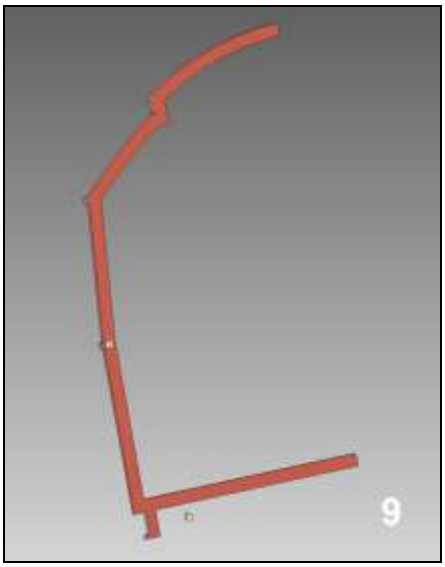


6. The front of the solebar/headstock with the ward coupler mounting, buffer and rivet pattern is visible. Half of the cab front door and the side door are pretty much complete. Similarly, at this stage, this cab could either be turned into the 1925 Cab as built or the modernised type.
7. The cab has been mirrored and the two halves fused prior to detailing the two sides of it. Front windows, headlamps etc., have become handed after modernisation so need to be done at this stage. If the original cab front with equal sized windows was being built, then the lateral window could have been added in the previous stage before mirroring.

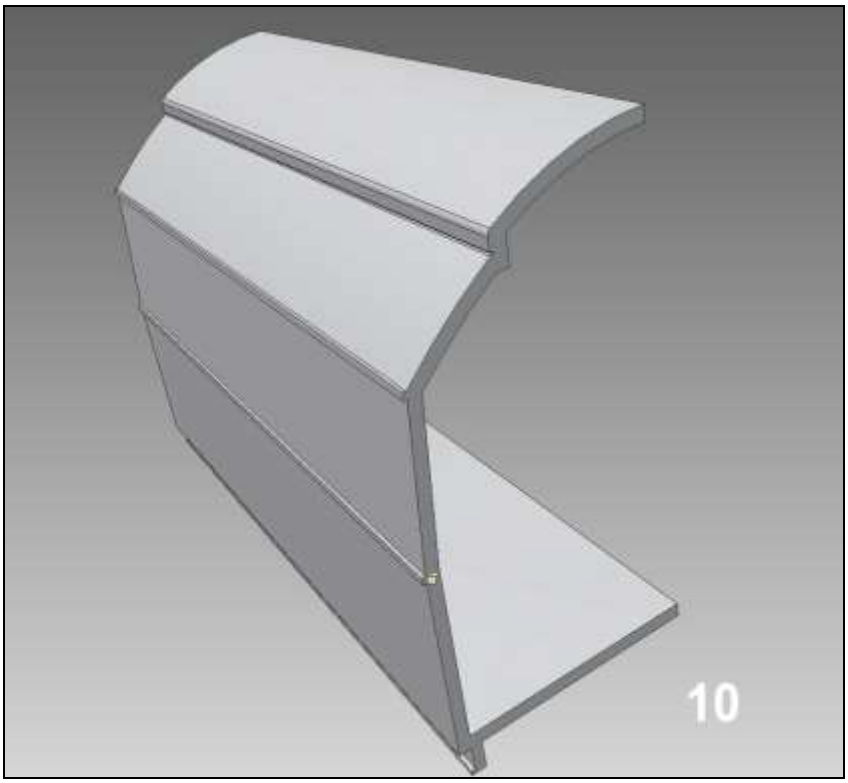
8. The cab front is now more or less complete. I was once asked about just building LT Underground train cabs, painting them and sticking them individually onto small wooden plaques as wall decorations or even as fridge magnets ..... In fact any of these individual stages could be SLA printed and duplicated.





