Challenges in the Reconstruction of Auckland Tramcar No.44

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Introduction

This paper is for delivery at ***KiwiTrax 2004*** (the 2004 combined conference of the Federation of New Zealand Rail Societies and the Confederation of Tramways Museums of Australasia) by David Cawood and his co-authors; but we wish to acknowledge the invaluable assistance of other members of the WST workshops team in the physical work — there are about 30 other contributors, both volunteer and permanent staff, without whose expertise, time and comradeship the reconstruction of No. 44 could not have come to fruition as well as it has.

Our paper (and illustrated conference presentation) gives a brief history of Auckland Electric Tramways Co. Ltd. passenger car No. 44, and presents some of the challenges in developing an acceptable, practicable conservation plan. We describe some of the photographic and other archival research involved in getting to "the real thing". We then review the physical work involved - covering coachwork, mechanical and electrical systems. We describe some of the special techniques developed or sourced during reconstruction and offer a few helpful tips for others facing similar problems.

Brief History of Car No.44

The history of the Auckland car (or cars) numbered 44 is a typical "grandfather's axe" story[2]. First in the "44" line was a 1904 locally-built freight car shown in Figure 1 (p.11).

The freight car's truck (Brush 4-wheel similar to Brill 21E type) and electrical equipment were "borrowed" in 1906 when commuter demand led to the urgent local construction of a passenger-car body of the "Dinghy" type (officially class "A"); this body was distinct from the other Dinghys (totalling 24 eventually - mostly built by Brush) because the car had only five saloon windows on each side compared with the norm of six. Another difference was that, in original form, there was probably just a single saloon with full-length longitudinal bench-seats both sides. The other (6-window) cars had a central partition and both "garden" seats and longitudinal benches in each saloon (arranged skew-symmetrically). There are two known photographs of the No.44 in this form, dating from August 1908 and 1909 respectively. These are shown in Figures 2 and 3.

The original freight body (with new equipment) returned to service in 1908 but was renumbered 300; Except to state that it was retired in 1948 and became derelict at Clevedon, its subsequent history is outside the scope of this paper.

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[1] © 2004. The second author, Bruce R Gamble, holds copyright over the text. Reproduction rights over the illustrations are held by various persons — who are thanked for their assistance.
[2] G C Stewart, *Always a Tram in Sight*, Gratham House Publishing, Wellington

The first change to passenger car No. 44 came in November 1912 when, in keeping with all the other early cars, the (as-built) open fronts were glazed in and air-brakes fitted.

The next event was the coupling of cars Nos. 44 and 49 (No. 49 being the only other idiosyncratic Dinghy – also locally built) in December 1918. This entailed essentially electrical and braking changes – to become a "4-motor" unit with just two driving positions.

Just over two years later, in February 1921, the most major structural changes to No. 44 (and to its "twin" No. 49) came about when both bodies were extensively rebuilt with sides (if not the chassis and bulkheads as well) being changed to match the 6-window, two-saloon form of the other "Dinghys" (now in 12 coupled twin-sets). At this stage the original tongue-and-groove cladding was replaced by panelled sides, again in keeping with most (but not all) other cars in the fleet. Curiously, the original clerestory roof with its 10 opening fanlights was retained. This became an important clue to the identity of the car when the body was first found in the 1960s, differentiating it from the other 23 Dinghys which of course had 12 opening fanlights each side.

Being comparatively inefficient (needing a crew of three) all the "Twins" were retired in 1931 as other more modern cars of the 1929-30 classes took over. Significantly, as developed below, the twinned car sets were separated and, after sale, moved to scattered locations.

The body of No. 44, sans truck and all electrical gear seems to have spent the next 30-odd years in the Auckland suburb of Royal Oak. Here it became a garden shed, honourably serving summerhouse duties, and, Emett-like, suffered the installation of a wood-stove and chimney through its roof. Fortunately nearly all of the internal woodwork survived well and in the early 60s it was offerred to MOTAT. No. 44 was the first tram-body to be brought to the Western Springs site "for future restoration".

An abortive start was made on refurbishment in the 1980s but progress faltered when funding did not materialise, the museum fell on hard times and other tramway priorities took over. Work continued in a desultry manner during the 1990s. But only in 2003 with the completion of the Melbourne 321 project did momentum pick up and funding become available through the MOTAT-Act levy . It is now realistic to expect that the car will run before the end of 2004.

Significant Remaining Elements of the Tram-Body

Summarising the above: before reconstruction started, the main components we had to work with were the clerestory roof (almost certainly dating from 1906), the 6-window saloon and steel-framed chassis (probably all dating from the extensive 1921 rebuild), two canopies (in rather poor condition) dating from the 1912 enclosure of the ends, and the badly deteriorated end-platforms. containing minor remenants of the 1906 construction, but definitely as modified during 1912 and 1918.

The interior woodwork was generally complete and in good condition, whereas the exterior panelling, mouldings and canvas roofing were severely weathered. At one location the heating stove had been installed; this caused damage to one of the longitudinal bench seats and a hole was roughly cut through the roof cladding for a chimney, allowing some localised wood-rot inside. Not remaining was the Brush 4-wheel truck nor any other electrical or mechanical gear.

Work Plan for the Project and MOTAT Conservation-Restoration Policy

Our review of the history and reveals the impossibility of returning 44 to its last known state in operable condition - of its "other half" No. 49, there is no known trace. A related dilemma is that No. 44 ran as a "6-window" car only in coupled form from 1918; therefore, strictly, reconstruction to an earlier single-unit Dinghy should require the reversion to a 5-window saloon - an undertaking that would have seen much of the fine internal woodwork of the 1921 rebuild heavily altered.

