

Modern Tram with a New Type of Scratch Building

David Voice describes a method of scratch building with a difference.



DLR Class B2K car 94 at West India Quay station in 2007. Photo by John Prentice

INTRODUCTION

In the past I have given details on the use of brass strip to make model trams. I am still in favour of this technique, but it has been described several times now, so I thought a different method should be used in this new model. The technique I will describe was developed by the late Vernon Cunningham for his 'O' gauge tramcars. I wanted to try it out and decided that the London Docklands Light Railway (DLR) cars would be ideal, particularly as I have wanted to build such a tramcar ever since I paid a visit to Essen and saw ex-Docklands cars running, still in Docklands colours.

However, back to Vernon's ideas. He had an interest in computer graphics and realised that he could compile and generate images of tram panels from photographs.



A line up of Docklands cars at Poplar Depot viewed as a passenger on the system.

Unless otherwise stated, all photos are by David Voice

He chose to make an 'O' gauge model of Leicester Corporation tramcar number 76, as restored at Crich Tramway Village. He started with a drawing of the tramcar and, with the permission of the draughtsman, he scanned the drawing. Then, a visit to Crich was undertaken and around 100 photographs taken. These were digitised and, using his computer graphics skills, he built up a coloured image of the sides, bulkheads and other panels. These were printed onto self-adhesive photographic paper and a clear plastic body shell was constructed of the upper and lower saloons. The appropriate printed panels were stuck over the shell. Then he cut out the windows, peeling the blank panels off, leaving a clear crisp window. The dash panels were made from brass cut and bent to shape and with printed panels overlaid both sides.

This method enabled a full colour overlay with all the lining, lettering and numbers to be produced which, quite literally, were a perfect reproduction of the original. The finished trams are superb miniatures of the real thing. I have had the pleasure of seeing Vernon's wonderful 'O' gauge tramway layout "Tramwick". It is a small portable layout that has all the atmosphere and feeling of a 1930s tramway. You feel as if you could actually board the trams for a ride around the streets.

LONDON DOCKLANDS LIGHT RAIL VEHICLE (LRV)

Reverting to the Docklands cars, the DLR was the second of the new generation of Light Rail/Tramways in Britain. It opened in 1987 and has been extended several times since. The first new generation light rail system was the Tyne and Wear Metro. Both it and the DLR run entirely on reserved track, while all subsequent Light Rail/Tramways have some street running sections. The Docklands system took advantage of this by using a third rail for its power supply and not an overhead line, although in early days one of the cars was taken to Manchester and fitted with a pantograph for demonstration running. The first batch of cars comprised eleven P86 stock. These were followed by ten more cars to the same design, but called the P89 stock. In 1990 new cars with sliding doors were built and called B90. These were followed in 1992 by B92 stock and in 2002 by B2K. In the meantime, the P86 and P89 stock had been sold to Essen for operation under overhead wire with pantographs as they were no longer suitable for the demands of the DLR.

I decided to make one of the more modern design of cars; the B2K class built in 2002, for which I had plenty of photographs suitable for the model. The

new cars were given numbers from the end of the original batch. However, the 2002 batch reached number 99 which was the limit of the DLR computer operating system, so the remainder of the batch were given old numbers from the original cars. This gave me the opportunity to make car number 01.

I decided that it would be simple to draw the car as it was a very straightforward design. I used the dimensions given in the third edition of the Official Docklands Handbook but, as this is now out of print, I repeat the key dimensions here:

Length	28m
Width over doors	2.65m
Height	3.468m
Bogie centres	10m
Bogie Wheelbase	2.10m
Seating	70
(24 transverse, 42 longitudinal, 4 tip-up)	

I will not give details of using the computer as there are numerous graphics software programs and each has its own system of operation. Suffice to say that you will need a flat-bed scanner, suitable photo-editing software and an inkjet (or colour laser) printer. I use Photoshop software, Vernon used Corel PhotoPaint-8, while Adrian Batt used Microsoft PowerPoint to produce advertisements for his trams and John Prentice uses CorelDraw and Paintshop Pro.

