Ticket to Ride

At Masterton Railway Station on a crisp, dark morning in May 2007, excited locals and dignitaries gathered for the launch of four new Metlink carriages: the first new passenger carriages in sixty years to work the Wairarapa to Wellington commuter run.

Masterton man Geoff Palmer had commuted by rail for fourteen years. It was his job to cut the ribbon using that iconic Masterton handtool, the golden shears, before he and 172 dignitaries and long-term commuters boarded the new train. Right on time at 7.30 a.m., the rumble of heavy diesels rolled across the town as they set off for Wellington.

Just over an hour and a half later, two green and yellow TollRail locos eased the train to a halt at platform nine. Beaming passengers streamed out of the servery car, the generator car, and the two passenger cars onto a red carpet symbolising the beginning of a new era. Transport minister Annette King told the welcoming party that the train's arrival was "something of a watershed for the city's public transport network... Today's train launch marks another step towards ensuring Wellington is a leader in public transport systems that work for people."

Engineers from Toll Holdings' Wellington-based Professional Services Group could be spotted amidst the milling crowd. For them, the launch was the latest milestone in a line of development that began with the Capital Connection, the Wellington-Palmerston North commuter train.

Like the Capital Connection, the Wairarapa cars have integrated steel frames with dramatically improved strength, stiffness, and collision resistance compared with the wood-framed steel-clad carriages they replace. These frames came from British Rail Mk2 carriages, a highly successful design of which thousands were built between 1964 and the mid 1970s. The Mk2's integrated frame was significantly less vulnerable to collision damage than earlier designs, in which the superstructure was bolted to a separate underframe.

By the 1990s, many Mk2's were being superseded by longer Mk3 carriages. The frames of many of these surplus cars were in excellent condition. And their width is similar to NZ carriages, because the British loading gauge is severely restricted by tunnels, overbridges, stations, and other line-side structures inherited from early to mid nineteenth-century railway systems. NZ railway engineers spotted an opportunity: Mk2 carriage frames could become the foundation of re-manufactured passenger cars that would be stronger and safer than NZ's ageing fleet.

The idea began to take concrete form in 1997 when sixty-nine surplus Mk2 passenger cars arrived in New Zealand. But before the Mk2's could ride NZ rails, some basic solutions were required. NZ's track gauge is narrower than Britain's, so the worn-out standard gauge (1435mm) bogies would have to be replaced with Cape gauge (1067 millimetres or 3 feet 6 inches) units. A plentiful supply of nearly-new X28020 bogies had become surplus when NZ goods trains were stripped of their guards vans, and these were superior to the bogies under existing NZ passenger cars. They were the logical choice for the reincarnated Mk2's.

More challenging was the problem of coupling the new carriages to NZ rolling stock. Standard British drawgear rides nearly 200mm higher than NZ couplers. To align the coupler mounts with NZ standards, the bogie pedestals would have to be cut down. This would also lower the carriage floors, bringing them close to the height of suburban NZ platforms. However, the structure would have to be altered to provide clearance for the wheels. At each end of the frame, two longitudinal structural members were trimmed, and an extra pair of longitudinals were added to restore the structural performance.

This basic platform—a modified Mk2 frame riding X28020 bogies—became the basis of the Capital Connection's eight S-class carriages. Because they retained the Mk2's distinctive chamfered-corner windows, they are instantly recognizable as remanufactured British carriages. However, because they ride so much lower, all their underfloor equipment was specially designed and built.

After showing how to revitalise long-distance commuter trains, railway engineers focused on push-pull trains for Auckland's suburban system. Rapid turnaround is an essential feature of suburban services, so push-pull trains have a locomotive at one end and a passenger car fitted with a driving cab and remote controls at the other. Each of Auckland's push-pull trains has a diesel locomotive, three SA-class passenger cars, and an SD-class car with driving cab.

Suburban carriages need wide, mid-mounted doors, and modifying the Mk2 frame to accommodate these doors was a new engineering challenge. The Auckland carriages also needed the strength to safely absorb collision loads in push mode, with the locomotive "behind" the train. Engineers developed a finite-element model of the modified Mk2 to verify its structural performance under normal conditions, as well as under abnormal conditions such as overloading and collisions. The SA/SD cars were a resounding success, and fifty-two of them now ride Auckland rails.

Attention returned to long distance commuter trains when, in late 2005, Toll Holdings won a $25m contract to design and build new Wellington-Wairarapa trains for the Greater Wellington Regional Council. This called for three six-car sets, each consisting of four 64-seat SW-class passenger cars, one 37-seat SWS-class servery car, and one 37-seat SWG-class generator car. The new cars would be built at Dunedin's Hillside Engineering Workshops. They would be the first railway vehicles owned by the GWRC, and they would replace an existing fleet dating from between 1937 and 1943.