One option would have been to conserve the remains "as is" and not attempt to reconstruct an operable tramcar — this may have gained some support from the current, somewhat academically-inspired "conservation" proponents. In the early 60s however, this was not the purpose of obtaining the body, nor would the project have developed to the point where space and other resources would ever have been a priority in a museum where "live" was (and is) such an important element.

The approach we have taken therefore, building upon earlier work commenced in the 70s, is to portray No.44 outwardly as a "typical" 6-window open-fronted car of the 1906 period. In this respect, apart from its fleet number, it is a remarkable likeness. Internally, the era represented is 1921 when the main reconstruction of the car saloon was undertaken. This allows all the existing internal work to be conserved. The deteriorated platform and canopy components of the car dating from the 1918 coupling are able to be put aside and conserved, and replaced in the operating car with replicas of the earlier 1906 work. Thus we are able to achieve the best of both approaches. Our interpretation will be explained in handout material to anyone interested in the car's history.

In relation to the Brush type-A 4-wheel truck, Brush 1200 motors, and Brush H2 controllers (or their 1918 replacements), and other mechanical and electric gear such as brakes and resistances — all of this had been stripped out upon scrapping. Some, such as the trucks and controllers could have been reproduced because our research (see below) has uncovered detailed drawings of these. However, as a number of museums have done, equipment ex-Brussels and Melbourne is sufficiently close in form and function as to represent "the real thing". This is the approach we have taken.

Research… making use of existing information

Research for reconstruction of the car developed from several sources:

- ***Photographs of No. 44 itself***: These are supported by research such as undertaken by Graham Stewart over many years and now published in his New Zealand tram researcher's "bible" [3]: there are only four known photographs of passenger car 44 in any of its forms (all photos are poorly-focussed, 44 being incidental only to larger panoramas) but each is useful in confirming significant details.
- ***Photographs of other Auckland cars:*** Fortunately there exist several high-resoluion photographs of early cars taken around the period when 44 was built. From comparison of these photographs with the few of 44, it can be stated with some certainty that various features of the Brush-built Dinghys and Double-Deckers must be identical to the same component, albeit shown only indistinctly, in the shots of 44.

[3] Graham C Stewart, Always A Tram in Sight

- ***Information extant in the remains of the body:*** (That is after 30 years re-use and adaptation as a garden shed, followed by many years at MOTAT as an on-again, off-again "restoration" project under a variety of workers.) Careful measurement of the remains, no matter how decrepit, can be crucial; and of course these "left over" bits must be carefully labelled and stored away as part of the whole conservation/reconstruction project.
- ***Drawings:*** Because there are no known drawings of any part of No. 44, the few surviving General Arrangement drawings of the 1902 Brush cars became vital. We were also very lucky that many early parts of the Brush and later cars had needed replacement and were drawn up during AET or ACCT days. (None were specifcally produced for 44.) Later, some thousands of these drawings were micro-copied onto 35-mm film stock. A problem is that 35-mm film readers have become hard find in this digital age. Consequently all the film frames were scanned digitally by a specialist contractor as part of the project. These covered: brake gear; handrail casings; window pulls; match strikers; many other small items relevant to the 44 project; and hundreds of items that will be relevant to future reconstruction projetcs.

The research preceding reconstruction of the 1906 motorman's platforms and canopies (which required full replication) illustrates the methodology described:

- The 1909 somewhat blurred front-view of the car coming up the 1 in 8.3 Parnell Hill can be seen in Figure 3. This image is useful because it shows the car open-fronted as built, and as we intend to reconstruct it. Vague details such as the canopy support brackets, stanchions, handrails and destination box are confirmed. But measurements down to a fraction of an inch are indistinguishable. Why such a question?… As an example, what diameter are the canopy support stanchions (full-height, in contrast to the first Brush Dinhys) that can be seen indistinctly in this view?… Half-inch waterpipe (21-mm OD) or three-quarter-inch (27-mm OD)? By reference to high-definition front photos of Cars 6 and 18, however, it is possible to resolve this question clearly to the first alternative.
- Other elements of the front — the handrail above the dash panel, the supporting stanchions and connecting brackets, brake gear, headlight, bumpers, bearers, steps, bolt and rivet positions — are also confirmed after reference to the same photos of cars 6 & 18 and various other less distinct shots of other Dinghys.
- This leads on to the next stage: obtaining precise dimensions of the components. Here, the General Arrangement drawings that have survived (PWD copies from the 1902 Brush order) tell us a key measurement: the exact height of the front dash panel.
- The photographs of relevant areas were then scanned, digitally enhanced (we use a program called Focus Magic®) and enlarged to allow scaling off against the known dimension of the dash. This usually allowed the components to be sized to the nearest one-eighth of an inch. And often it became clear that a standard (or rounded) dimension had been used in the design. Where necessary, for the curved shapes, a bit of elementary geometry and trigonometry assisted in reaching the a new General Arrangement drawing, the many components of which were detailed separately for manufacture, final fitting and assembly. Where possible these were

checked against car No. 11, the bits of No. 44, or various parts salvaged from other cars over the years.

Discoveries

During recent re-examination of all the bits and pieces a number discoveries were made, illustrating the importance of not stripping off old finishes (or even keeping unskilled hands busy by "painting everything") before all research has been completed.