THE MODEL

I scanned the drawing for one side of the car then, using photographs, filled the appropriate areas with them scaled to fit the drawing. I found that the colours were a bit of a mixture, so I



My working sketch for cutting and assembling the body panels from 40 thou clear plastic sheet.

filled the areas with the appropriate solid colour. There is inevitable parallax from the camera, where the side appears to be curved due to the ends being further away from the camera than the middle. This can be corrected using the software. The livery of the DLR is basically simple and can easily be adjusted. I also added extra colour to the ends of the cars to allow the printed sheet to be wrapped around the body shell. This is all a time-consuming task, especially as it was my first attempt at this technique. But I was heartened in the knowledge that I would not have to paint the model. I repeated the task for the other side (the computer allows the

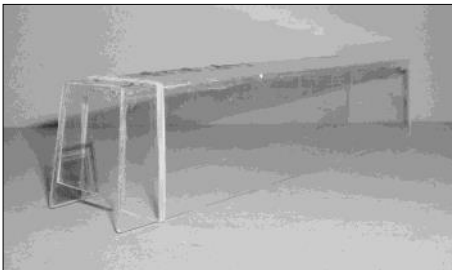
first side to be copied and then flipped end to end, so only a few more adjustments had to be made, mainly changing the end window for a smaller one). Similarly for the roof and the end. I also added a few extra panels of solid colour in case I needed them when making the model.

The body shell was constructed from 40 thou clear plastic sheet. This can be obtained from model shops or sourced on the internet. Using my drawing, I cut two sides, an end and the roof. I cut the sides to full dimensions of the drawing and the roof and end were adjusted to allow for the thickness of the sides (40 thou is 1mm).

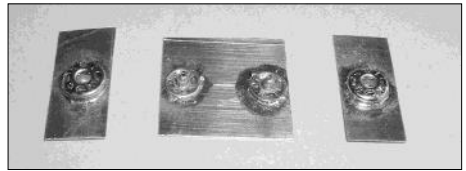


▲ Two sides, the roof and the end, enough to make the body of one unit of the vehicle.

▼ The parts glued together and held with an elastic band overnight while the glue set securely.



It was a simple matter to glue the four parts together to make the box forming the saloon. The articulated end was left open and I repeated the whole process for the other half of the car. I had decided to use Halling four-wheel mechanism. This very useful unit has two flywheels and an adjustable wheelbase. By moving one wheel out, I obtained the necessary 26mm wheelbase. Normally, the Halling mechanism clips into a moulded hole in the Halling four-wheel trams, but this was not a suitable way for me. I made a flat top cover from plastic card and glued pieces of plastic card under it that fitted either side of the motor and at each end of the motor, while keeping the cover central in relation to the wheels (not the motor). This gave a comfortable fit.

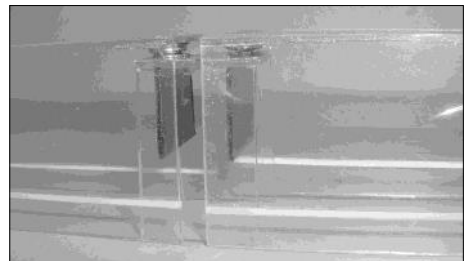


For the articulation I soldered press studs to brass shim ready to be glued in the bodies of the vehicle.

At this stage I was pondering how to achieve the articulation. The motor was quite high and I was sketching out ways of raising the floors in the centre of the tram, while maintaining strength and not interfering too much with the view through the windows, but I was not having much luck. It was then suggested articulating the model from the roof, using press studs. It was a stunning solution. There was no need to construct any special parts, as the roof was always going to have to be there, so I set to work.

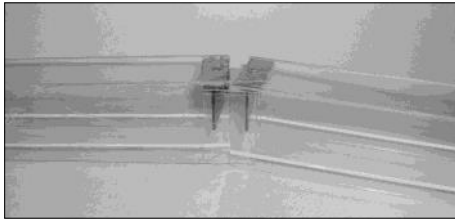
My first problem was how to hold the press studs in place. Previous experience had shown me that trying to glue press studs onto plastic was a futile task, as they would not take any strain at all and would just peel off. Then I remembered that I used nickel silver rails and brass shim to hold the studs in place when mounting Bec bogies into a Liverpool Green Goddess model. If I soldered the studs to brass shim, I could glue the much larger area of shim to the plastic. I used small rectangles that fitted the ceiling of the tram sections and a larger almost square section for the centre.