This project was more ambitious than its predecessors. The only Mk2 components used in the Wairarapa trains were the frames, the galvanised-steel roofs, the end concertinas, and some minor brake rigging components. Everything else was new. Below the roof-line, they were clad with corrosion-resistant Cor-Ten steel. New centrally-controlled swing plug doors, similar to those used on the Capital Connection, replace the original outward-opening slam doors. Ribbon windows, similar to those on TranzScenic carriages, displace the Mk2's discrete, chamfered-corner rectangular windows. Under their floors, NZ-built airconditioning units, water tanks, and retention tanks ride alongside new air-brake equipment.

Principal Design Engineer Tony Pepperell oversaw the SW design project. It was complex and challenging. A complete set of printouts from PSG's CAD system would easily consume more than an entire ream of paper, and most of those drawings were reviewed by one or more stakeholders. Consulting engineers for groups such as the GWRC pored over the design and offered suggestions for improvements. Production and quality engineers at Hillside reviewed manufacturability issues. Subcontractors developed new or upgraded systems, such as the GPS-based passenger information system.

The SW design involved significant structural modifications. The servery car frames needed large side openings, similar to those on SA/SD cars, to accommodate the wheelchair lifts. To make way for the ribbon windows, structural elements had to be cut away from the sides and replaced with a new ladder frame. The corner-mounted doors were to have redesigned

frames which would simplify assembly. PSG engineers pressed their finite-element model into service to analyse all these structural changes. As with many other project tasks, the finite-element work was peer-reviewed by the client's consulting engineer.

Construction began with the dismantling at Lower Hutt of the last seven Mk2 carriages from the 1997 batch, and the shipping of their frames to Hillside. Since they began building SA/SD carriages, Hillside's staff has grown from 110 to 210, and its experienced workforce were ready and keen to get stuck into the SW's. While they did, TollRail purchased another eleven Mk2 carriages in the UK, and shipped them (without bogies) to Hillside via Auckland.

After building the Auckland trains, Hillside knew a thing or two about remanufacturing British carriages, but the Wairarapa trains presented new challenges. Suburban trains lack the complex electrical and plumbing systems of the long-distance SW carriages, so the interior fit-out required a great deal more work. Offsetting this, the ladder frame for the new windows proved a timesaver. Jig-assembled and then welded into the carriage frames, it dramatically reduced the time spent installing windows. Another big improvement was the fibreglass interior, which was quicker and easier to instal than that of the SA/SD, because the new design allowed for manufacturing tolerances. There was no need for fiddly adjustments.

By the time the first four carriages arrived in Wellington in late April, they had passed an exhaustive inspection and testing programme. Hillside's internal quality checking system had verified that everything had been built according the drawings. A comprehensive testing programme had checked that every system functioned as the designers intended. After that, an engineer from PSG and another from the GWRC's consulting engineers joined Hillside staff for a return trip to Milton, 120km away.

The SW design incorporates a mix of new and proven features. For example, they use the same package air conditioning systems as the Capital Connection cars.

The Capital Connection also featured the first wheelchair lifts ever fitted to NZ railway carriages. These were mounted at the ends of the carriages, but with the benefit of finite element analysis, PSG engineers were able to move them to a more central location. Wheelchair-bound Wairarapa passengers enter a more sociable part of the train—the servery.

The passenger information system on the Wairarapa cars is the end result of an evolutionary development that began with the SA/SD carriages. When the US military upgraded the GPS system so that GPS receivers could accurately fix their positions within a few metres, PSG engineers exploited the improvement. GPS receivers sense the train's location and prompt the system to display the appropriate announcement, leaving the train manager's memory free for more complex information. For the Wairarapa carriages, audio announcements were added to the previously text-only system.

The odd tricky problem demanded an innovative solution. For example, the platforms at rural stations are lower than those at suburban stations. On the existing NZ carriages, this is not a problem as the vestibules are narrower than the car bodies, so the steps don't protrude far enough to hit the platforms. The British carriage bodies are parallel, forcing engineers to mount the steps further outboard. Steps designed for country platforms would crash into suburban ones, so PSG developed a retractable pneumatic step which extends when the doors are unlocked. If a sensor detects a platform, the step retracts, otherwise, it stays extended until the train manager closes the doors.

The rest of the Wairarapa carriages will be delivered in batches, with final batch entering

service in December 2007. Passengers on the inaugural run hankered for the day when, with SW's on every train, they'll enjoy the new, individual seats on every commute. Some looked appreciatively at the individual power points which let them plug in their laptops and get to right down to work. The old trains had no public-address system, no CCTV, no servery, no disabled access toilets, no baby-changing station, and so the list goes on. But what excited many passengers was the smooth ride. No longer would they spend an hour and a half, morning and evening, battling with jiggling cursors or struggling to focus on shivering newspapers or dancing novels.

The SW project illustrates how railway engineering has changed dramatically since the days of NZ Rail. Seventy-five percent of PSG's workload now involves external clients, and this requires PSG engineers to work closely with many other groups. It's a change they seem to enjoy.

PSG engineers also enjoyed the opportunity to improve on what they had done before. It had been a complex project, but they had created the most up-to-date and safest trains ever to ride NZ rails. Along the way, they had simultaneously improved quality and reduced cost by simplifying manufacturing processes. No wonder so many dignitaries showed up to welcome that train into Wellington Railway Station.

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