

The Bellcord



A new addition to Melbourne's tram fleet, E class 6081, working route 86a to 'Parliament Station – Albert St' (November 2019). As with all of Melbourne's trams, E 6081 is tracked on the network using the Automatic Vehicle Monitoring system. The red scrolling text at the bottom of the windscreen reads 'Passengers Alighting'. Photo: Geoff Brown

What time is the next tram?

Today's travellers can check the time of their next tram by consulting tramTRACKER, the popular real-time information service available on mobile phones, computers and passenger information displays (PIDs). This certainly beats searching for a printed timetable and peering into the distance to see if a tram is approaching.

TramTRACKER was introduced to Melbourne in 2006 with tram arrival information provided by voice or text message. With the advent of 'smartphones', a tramTRACKER application for the iPhone was released in 2009 and for other mobile brands and PIDs in the following years.

The information used by tramTRACKER is provided by an Automatic Vehicle Monitoring (AVM) system which was introduced to Melbourne in stages from the late 1970s, decades before smartphones and the tramTRACKER App.

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Automatic Vehicle Monitoring

AVM originated in the 1960s when technological advances made it possible to continuously monitor moving vehicles with little demand on drivers or roving supervisors. European and American cities soon began trials with their trams and buses, and many cities adopted it for their emergency services.

In the late 1970s the Melbourne and Metropolitan Tramways Board (M&MTB) began AVM trials with the installation of automatic passenger counters on four buses operating on the West Heidelberg to city route. This required on-board equipment, transponders installed along the route and a radio centre at the M&MTB's laboratories in Preston.

A contract for AVM equipment was then awarded to Phillips Communications Systems of Clayton and AVM Systems of Forth Worth, Texas. In 1985 AVM was first introduced at the Footscray bus depot with a monitoring centre in Fitzroy South.

By the early 1990s AVM equipment had been installed on many of the trams at Brunswick, Camberwell and Essendon depots and buses at Doncaster, Footscray and North Fitzroy depots. Within four years most of the tram and government bus fleet had been fitted with AVM. It was subsequently removed from the buses by the National Bus Company after privatisation.

Key components

Some of the key components of the AVM system are illustrated in the above diagram provided to drivers by the Melbourne Transit Authority (MTA), the successor to the M&MTB.

Low powered radio signposts located on poles along each route transmit a unique location code which is processed by a data unit on each tram. Information about the tram's speed, direction of travel and distance from the

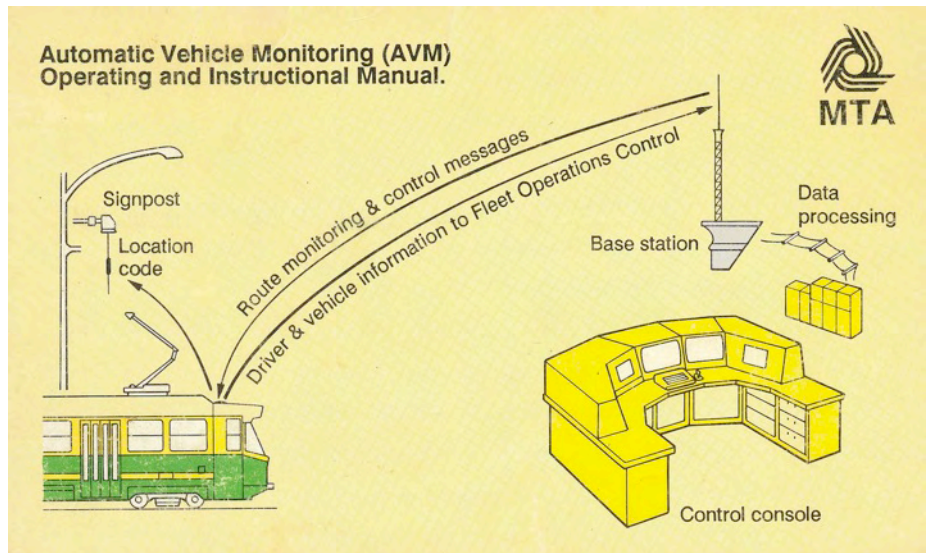
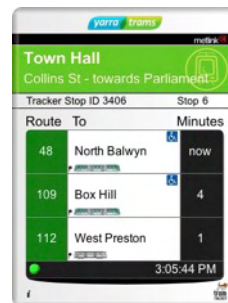


Diagram from MTA instruction manual (c1989)

terminus is then relayed to a base station and onto the computers at the Operations Centre (OC), previously known as Fleet Operations Centre (FOC).

As this data is received, it is compared with the schedule, time of day and other variables to monitor the tram's performance and predict its location.



TramTRACKER uses these predictions to calculate the next three arrival times at a particular stop. If traffic congestion or other disruptions occur, these predictions can be imprecise.