To give plenty of movement, I used Size 1 (9mm) female studs for the ceilings and Size 0 (7mm) for the centre section. I drilled a hole in the centre of the rectangles for the female studs, so they fitted flat to the shim. I marked the centres of the male studs on the larger shim and then soldered all in place. Note that as before I placed the female studs so that the retaining springs (two small wires inside the hole) were parallel to the length of the tram.



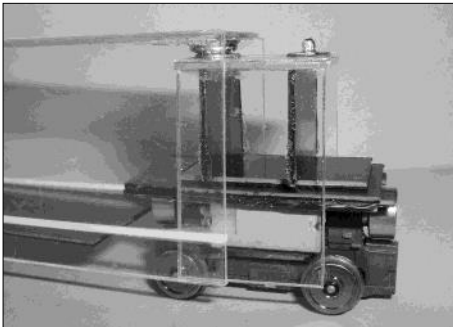
The two end sections and the centre section held together by the press studs to allow the bending of the articulation.

After checking that they fitted and moved easily I glued the rectangles onto the ceilings.



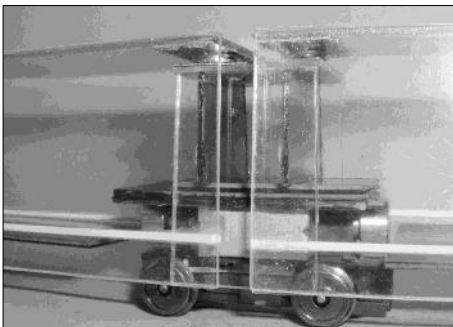
Testing the movement of the articulated joint

Using more of the clear plastic I cut two centre-section sides and a roof, plus two central formers, to give the distinctive slant inwards of the sides. The height of the sides was determined by clipping the brass shim with the male studs into one section and measuring the distance from the bottom of the shim to the bottom of the side.



The centre section with its Halling power unit and black plastic spacers.

Because of the thickness of the shim and studs, the inner roof is somewhat lower than it should be, but it is not noticeable on the completed model.



As this is an important part of the model I have included the articulation from another viewpoint.

The height of the inner formers was made so that when the roof and ends were mounted on the power unit, the central unit would be the correct height. It is best to err slightly on the low side, as it is easy to pack the motor cover with thin plastic to raise the roof to the correct height. When the roof and sides section is glued onto the motor unit there is a space in the centre formed by the roof, motor cover, formers and sides. I recommend gluing some weights, such as lead pieces, into this space, as it gives useful weight directly over the motor unit. I fixed the plastic cover to the motor by the simple, if rather crude, method of placing strips of double-sided sticky tape around the edges of the top of the motor and placing the cover onto them. This gives a good fixing, but one that can be broken if it is necessary to get to the motor for repairs.



The other two bogies are very simply constructed and fitted.

Next, I turned to the floors and non-driving bogies. I felt that it must be possible to make simple non driving bogies for a unit like this. First I took two 9mm diameter wheel sets with 2mm diameter axles for each bogie. I took 40 thou plastic card, using black to avoid the necessity of painting, cut four rectangles 48mm by 6mm and drilled two 2mm diameter holes 26mm apart and 2mm from one edge. I marked out one rectangle first and drilled the holes and, when all was well, I used that as a jig to drill the others. Then I cut the plastic away between the hole and the edge to give "U" shaped holes. Although the drills were 2mm diameter they always drill a little oversize, so the axles fit into the slots with enough freedom to rotate easily. I cut two rectangles (one for each bogie) 50mm by 12mm and four 12mm by 6mm. The larger rectangles formed the top of the bogie and I glued the others in place with sides and ends. Turning the bogie over, the wheels dropped into place and rotated freely. To hold them I glued a couple more rectangles of plastic 12mm by 10mm over the axles gluing lightly to the sides (being careful not to get any glue into the "U" slots. Finally, I glued a last rectangle 12mm by 5mm over the top in the centre and drilled a hole through the centre for the fixing screw.