- ***"Car 49 end":*** Most of the interior woodwork was numbered or had pencil markings to indicate location. One puzzler was an inscription "Car 49 end" on one of the bulkhead panels, which made us think that we could have mis-identified the body we had. However the 10-window clerestory roof made it clear that the end referred to was only **adjacent to** the coupled car, No. 49. It thus became clearer that the control gear at the 'A' ends of both had been removed in 1918 (when the cars were coupled together).
- ***Smoking saloon:*** The importance of not hurriedly stripping finishes was illustrated when faint traces of match-striker plates became visible in the painted-over varnish of the pillar-cover strips between windows at one end (only) of the car. This means that the outer (or 'B'-end') saloon was for the use of smokers; and the exterior can now be sign-written as such.
- ***External paint scheme:*** One significant feature of the car is referred to in *Always a tram in Sight*: that No. 44 was the first tram to be painted in the new green colour scheme. Prior to this a quite bilious yellow-orange (with red and blue lining-out) had been in vogue. This was verified by reference to a 4 December 1906 report in the *New Zealand Herald: "… The new car, which is painted green, and bears the number 44 (the old freight car's number) was put in service on Saturday [1 December 1906] and is now being utilised for the Herne Bay line…"*

  Unfortunately, due to weathering, but possibly because of excessive zeal on the part of pre-2002 "restorers", no trace of either of these paint schemes was found recently.

Scope of Reconstruction

To complete this paper, following is a summary of the work on the project, undertaken mainly during the past two years:

Coachwork

- ***Chassis:*** After lifting the superstructure clear (of the floor, chassis and truck) we removed all the floor-boards and dismantled the composite chassis (RSJ longitudinal beams with hardwood cross-bearers). All fasteners, tie-rods and metal brackets were removed and corrosion-protected before reassembly. The truck was then removed for dismantling and rebuilding also (see below).
- ***Platforms, bearers and bumpers:*** Each old (1918) end platform was removed as a unit (one end had been partly chain-sawed off before recovery in the 1960s) and set aside for further research. Using Western-Australian Karri timbers, new bearers were made up. Some of the original cone-head coach bolts (up to 13" long and subject to large tensions in service) were extensively corroded; some were replaced with new

specially made (imperial-size) bolts whilst others were recovered in re-usable condition from the burnt-out (annealed) remains of Dinghy No. 3 at Langholm Beach near Titirangi. New head-stocks (the controller support planks) were made up from Kwila timber to match the 16" x 2¼" original hardwood items. Tongue-and-groove platform flooring was milled on site from 1" Matai boards as originally.

Also from the remains of No. 3 at Langholm are the front bumpers for No. 44. These are of 5" x 2½" channel and were somewhat distorted by the fire. The alignment was readily corrected by our own blacksmith, working to a curve template.

- ***Canopies:*** The as-recovered canopies were made around 1912 — besides their deterioration, the plan shape was quite different from the earlier 1902-1906 design. Re-design meant going back to first principles, after the principal dimensions had been established from various photographs.

  The geometry is based on the roof centre-line, fore-and-aft, being a perfectly circular arc. The three cross-arches are also circular arcs, though of increasing radius as the front of the canopy is approached. We found that this geometry successfully replicated the slight "duck-bill" appearance of the original canopies.

  The canopy edge-beams, which are sharply curved at the two front corners, posed the biggest challenge from a production perspective. We made up the 2¾" x 1¾" cross-section from five hardwood (Kwila) laminations pre-bent to 14" corner radius using the anhyrous-ammonia process (by an off-site specialist contractor) rather than steaming. The contractor glued these laminations into two L-beams (in plan) which we then spliced end-on by means of a long scarf-joint, reinforced by shear-keys, into one U-beam (again in plan). [An example will be demonstrated in the presentation.]

  The three cross-arches were easier to make; these were done in-house using four laminations of Kwila, cold bent slightly over or under the desired radius (depending upon the forces from the cladding boards to be resisted finally) and glued up to jig using many G-clamps.

  The canopy frame components were all mortised/socketed together as per the originals and then the 2-inch wide x ⅜" Kauri cladding boards (running fore-and-aft) cold bent and screwed down at each intersection. The cladding boards have the original "raised bead" feature which is not readily available commercially. Accordingly the acquisition of a spindle moulder and cutters was a boon and many metres of several types of mouldings were run.

  The final step was applying the canvas and edge beadings. This followed our well-tried formula as had already been applied to the saloon roof — see below.

- ***Front dash panels:*** The front dash is of surprisingly light construction — very likely based on horse-tram building techniques but nonetheless, as in best modern practice, takes a "stressed-skin" approach. The main members and their dimensions were determined from our research as above. Essentially these comprise vertical uprights of ½" water-pipe, a top curved handrail of 1½" x ⅜" flat bar-stock, the rolled dash panels of 14-SWG steel-sheet and an edging of 1¼" coping- or D-iron, all connected together with various cast brackets and rivets. All ofthe cladding panels are rivetted

as per traditional (and modern) practice. These components will all be shown during the presentation.