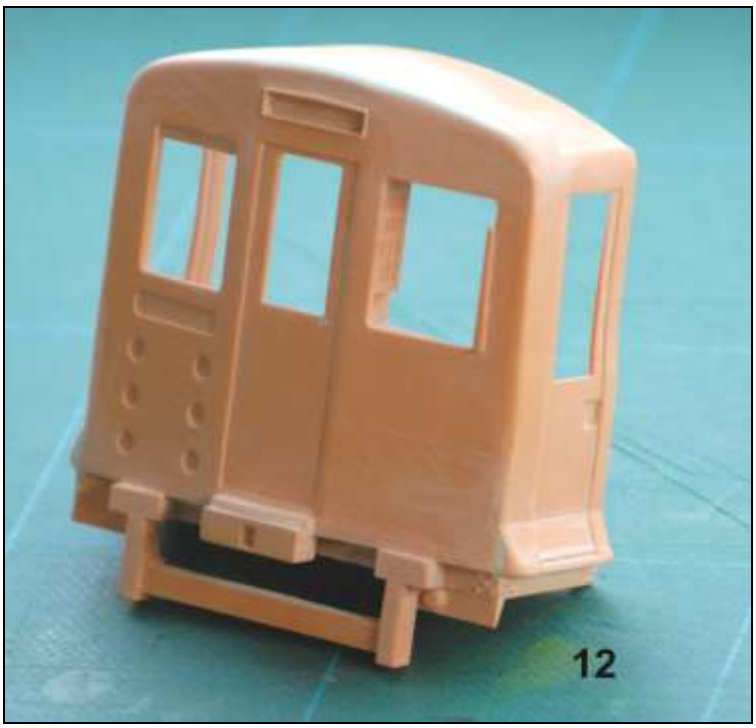


9. At Stage 5, i.e., when the cab and clerestory outline was complete, a 1mm slice was taken off the back and saved as a separate file. Obviously this will have the same profile as the back of the cab so a body formed by extruding this will abut flush to the cab if need be. It is more obvious in the next picture but note that the roof, body side and floor are all part of the same extrusion. Thus no problems with marrying up adjoining sections should arise as they might do if these parts were separate brass, resin or white metal elements.
10. This is a 90mm long extrusion of Stage 9 and will be used to form both the forward and rear passenger compartments. Some work will still be required to produce the varying roof profile found on this stock as well as the contactor side vents and the double doors. As these are both paired structures, only a single one will be drawn and then mirrored.



11. (Overleaf). This is an assembly of the cab, trailing end, LHS contactor section and LHS rear passenger section. The Y and V2 bogies are added as these assemblies are useful to check clearances. In this instance the rear passenger compartment seating will need to be raised off the floor so as to make room for the wheels of the trailing bogie. The car body is complete [less rainstrips and roof vents] but the cab and trailing end will need the auxiliary control connector boxes added. Only two boxes will be added to the cab/trailing end when sending it off to be SLA printed [also referred to as “rapid prototyping” or “RP”] as that allows the final builder to add one extra himself.

This can be on one side or the other, depending on whether the end is to be an “A” or “D” end.



12. This R49 DM cab was modelled from Piers Connor's schematic in his LURS monograph on the R Stock and further detailed following visits to the preserved survivor at Acton. Essentially it was built via the same stages as the Standard Stock cab – just using different inputs.

On odd occasions I have produced SLA cab masters of Southern Region EMUs which have subsequently been used as bases for white metal castings.

These have then been "married" to brass etched body sides and the end results can be rather impressive. It isn't something I do with the early twentieth century LT models because there needs to be a separate carriage roof with the problems previously mentioned.

RESEARCH, LIAISON AND SHOW-STOPPERS

Modellers in 7mm scale quite rightly expect to see that sort of level of detail taken into account but some times both large and small detail just can't be confirmed and intelligent guesswork is required. For example, I have no real information on the cab layout of these particular 1925 CL cars but it is a reasonable assumption that they were laid out broadly similar to the 1927 MCCW car [3327] preserved at The Museum Depot. There is a saying amongst railway modellers that the best way to find the answer to this sort of question is to go ahead and build it – as soon as you've done so, someone is bound to come along and prove to you that you've got it wrong!

Where it's a small matter, perhaps it can be glossed over but sometimes the lack of a small amount of information can stop a project from getting off the ground at all. I have a reasonable amount of information on the underframes and bodysides of the 1920 F Stock but nothing on what the cab rear bulkhead looked like or what the guard's area layout was – or even confirmation that the guard was situated in what was the demobbed cab of the original double-ended DMs. I suspect that the arrangement was very similar eventually to that found in the G to Q23 conversion where the end windows were plated over and the guards controls mounted on that rear wall. But without speaking to an F Stock guard or driver [the very youngest would be 70 or so now] it seems impossible to confirm. I make a point now of carrying a digital camera and tape measure with me. What is commonplace today won't be tomorrow which makes societies such as ours with their corporate memory so important and valuable.