Global Positioning System (GPS) equipment is installed on Melbourne's trams for the myki ticketing system, PIDs and next-stop announcements. It is also being used in traffic light priority trials on route 75. However, Yarra Trams notes that the AVM system is retained for tram tracking because tall buildings in the city cause interference to the GPS.

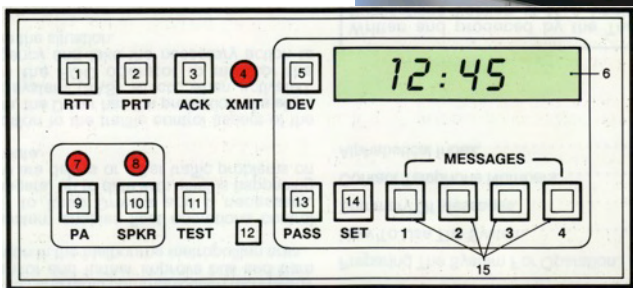
In the driver's cabin

To identify individual trams on the network, each vehicle is allocated a 'run number' that indicates which trips on the timetable it is operating. When starting a shift, a driver collects these details in both printed and electronic form. The printed 'table card' lists relevant destinations, times and run numbers. The electronic format has varied over 30 years.



RIGHT: Driver's cab in E.6001 (2013). The AVM control head is the rectangular console above the large coloured buttons. Its location varies in different tram classes.

Photo: Mal Rowe



INSET: Diagram of the AVM control head from the driver's manual (c1989). Buttons 1, 2, 3 & 10 are for communications with the Operations Centre, PA (9) is for passenger announcements and TEST (11) self-tests all AVM functions before departing the depot. Several items of information were added to the default screen (6) in the 1990s.

When AVM was first introduced, a variation on the long-used run number plate was utilised to transmit this information. Known as 'run cards', these plates had a series of coded perforations along one edge and were inserted into a holder at the front of each tram or bus. However, frequent malfunctions were experienced.

These run cards were superseded by the driver's 'portable memory key'. At the start of a shift, the key was loaded with run details then inserted into a console on the assigned vehicle. In recent years this key was then superseded by a driver's myki card which provides the same details when tapped onto or inserted into a tram's console, depending on the class of tram.



North Fitzroy run card 3 with coded perforations along the left edge (Richard Youl); Portable memory key (length 7cm) with a cover protecting metal contacts (Geoff Dean)

In the cabin the AVM 'control head' (see photo above) provides text and verbal communications with the OC. When the run details are transferred from the driver's key or card, they are displayed on the control head screen for confirmation or correction by the driver, then transmission to the OC.

Alternatively, the run number details can be provided verbally. When a driver presses the 'Test' button on the control head, the unit automatically performs a test sequence, culminating in a request to talk with the OC to ensure connection. OC staff enter the information which then appears on the control head.

When first introduced, the default screen on the control head only displayed the time. After a few years, it was upgraded to display trip details including a continuous update of the minutes ahead (+) or behind (-) schedule the tram is running. A zero indicates on-time running.

If a tram is more than a minute early at a timing point, the screen will display a code to lay up at the nearest available location to keep to the schedule. With the latest franchise agreement, the number of timing points along each route has increased from five to seven, except for the City Circle route.

Drivers also carry a printed table card. The accompanying example is part of Southbank Depot table 19 from 2003. The shift began at 5.10am, operated run number 61 on route 109. The letters next to the times indicate monitoring points. The table signed off at 2.15pm.

Operations Centre

In the first years of AVM, the OC was located in in the former cable tram winding house in Fitzroy South. It began with four consoles and text-based displays. When tram operations were split between two companies, separate OCs were established in Brunswick and South Melbourne.

With technological advances over the decades, more consoles, faster data handling and greater use of graphic displays have been introduced.

The South Melbourne facility continued until 2015 when operations were relocated to the CBD along with the Power Centre (previously Carlton Control) and other operational sections.



Monitoring trams and buses before AVM

Prior to the introduction of AVM, a decentralised and more labour intensive monitoring system was used by the M&MTB. It involved Traffic or Line Inspectors located at strategic points around the network. For many decades their main method of communication with head office or the depots was a system of landline 'track phones' installed at several locations along each route.

Inspectors would first check their watches with the clock in the Depot Starter's office then move to their assigned locations to monitor the headways (scheduled times) of trams and buses that passed. When a service gap appeared, inspectors used the track phones to seek information about breakdowns or cancellations.

Run number plates displayed at the front of all trams and buses allowed inspectors to match each to the headway list. Early or late running could be recorded for future reference and if circumstances required immediate adjustments, inspectors would instruct crews on these changes.