- ***New sashes:*** Twelve new large sashes for the main saloon section were made up from New Zealand Kauri to replace the originals, which were well rotted. All glazing is in safety-glass throughout, beaded in from the inside in contrasting timber.
- ***Stripping and varnishing:*** Stripping of the internal woodwork was the first job to be commenced many years ago. The process and result might have been different today had we found information worth conserving in the final as-received finish. But we doubt it, given the "garden-shed" history. Some spray-varnishing of items has been done, but a lot is finished using hand brushing methods.
- ***Flooring:*** During a trial refit of the Kauri flooring we noted that the planks had shrunk crosswise over their lifetime a total of some 1¼ to 1½". Besides unsightly gaps, this threw out various locating mortises for the longitudinal seats — so instead, one central board was slit lengthwise and a packer of the above width glued in. This resolved both problems.
- ***Seats:*** One of the longitudinal bench seats is being reconstructed because of "summer-house" damage as noted already. The cross-bench or "garden" seats were all removed at the time of scrapping around 1931 and sold off. Some of these found use at the Auckland Zoo. From there they were rescued in a much deteriorated state some years ago; many vital metal parts are in the process of refurbishment for the No. 44 project and new timber work is being milled.
- ***Exterior coachwork:*** As noted above, the exterior of the body was well-weathered. Timber cover-mouldings had warped and split and the fixings were severely rusted by the time we received the body. All were removed, along with the panelled side cladding, at an early stage. The cladding was soon replaced, not with conventional tongue-and-groove boards but with grooved sign-board of the correct thickness. Twelve years on we might have some qualms about not replicating traditional practice. But at least it is documented and thoroughly weather resistant and there is no going back. The cover mouldings were run by us from Kauri to exact profile, sealed using modern elastomeric sealants and fastened using stainless nails.
- ***Roof cladding and canvas:*** Some tongue-and-groove on the roof had to be refixed where split or poorly nailed. The area where a chimney had been punched through was totally replaced with boards milled to correct profile.

  Canvassing followed the practice developed for Melbourne 321 — not dissimilar from Auckland practice (which, nonetheless, used white-lead extensively). The tongue-and-groove cladding was thoroughly painted with heavy emulsion to seal it. A light gauze mesh or "scrim" was then rolled out and two more coats of heavy paint applied through the weave. Then 15-ounce duck canvas was applied, tacked along the centreline, or at the clerestory windows, wetted down with a spray containing a few drops of detergent and weighed down with old cast-iron brake-blocks at 2-foot centres. After a few days of stretching, edge tacking every 1½" was completed and half round moulding nailed over the edges. Trimming and painting followed, several coats of Emerclad high-build acrylic emulsion being used to build up an elastic coating

about 1/32" (1mm) thick. The same technique was used on the compound-curved canopies — these requiring just a little more stretching.

- ***Roof ducts and trolley bridge:*** The roof ducts carrying the traction and lighting circuit cables along the roof are all original and were carefully surveyed so that screw fixings would enter the original holes in the rooflines after recanvassing.

  Cross supports for the trolley plank (trolley bridge) are original, simply refurbished and again carefully surveyed as to position in relation to rooflines below. The trolley plank itself was replaced in one length, using Kwila joined up to 13½" wide x 1¾" thick.

Mechanical work

- ***Truck:*** Refurbishing the 21E-type truck, ex-Brussels, has involved the following steps: complete dismantling; shortening the main side-frames from a wheel base of 9' to 6'-6"; removal of the conventional Brill-type joggled top chord-bars which support the chassis; replacement of the top chord bars with straight bar — this latter step brings the body of No. 44 to the correct height and also is more in accord with the look of the Brush type-A truck.

  Recalculation of the main springing was necessary and a new set of coil springs were made to match the four (out of eight) that were correct. The leaf springs are OK as is.

  All components were sent out for sand-blasting and corrosion protection.

  As the truck had been single-ended at some time as far as braking was concerned, brake gear from our second ex-Brussels truck was obtained and will be installed in the one for No. 44.

- ***Brake gear:*** A prominent feature on the platforms of all the early Auckland cars was the goose-neck handle operating the wheel-brakes and the large horizontally-mounted wheel which operated the track brakes. Car No. 11 retained these features until the 1940s when unfortunately they were replaced by a "standard" windlasses. It has been our intention for some years to replace the windlasses on No. 11 with the earlier gear appropriate to its otherwise 1912 configuration. The 44 project provided the ideal opportunity to make up the old-style braking gear, en-masse, for tram Nos. 11, 17 (Double-Decker) and 44; also for Dinghy No.8 in the process of accession/recovery.

  All drawings necessary were located on the micro-film/scanned collection and orders placed for six complete sets of parts. These were cast and/or machined by local contractors.

  Allowance will be made under the car for the possible installation of emer

- ***Trolley pole-base:*** The pole base to be used on No. 44 is of the dwarf stove-pipe type, the same as that on No. 11, made by R W Blackwell, England. Both of the Blackwell pole bases we have came from the scrapping of Auckland No. 304, but were in pieces for many years. That on No. 11 is now refurbished and the second will soon be ready for No. 44. Further castings of the main parts for other early Auckland cars will be necessary.

- ***Patternmaking and machining:*** Much of the work above has entailed making new foundry patterns, either from the micro-filmed drawings or from new drawings. The tricky job of making the patterns (including core-boxes as required) for the gooseneck brake handle and the track-brake wheel was done in house. A large amount of pattern-making, foundry work and machining has also been contracted out. This includes the major job (and expense) of reproducing all of the main hand-braking gear as noted above.

Electrical work

- ***Motors:*** Although our Belgian 21E trucks came complete with ACEC traction motors, the electrical characteristics of these motors, despite extensive enquiries in Europe, and from other museums using the Belgian trucks, are not available in the form of standard curves. On the motors we have, the aluminium namepletes are badly corroded. But from the large size of the motors, they appear to be capable of being rated at 65-70HP (48 - 55 kW) or more. On the other hand, the nameplates deciphered by other museums indicate 49HP (36kW).