Research and forward planning is thus essential and can not only affect what is built but how it is designed and built. As stated, the majority of these parts will go forward to SLA/RP and some will become masters for lost wax castings and others for resin castings. Some knowledge of how these two different processes work is essential if time and money is not to be wasted. Invariably, casters and mould makers are delighted to speak to pattern makers to advise on the limitations of their processes so that nether party wastes time and effort. To give an example, those readers familiar with the shoebeams latterly fitted to the R stock will be aware that they were handed as there was a semi-circular boss on the end of the shoebeam mounting on the axlebox which was handed. When I originally drew both Right and Left axleboxes and these mountings, I sent both drawings off to the firm, which was going to both produce the SLA masters and then use them to cast copies, to confirm whether it was possible to cast these parts. They advised removing the mounting boss from each axlebox so that each axlebox was now identical and thus only one master was required. They also advised that the two mounting bosses could be RP and cast as a separate item. This saved the cost of a mould charge and a significant RP charge. More importantly, the success of this particular model meant that I would never again have to pay others to make patterns for me.

When drawing an item that will be sent to a foundry to be cast, it makes sense to add an extra piece to it that will form the union of the part and the casting feed. If you don't, then you might find that a detailed part of the surface has a blob of brass on it that needs to be carefully filed away. How do I know this .....?

Thinking about the design before picking up the computer mouse can save much grief. I had just completed an 0 gauge model of the 30 ton LT Flat Wagon and needed something to fill the bed of the wagon. I thought that putting three 0 gauge skips into it and attaching it to my 1939 battery loco to go around stations at night to collect black plastic rubbish bags made sense. So I went off to find a suitable skip to measure – there never being one around when you want one! After rather confusing a local builder [who I'm sure still thinks that I came from the local council and had some devious tax-based reason to measure his skip], I drew one and produced a SLA model. Actually I only needed to draw a quarter of it as it was both bilaterally and longitudinally symmetrical. Two mirror commands turned the quarter into the whole. An identical process of just producing one quarter and twice mirroring it was also used when designing the 4-wheel wooden sided MET ballast wagon. Incidentally, the black bin liners will probably be made out of DAS modelling putty in due course.

Another area where it is worth speaking to the SLA company relates to how big a model they can make. An early Standard Stock car in 0 gauge is about 35cm long. The working bed length for many high resolution SLA machines is about 20-25cm. That dictates firstly that a complete car can't be produced in one go but also, that it needs to be sliced up/designed in sections. In practice that means two ends and four half body sides. When I produced the District Q23 DM and the associated double-ended G class South Acton shuttle, there was a different consideration. Once the two cabs/cab and guard's end were removed, the sides of the vehicles were symmetrical and true mirror images – both Left side and Right side as well as end to end. That way, only three parts needed to be made as each could be copied and the six parts together would make up the complete car. The downside of producing the Q23 was the large number of underframe fuseboxes, grids, compressor, air tanks et al. This involved making arrangements with Covent Garden to lurk underneath 4284 to photograph and measure the parts one Friday before the museum opened to the public. Each separate part was individually drawn and carried its own SLA and moulding charge so the complexity of a carriage dictates its cost. Hence the value here of being able to produce the car body with three parts rather than four.

Shrinkage of metal castings appears to only be significant with large lost wax castings. It appears not to be a noticeable problem with something of the size of an 0 gauge axlebox. As far as resin is concerned, I have not noticed any significant shrinkage but then if the whole model is resin, only differential shrinkage is likely to be of concern and that is particularly unlikely. In practice I have never had to produce masters oversize to take into account shrinkage of castings. However, if it ever became an issue then, as previously stated, it would be straightforward to proportionately increase the overall size of the master by a few percent.