By putting the centre section in place and clipping the end sections onto the press studs, it was possible to determine where the floors needed to be placed in order that the whole tramcar was level. I cut the floor from 40 thou black plastic card the width of the inside of the body at the height of the floor and long enough to reach the end. Taking the bodies, I then glued a length of 40 thou square plastic card strip inside the body at the correct height for the floor to locate up to. The easiest way to do this is to lay the square section in the correct place and then brush plastic liquid glue along the underside joint. When the glue dries it gives a good fixing for the strip. I checked that the floor rested on the two strips, then marked a hole on the centre line of the floor that was 52mm from the very front of the tram. I drilled it just smaller than the screw I used for the bogie. This allowed me to tighten the screw into the hole, cutting its own thread. The bogie was allowed to be a sloppy fit on the screw. I cut a second floor which fitted onto the first floor and between the locating strips. I marked the position of the hole on second floor, drilled the hole and, holding the two floors together, screwed the screw through both holes. Putting the upper floor to one side, I checked the location of the centre section and determined where the floor had to be cut to allow enough room for the motor unit. Then I glued the floor in place. This gave me a rigid body on which to place the printed body.



Now it begins to look like a tram. The printed paper is stuck over the shell and on the left-hand section the windows have been cut out.

I printed the graphics on to a sheet of photo quality single label A4 paper. This is self-adhesive with a backing sheet. It does have a border so the useable area is 186mm by 263mm, but this is large enough to print one section plus the centre on each sheet. It is can be sourced on the internet (several eBay shops).

Editor's note. Alternatively, the graphics could be printed onto a sheet of A4 White adhesive film. It can currently be obtained in laser or inkjet types from Mr Decal Paper (www.mrdecalpaper.com).

NOTE: *The printing is done on an inkjet (or colour laser) printer. This means that the printing can be extremely water soluble. From this point on you must ensure that your hands are completely dry whenever you handle the print and take care not to allow any liquid to drop onto the printed surface. Otherwise, you will get a smudge that is impossible to remove.*

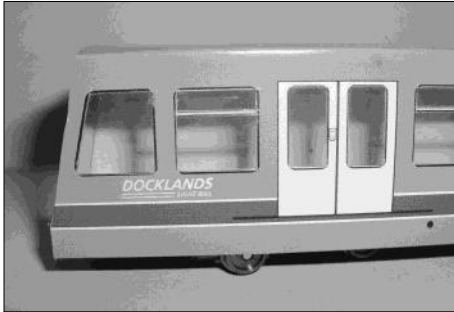
I had deliberately left an overlap of blue on each side to wrap over the roof and I also left the side overlong at each end. I put a small mark on the side where the edge of the inner end comes. I cut the bottom absolutely flush with the graphics. I checked that it fitted properly while leaving the backing paper on. This meant holding the side up to a strong light and seeing where the edges of the body lay in relation to the photograph. All was well so I took a deep breath and peeled off the backing paper and gently placed the side in position, making sure that the mark was on the very end of the side and that the bottom was flush with the bottom of the side all the way along. I only allowed small parts of the paper to stick to the body shell as I expected to have to have a couple of tries. I was quite right. It did take three tries before I was happy. Then the whole side was pressed down over the body side. I wrapped the excess at the top over the roof. This was cut so that it did not quite reach the centre line of the roof. I did not want to risk an overlap, so I left a small gap. I repeated the exercise with the other side and as I planned there was a small gap between the roof overlaps. Where the paper protruded beyond the centre section I cut along the fold and the thickness of the plastic below. This let me fold the side excess around the end of the side. I did the same for the roof, cutting the excess to allow it to clear the female stud. I was now left with excess at the front. Taking the craft knife I carefully cut along the end of the plastic side to give a clean-cut ending exactly on the end of the side.

You may find that the sticky side of the paper does not hold it fast on sharp corners. At the ends this can be cured by using a small amount of Evostik in addition to the paper's own glue. On the roof the overlap is held down later by the roof printed section. Before placing the roof or the front in place I decided to cut out the windows.