  Even with 2 x49HP, the accleration of No. 44 would be too great. This was confirmed by a number of motor torque tests, and from calculations. Other museums have attacked the problem by installing permanent series resistances so that the motors always run effectively on reduced voltage. We have considered an alternative approach, short of a complete armature rewind, to derate the motors.

  Our appraoch, to some extent confirmed already by our tests, is to strengthen the fields. This has involved having the series field coils rewound whilst the motors were being cleaned and overhauled mechanically. Given the strengthened fields and the increase in motor resistance, we expect that accelerations will be decreased, together with the normal maximum speed. The actual percentage reductions have yet to be measured. Our experiments are also contingent upon motor commutation (brush sparking) remaining within acceptable limits.

  Aside for the above work, the motors and bearings have been completely dismantled cleaned and vacuum reinsulated — these aspects being undertaken by outside contract.

- ***Controllers***: Although the original Brush H2 controllers could have been remanufactured from micro-filmed drawings this would have been lengthy and expensive. There are no spare K6 controllers available of the type fitted in 1918 to the coupled cars. On the other hand K35JJ controllers ex-Melbourne were in stock and are readily adaptable to two-motor control. Two were selected and completely stripped down, cleaned and adjusted. Wiring insulation was checked and repaired where necessary. Ratchet switches were removed as no line breaker is likely to be needed at reduced current, all "making and breaking" of contacts will now take place in the controller itself. Again, this is subject to experiment.

- ***Traction, lighting and bell circuits:*** All wiring had either been stripped out, cut short or was in badly deteriorated condition. New traction circuits have been designed for use of the K35JJ controllers (5-series, 3-parallel notches), converted to two-motor operation. Two main circuit breakers, in series, one at each end in accordance with Auckland practice, will be installed.

Lighting now consists of eighteen 110-volt lamps in three circuits.

As originally installed, the electric bell circuits will run from low-voltage current powered either by dry or Leclanche wet cells installed under one end seat. Surface-mounted bell pushes have yet to be fully researched and manufactured.

External suppliers

- ***Woodscrews and rivets:*** A major problem in recent years has been sourcing traditional-pattern slotted woodscrews, especially raised-head, counter-sunk in all sizes and, to a lesser extent, round-head and ordinary flat-head, counter-sunk screws. After searching the UK, France and the USA we have now located a source in Los Angeles able to ship in quantity to reach us within 4-5 days. This firm is McMaster-Carr: they have an online catalogue and order desk at www.mcmaster.com and provide an amazing array of other fasteners such as rivets, and other tools and equipment. Their service is superb .
- ***Imperial coachwork bolts:*** although we were fortunate in salvaging a large quantity of hardware and fastenings (mainly $\frac{1}{2}$" amd $\frac{5}{8}$" round- and cone-headed coach bolts from the burned remains of Auckland No.3) we did not have enough of these to complete the work. Fortunately our WST railway colleagues knew of a South-Auckland firm with the ability to make these using forging equipment recovered from the former NZR Otahuhu Workshops facility.
- ***Front dash handrails:*** As noted above these are $1\frac{1}{2}$" x $\frac{3}{8}$" flat bar curved in the flat plane. Ordinary rolls do not prevent the bar from bending in the less stiff direction. Therefore this job was contracted to a local specialist firm experienced in bending tube. This firm, in Auckland, is Tube Benders Ltd. They made an excellent job of keeping the handrail exactly flat whilst achieving the correct curve radius of $41\frac{1}{2}$" within very tight tolerance
- ***Coping iron (D- or half-oval bar) supply***: As many tramcar and railway restorers have observed, coping- or D-iron (referred in Europe and USA as half-oval bar) is as rare as hen's teeth and as hard to get a supply of. A local firm, Knobs 'n Knockers Ltd, imports a range of sizes from an Italian wrought iron firm, Industria Italiana Arteferro. We needed $1\frac{1}{4}$" x $\frac{3}{8}$" but it is available in much smaller and much larger sizes. Bending of the coping iron to suit the profile of the front dash was undertaken by our blacksmith.
- ***Woodbending;*** As outlined above, the canopies required tight radius bends to be made in the hardwood edge beams. This appeared to be beyond our steam-bending capacity or experience. Consequently we sought out a local firm, who uses the anhydrous ammonia process, for this type of bending. The company is Woodbenders Ltd.

Other acknowledgements

As noted in our introduction, the contributions to the physical aspects of the project to date have been by a large team — their efforts show in the quality of what has been achieved. We also thank a large group of people outside the formal MOTAT structure — especially to Graham Stewart for his untiring support when-ever and where-ever possible.

Also to members of the National Tramaway Museum at Crich, UK who have answered many questions and gone out of their way to take photographs or measurements when help was needed.

Lastly it is opportune to thank the funders of the work. Firstly the volunteer tramway crews and maintainers who raise many thousands of dollars each year by providing tram-rides on the Western Springs Tramway, 364 days of the year. And not least thank you to the citizens of Greater Auckland who assist with their contributions by way of the Annual Levy under the MOTAT Act 2000.

Photographs

Several photographs and drawings illustrating the paper are attached on the next pages…



Figure 1: The original car No. 44 was renumbered 300 in 1908, once the borrowed truck and electrial gear "borrowed" for passenger car No.44 in 1906 had been replaced. The freight car was **not** converted to a passenger car as is sometimes stated.