One unusual problem with casting masters relates to hollow spaces. I was producing the air cylinder that is attached to one side of the Standard Stock DM underframe by the centre doors. I took a short length of brass tube and soldered a couple of thin strips of brass around it to suggest ribs. The ends were then plugged with Isopon filler and sanded into smooth domes. "Job Done", I thought until I got a call from the white metal caster who told me this master had exploded in his workshop. He was using a hot-cure vulcanising rubber to make the mould and the air/epoxy vapour trapped inside the sealed tube had expanded and forced itself violently out through the Isopon plugs!

SCALING UP OR DOWN

Clearly most G Stock components will be common to the Q23 but parts such as the K2 trailing bogies might also find use under late-period Dreadnought coaches so commonality can also influence choice of modelling subject. The same applies to the afore-mentioned model of L8. The US-style bogies on this loco were common to the 1907 AC&F Hampstead Stock and so a model of the original double-ended Acton shunter L10 is feasible. The same bogie was also used on the two Hungarian-built Piccadilly/Hampstead "Gate Stock" DM cars converted to battery locos [L11 and L12] and even the 1905 District Railway electric locos.

Whilst personally I prefer 0 gauge models, one of the cleverer aspects of “Inventor” is its ability to scale objects. Whether designing a trolleybus, tube car or a rubbish skip, I always scale the base source drawing to a simple multiple of 0 gauge. The reason is that over time I have become familiar with the conversion table of feet and inches divided by 43 and output in millimetres. Once the completed design is finished [be it a single part or a grouping of parts in an assembly], it can with very few mouse/keyboard inputs be e.g., shrunken to 0.571 of its size i.e., 00 gauge and sent off for RP. As mentioned previously, the bed size of many RP machines is 20-25cm and that makes them capable of printing an entire car in 00 scale. If doing so, it no longer makes sense to separate the cab from the body or send off four separate body sides. What is actually sent off for SLA is usually an assembly resembling a five-sided open box. However, the software shrinking process is uniform so every wall thickness has also been reduced to 57.1 percent. These walls will need to be re-thickened to 1.5mm prior to SLA but that is straightforward.

Any other larger or smaller scale is possible of course. Many modellers for example prefer $^{1}/_{64}$th scale [S gauge] or $^{1}/_{148}^{th}$ scale [N gauge] and it presents no problem producing SLA parts in those scales from Inventor 0 gauge drawings..

TRAIN SETS AND MOTORS

Many 0 gauge modellers do not have a layout at home though they may well attend “running sessions” at a model railway society locally. An 0 gauge layout where trains can be run at high speeds will take up quite a lot of space. Hence many 0 gauge modellers are perfectly happy to just produce models and keep them on a shelf most of the time. Personally, I don’t have a layout but I do have a diorama base which appeared in these pages some months ago and which forms a backdrop for these models when displayed at exhibitions. Whether they go out on club days or whether they run up and down a short stretch of track on a mantelpiece, the models will need a motor and gearbox.

Motorising LT rail models whether steam, electric or diesel prototype is not straightforward because of the presence of the negative return rail between the two running rails. The conventional motor and gearbox combination will cause the gearwheel to hit this centre rail – perhaps all the time or possibly just when crossing points. Thus the first consideration, if using this type of motor-gearbox combination, is to use the smallest diameter gear cog possible. Personally, I’ve found that a Roxey 26:1 gearwheel gives sufficient clearance as long as the vehicle has scale 3ft [or larger] diameter wheels on the motor bogie. A gearbox that will take this cogwheel is available for both common [16xx and 18xx] sizes of small motors.

Figure 1 below is hopefully self-explanatory but, in essence, the motor bogie consists of several parts. Firstly there is an outer cosmetic bogie frame with cosmetic axleboxes attached to it. This has an inner functional chassis inserted into it. This inner chassis has the two axles passing through it and the wheels are outside the inner chassis and inside the cosmetic bogie frame. Halfway along the upper face of the inner chassis, which is really a five-sided box, there is a slot through which passes a bolt attached to the underside of the carriage. Rearwards of this slot is a square hole through which passes the upper part of the motor/gearbox combination. The lower part of this combination is the gear cogwheel through which passes the rear axle.