One section is completely covered and the windows cut out. Just some detail work to go.

On the first side I cut along the windows using a new blade in a craft knife and a six-inch steel rule. I also wanted to cut the curved corners on the windows. This I did by eye but found that I could not exactly line up the hand-cut round corner with the straight cuts along the sides. So, when the printed window was removed, I was left with "hairs" of paper which were white and looked rather obtrusive. I noticed that the corners on the upper quarter light windows, which were square, did not have this problem. So, on future sides I cut all the corners square and it did not notice.



After being disappointed with my attempts at the curved corners of the windows I cut them square.

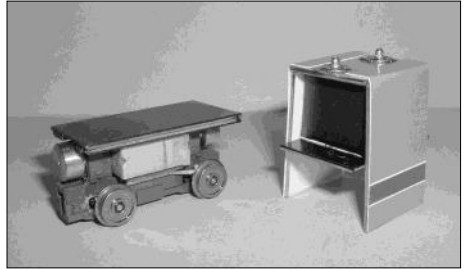
Having cut a clean line along the four edges, making sure that the corners met, I used the point of the knife to carefully lift the corner of the printed window until I could catch the edge with the tweezers. Then I peeled the printed rectangle off. This left a clear plastic window. The finish on the square cornered windows was far better



I left finishing off the bottom of the end until a little later

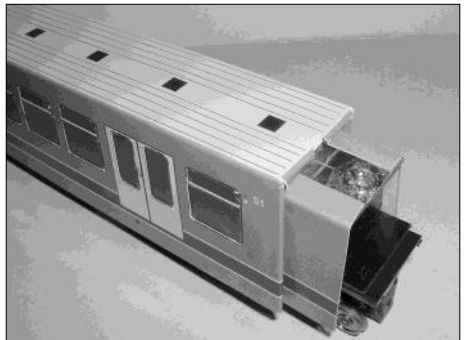
I did notice that the edges of the paper were white, while the window edges were black, representing the rubber seal around the window. I tried using a

soft pencil and it looked better, but not as good as I wanted. Then I tried a black ball point pen which was great; it put a black line over the edge, giving the finish I wanted. So, I went around all the windows blackening the edges.



▲ I left the power unit removable. Here it is seen next to the centre section, that is waiting for its roof print.

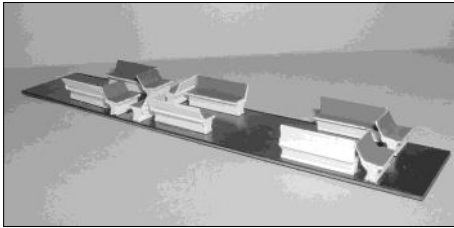
▼ Checking the fit of the centre section to an end section.



Next, I took the end and placed it over the body end, making sure that the red strip lined up each side and that the sides of the body were equidistant from the printed window frames. I folded the upper excess over the roof and then cut the sides of the end by using the craft knife along the sides. Then I cut the windows out. Finally, I cut the roof to size and put it in place. This held down the overlaps and gave a very satisfying finish to the roof. I repeated the whole thing for the second section. Looking at the body I realised that it was very easy to see into the tramcar, so it was necessary to add some interior detail.

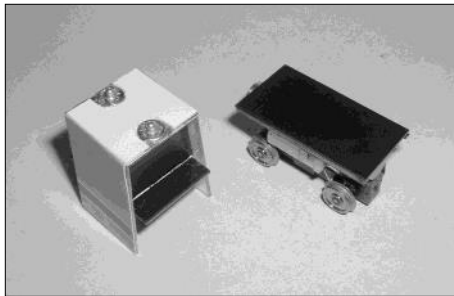
For this I took the second smaller floor for each section. I compared model tram seating strip to the seats in the real vehicles. Whilst not exactly the same they looked similar enough to be used. The Docklands seats have a white frame and are upholstered in a mainly deep red fabric. For each section I cut six seats 10mm long and another six

seats 20mm long. These I painted white with a reddish-brown seat and back. The 20mm seats are set longitudinally, while the 10mm seats are set across the tramcars. I lightly marked on the floor the position of the doors and the window pillars between the doors. The long seats were glued along the edge of the floor facing inwards with one end by the door frame. Four short seats were placed facing each other at the ends of the seats between the doors. While at the front the final two short seats were placed at the ends of the two long seats. The floors were slipped in place to check that the seats were in the right position. When I was satisfied, I took them out, put double sided adhesive tape under the floor and put it back into the tram body.