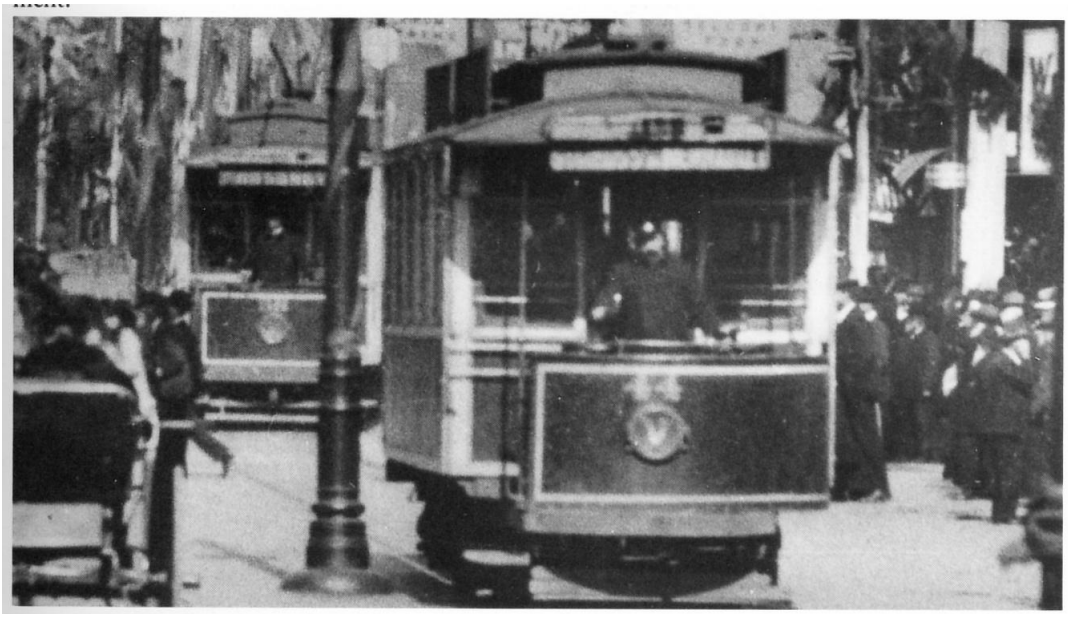


Figure 2: This view of passenger car No. 44 in Queen Street in August 1908 is part of a much larger photograph. Although blurred in this view some digital enhancement is possible. Then, various essential features, particularly relating to the layout of the front dash, canopy, handrails and other constrction details, become obviously present and clearer.



Figure 3: This view of passenger car No. 44 (in the 5-window saloon configuration) ascending the Parnell hill in 1909 is part of a much larger panorama. (The date can be deduced from the single span railway bridge at the foot of the hill which replaced the older 3-span bridge in that year. Although blurred in this detail of the photograph, some digital enhancement of the image is possible. Once again, various details of the front dash, canopy, handrails and other construction details become obviously present and clearer.

However, it is still not possible to obtain accurate scaled measurements from this photograph, at the level of accuracy needed for recostructioin

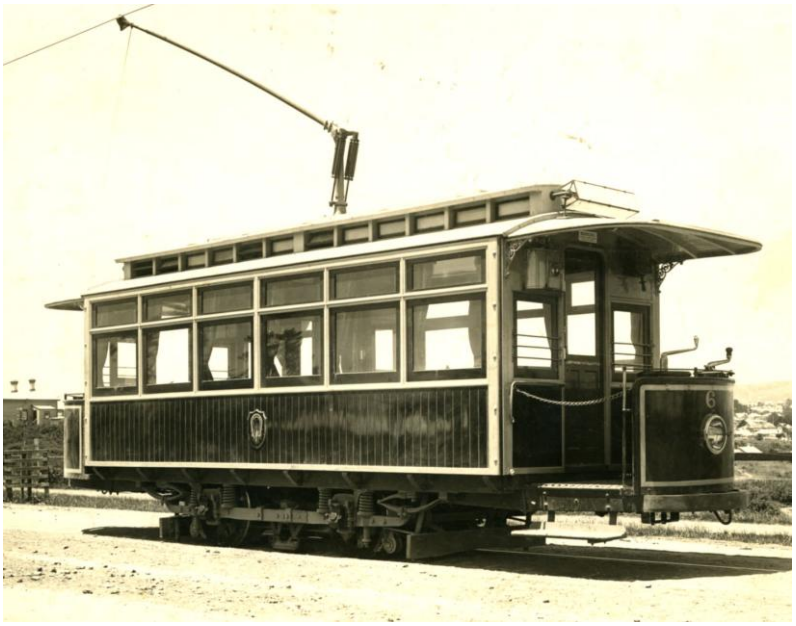
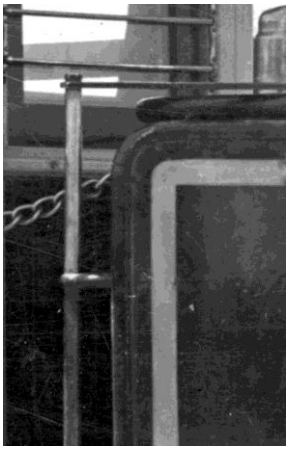