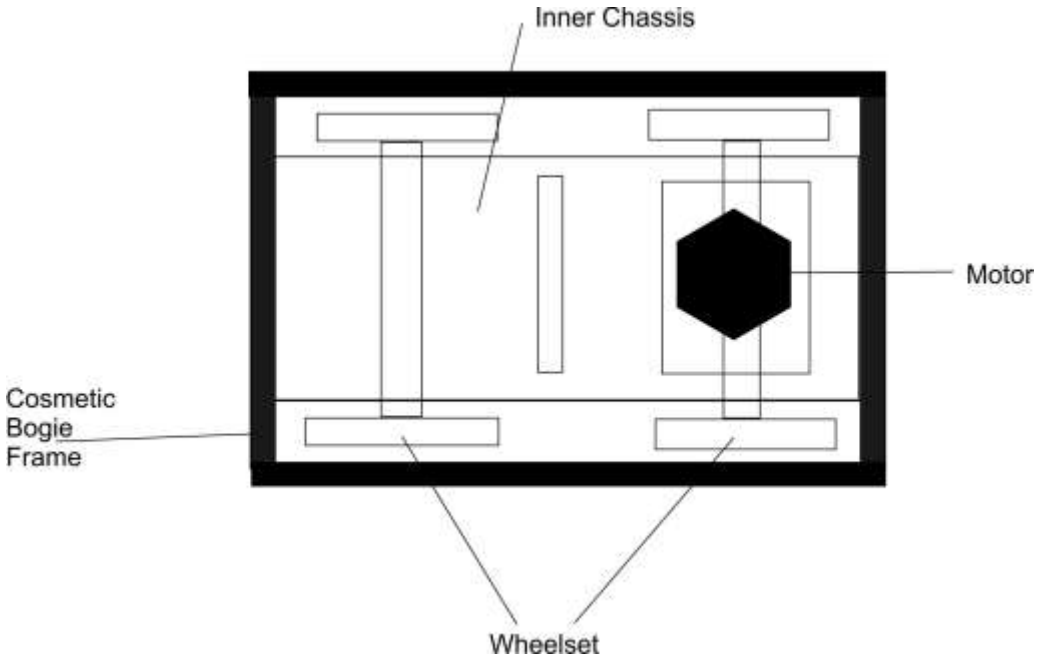


Figure 1 – Looking Down on Conventional Motor Bogie – Outer Frame and Inner Chassis.

One downside to using this type of motor/gearbox combination is that because the motor/gearbox combination is vertically above the rear axle, it will probably penetrate some part of the car. As far as the Standard Stock is concerned, this doesn't matter as the protrusion is into the windowless contactor compartment from whence strange noises are expected anyway. However, it is a problem with vehicles like the R49 DM where the motor protrudes a little way into the passenger compartment. Personally, I can live with that compromise if I have to.

The second downside is that several of my personal favourite tube stocks employ smaller driving wheels and therefore don't have sufficient clearance for this type of gear cogwheel. The car I would really like to build is the charismatic red-painted 1935 Experimental Tube Stock car 10010 which had 2ft 8in driving wheels but this would need an alternative method of motorising. However, there is a solution, albeit currently fairly expensive.

This solution involves mounting a small diameter motor horizontally within the inner chassis parallel to one or other axle and using that to rotate a gearwheel connected by reduction gearing to whichever axle it is closest to. In this arrangement there is no motor protruding above the top of the chassis and therefore no need to make a compensatory hole in the floor of the car. At present "ABC Gears" manufacture bespoke motor chassis of that type with a choice of one or both axles motored but other manufacturers are looking at off the shelf solutions using a newer generation of small motors.

IN CONCLUSION

Railway modelling is a broad church. There is no right or wrong way to go about it. Many fine modellers do however currently consider that using resin and computers is somehow "cheating" and not really being "engineering in miniature". Perhaps it isn't, but life is short and this process works for me and allows me to have shelves of models of prototypes remembered from younger days that are firstly, unique and secondly, exactly what I want.

Producing the models in this way means that they fit together without much fettling. It also means that the number of parts are kept to a minimum with consequent reduced costs. Once painted, it is not obvious that the models are not metal based.

In addition to those mentioned by name, I would also like to extend my thanks to all those members of LURS and the staff of the LT Museum who have helped by supplying me with information and encouragement.