The seats are glued to the false floor.

I fixed the bogie in place with the screw that went through both layers of the floor. The inside of the tram is white, because it is formed by the un-printed side of the label photo paper. Luckily, the inside of the actual trams is white, so there is no need to make any changes. If you want to add super detail to your model you can make hand and grab rails from wire, paint them red and fix them to the floor, before putting it into place. Passengers and a pushchair or two would also add authentic detail. Do not add a driver; the trams are usually computer-controlled but do have “Captains” (subsequently renamed several times). Only occasionally do the “Captains” have to open the small driving position at the front of the tram. Otherwise, the front seat passengers have the best view.



The centre section gets its roof.

The final touches were to add the roof vents, from small squares of the printed paper, roof coloured and stuck over the black squares on the roof. The circular vents at the ends were treated the same way. Under the ends of the tramcar, the distinctive cut-away was formed with plastic card and covered with red printed card. I did have a long ponder about the bogies. On the model the bogies are all inside frame. Now I am sure that the Docklands cars do not have such bogies. I looked at all the photographs of the cars that I could find and not on one could I see any of the bogies. So, I decided to leave them as they were on the model. This also meant that there was no need to represent the third rail pick-up, which is equally hidden.



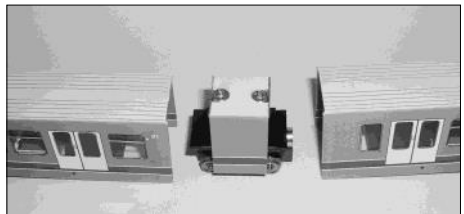
I finished the end by cutting out the slot and making the recess from black plastic card.

I did try my model out on a test track. It was quite clear that it was only able to go around fairly large radius curves. The tightness of the curves is governed entirely by the amount of movement in the centre.



▲ The completed unit.

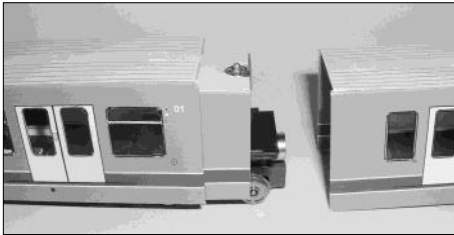
▼ The press studs allow it to be separated for packing away



By extending the distance between the studs on the central section a tighter radius can be taken. If tight curves are an issue for you, I recommend planning out the model on your tightest curve before starting to make it. Cut three pieces of card in the shape of the plan of each section. Mark the bogie centres for the end sections. Place these onto the centre line of the curved track. Allow the inner corners to just touch. Place the centre section plan over them. The centres of the female studs will be on the centre line 5mm in from the end of the section. Mark on the card where the male studs will need to be. This then sets the size of the central section for your model. It is possible that the gap between the end sections will be a little oversize, but I doubt if many people will notice it (unless they have read this article!).



The articulation assembled. The centre section roof is a little lower than on the actual vehicle, but that is to allow room for the press studs.



One end section is clipped to the centre section.

On a final note. I made this model using a technique entirely new to me. Like all such methods I found that my technique, and hence the finish of the model, got better as I practiced more. I am sure that my next model using this method will be better. It does save an enormous amount of time painting the model, but it does require more time during assembly, so the overall saving is not great. However, the finish that can be achieved using photographs and computer graphics is superb. It also allows fine detail that is impossible or impractical by any other method. I found it a very interesting project and a most enjoyable experience.



The late Vernon Cunningham's 'Tramwick' layout as seen at the 2002 Festival of Model Tramways, with models that he built using this technique and which was David Voice's inspiration. *Photo by John Prentice*

This article was written by David Voice in 2005 and originally published in the 3rd edition of his book, "How to Go Tramway Modelling".

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