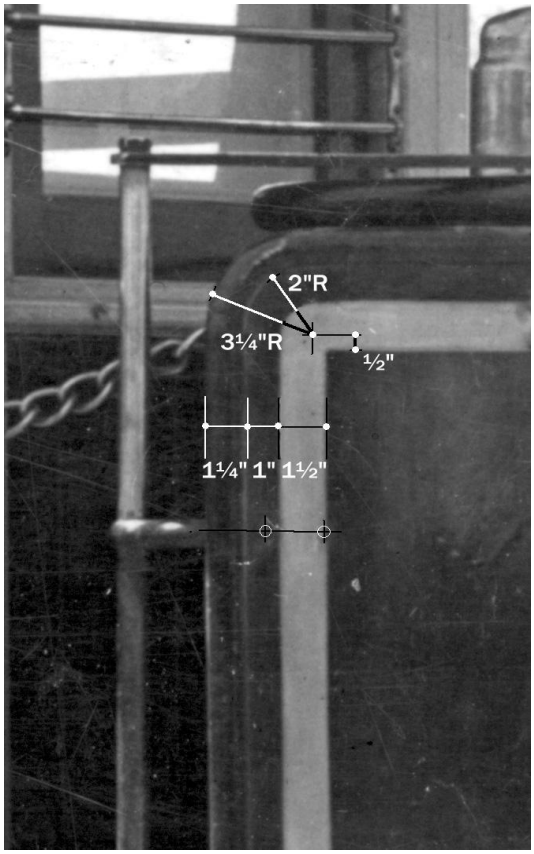
Figure 4: This view of 1902 Brush-built Dinghy No. 6 is from an original print in the Graham Stewart collection. It is sharply focussed and not very grainy.

By comparison with the images of No.44 in Figure 2 and 3 the photograph shows which features are present in the local (AET Ponsonby) construction of and which not.

Those features that are present in both cars are capable of being resolved in considerable detail from this image, as the following illustrations show.







Figures 5, 6 & 7: (Left upper, lower and right resp.): These three images show what was possible with higher magnification of the photographic print shown in Figure 4.

Figure 5 shows the section of the photograph of interest in reconstructing the left section of the dash panel. A critical measurement the height of the dash panel is known from the Brush General Arrangement drawings.

Figure 6 is a further enlargement, enhanced by means of Focus Magic® software.

Figure 7 shows the detailed dimensions arrived at by scaling from the height of the dash panel. An accuracy of ⅛" (3mm) is achieved.

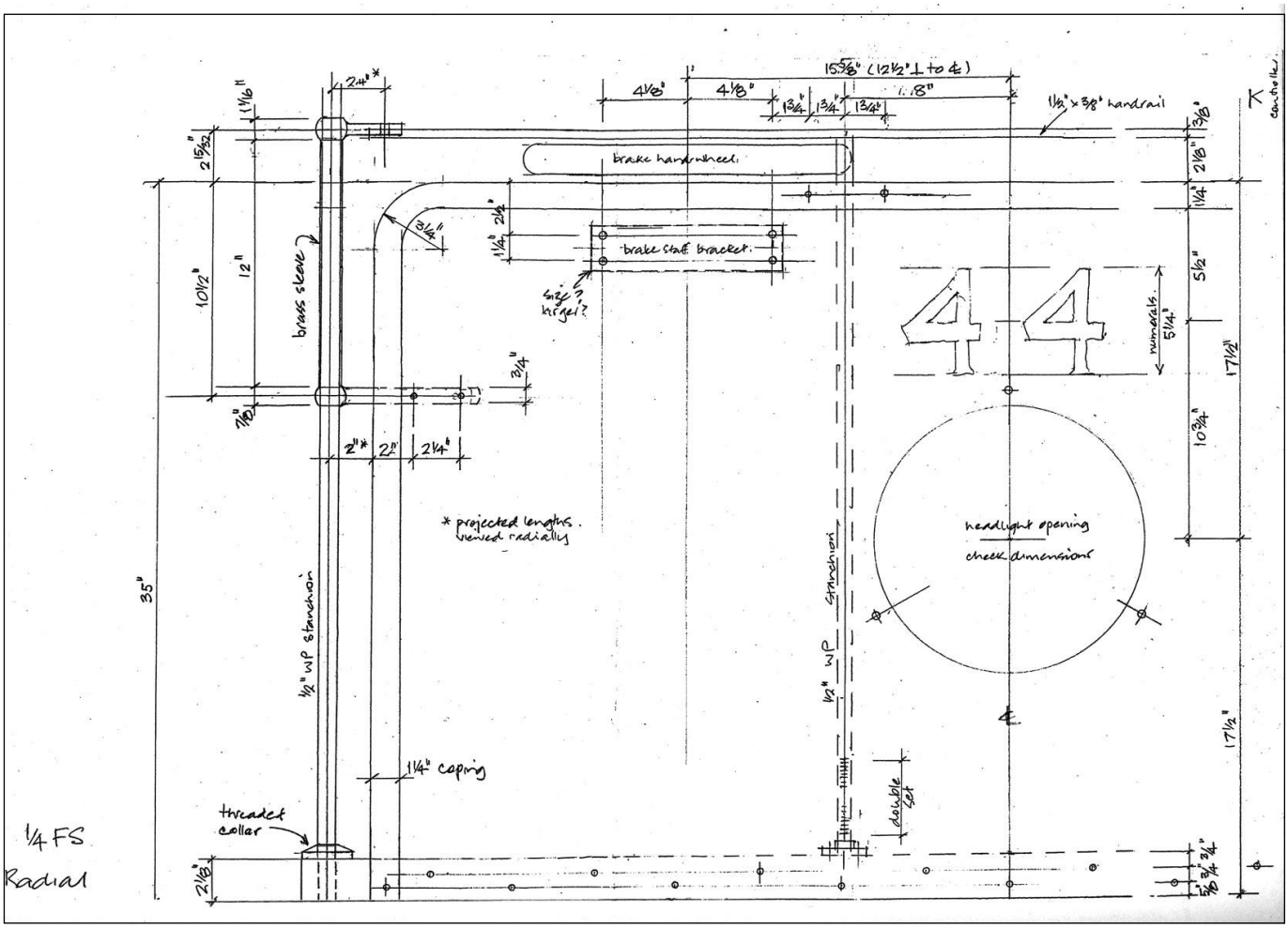


Figure 8: After a succession of enlargements of relevant areas of the car has been made and dimensions scaled off a series of preliminary general arrangement drawings for the reconstruction was made. This is one of them. From this more detailed individual drawings are made up for manufacture of the components — see Figure 9. In a few cases suitable drawings on micro-film already existed.

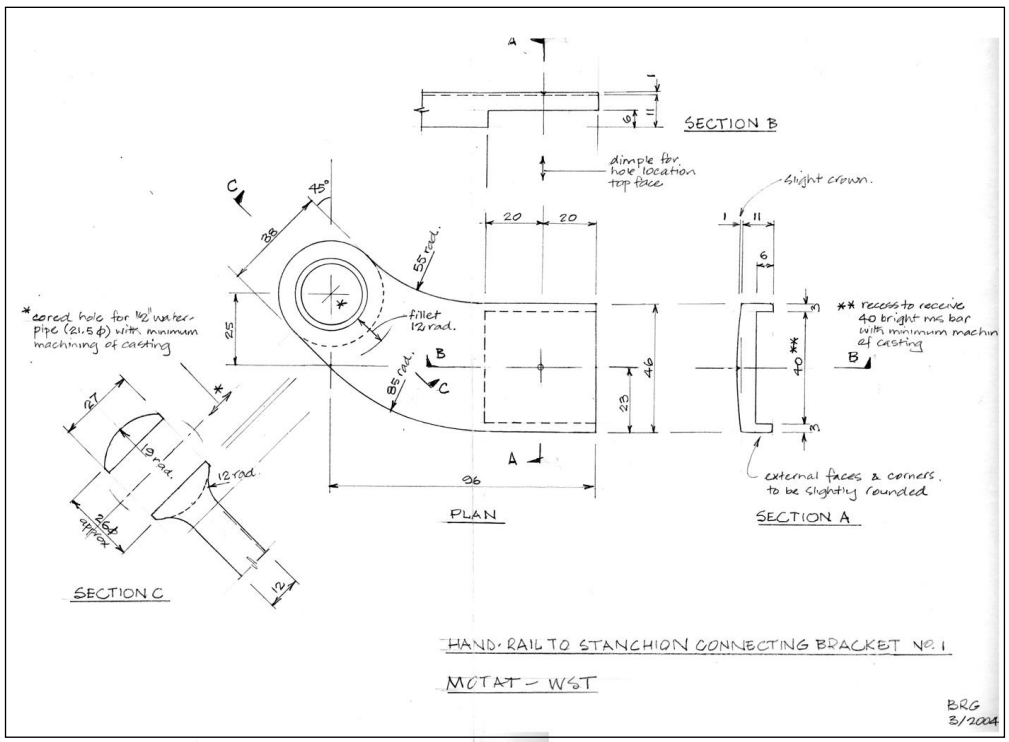


Figure 9: One of many component drawings made for the purpose of manufacturing replica parts for the reconstruction of the platforms, front dash panels and canopies.

This drwaing is for the patternmaker to prepare a pattern for the bracket shown at the upper left of Figure 8. This holds the curved handrail onto the upright ½" - waterpipe stanchion



Figure 10: As in the case of the photograph of Brush car No. 6, this is a similarly high-quality shot of Double-Decker No.18.

Its value in relation to the layout and detail of the front of No. 44 is also very high. For example, many of the details of the bracket shown in Figure 9 can be seen under magnification in this view, thus enabling critical measurements to be scaled off.

Again, many thanks to Graham Stewart for the loan of this original print.

Questions:

Simon Green, Ballarat Tramway Museum
Q – How long to do?
A – Work done in fits and starts. Started during the 1970's, then some work in the 1980's then over the last couple of years – intensive work.

John Binns, Launceston Tramway Museum
Q – Use of canvas for roof, rather than fibre glass?
A – Car bodies move around too much to allow for fibre glass – too rigid.

John Matts, Sydney Tramway Museum
Q – What did you put under the canvas?
A – Firstly put on a scrim, softened the appearance of the roof , allows for movement of the roof boards. The two layers are free to move. Canvas is free to move, except at the edges and is not formally stuck to the roof.

THS Christchurch – noted similar problem, put the scrim down, put canvas down, and then paint. Scrim acts as a buffer.

John Phillips, Ballarat Tramway Museum
Q – Regarding the formation of the laminated timber – was each laminated individually bent and then laminated together, or done as a one piece?
A - Individually done and then joined together. The laminated sections each have a different radius.

Q – unrecorded person – source of the ½ oval D iron.
A – Sourced from Italy – reference in the paper.

Tony Colman – Hobart City Council, noted that they had the coping iron, laser cut from bar.