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=====
TABLE 19 SOUTHBANK Side A
MYER Xmas Window [SAT] Driver
Last Update on 15/11/03
=====
Rte Sign On 0510
    ## Run S061 ##
109 Car Out (Southbank Depot) ... 0520
    Spencer & Collins..... 0525
-----
109 Spencer & Collins..... 0525
    Collins & Elizabeth..... 0529p
    Brunswick & Victoria..... 0537q
    East Melbourne..... 0539
    Kew Depot Gates..... 0546
    Kew - Cotham & Glenferrie.. 0550
    Mont Albert..... 0600r
    Box Hill Central..... 0604
-----
109 Box Hill Central..... 0618
    Mont Albert..... 0622p
    Kew - Cotham & Glenferrie.. 0629
    Kew Depot (Barkers & High). 0633
    East Melbourne..... 0642
    Brunswick & Victoria..... 0646q
    Spencer & Collins..... 0656
    North Port Light Rail Stop. 0704r
    Port Melbourne..... 0706
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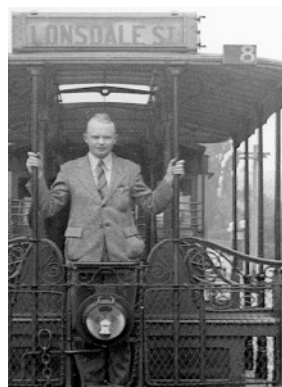
Part of Southbank Depot table 19.

Melbourne Tram Museum



Operations Centre in South Melbourne (2014)

Photo: The Wire, Yarra Trams



Run number 8 next to destination sign on a grip car at Collingwood terminus (A C Clarke, 1938); Preston Depot run number 12 (Geoff Dean, 1970s-80s)

Timing clocks

At each terminus and at strategic intermediate points along each route, timing clocks were located for drivers to record departure times. These clocks were commonly known as Bundy clocks, although Cincinnati clocks were also used. (See *Keeping Time: Bundy clocks in the M&MTB*, Russell Jones)

Drivers carried a 'table key' and 'table card'. The key was embossed in reverse with the depot letter and table number and was inserted into the keyhole and turned. A paper tape was forced against the key and time recording equipment thus printing the time and table number.

Before computer printers, these table cards were hand written and glued to strips of masonite board for durability. Tables showed destinations and key times in an abbreviated format. Drivers were expected to remember the running minutes between timing points and make the calculations themselves.

The accompanying example is part of South Melbourne Depot table 53 from the 1960s. The shift began at 5.09am and operated Route 12.

The inspector's duties also included ensuring the Bundy clocks were operating to time and the recording tape for the previous day was removed and handed in with the Inspector's Journal at the end of the shift. If all was running to time, inspectors would monitor drivers and conductors or check passenger tickets.

Every function performed during a shift had to be recorded on the appropriate reports and submitted each day. Any unaccounted gaps could elicit a visit from the Superintendent.



Bundy clock (2013, Marcus Wong) and table key A81 (South Melbourne Depot table 81, Melbourne Tram Museum)

53.

| Northern Up Trip @ Terminus | Southern Down Trip Leave City | Southern Up Trip @ Terminus | Northern Down Trip Leave City |
|---------------------------------|-------------------------------|-----------------------------|-------------------------------|
| SIGN ON | 5:9 | | |
| CAR OUT @ 5:19 FITZROY ST | | | |
| PICK UP PASSENGERS ← 5:27 | | | 5:56 |
| EX J. 100 CAR @ WILL. ST @ 5:58 | | | |
| AND 29 MINS TO R. WICK ST. | | | |
| BROWN ST | FITZROY ST. | | |
| 6:7 | 6:9 | 6:40 | 6:59 |
| 7:13 | 7:15 | 7:49 | 8:8 |
| 8:23 | 8:25 | 8:58 | |
| CAR IN @ 9:16 | | | |

Part of South Melbourne Depot table 53 (1960s) Melbourne Tram Museum

| MELBOURNE AND METROPOLITAN TRAMWAYS BOARD | | | | |
|---|-------------------|-----------------|---------------------------|--|
| A.M./P.M. PEAK HEADWAY REPORT | | | | |
| FROM INSPECTOR | | | WEDNESDAY DAY 15-OCT-1980 | |
| TO THE TRAFFIC MANAGER | | | DEPOT South MELBOURNE | |
| POINT | | | TABLE | |
| DOMAIN + ST KILDA ROADS | | | 1 | |
| WEATHER | | | FINE | |
| ROUTE | LATE RUNNING FROM | LATE RUNNING TO | MINS. LATE | TODAY'S REASONS |
| TOORAK | UP | 8:01 9:16 | 5/12 | TRAFFIC BRANGE ROAD TO CLEARING PUNT ROAD. |
| | DN | 8:29 9:07 | 3/7 | LATE FROM "UP" TRIP. |
| CANNBREWELL | UP | 7:49 9:23 | 5/23 | TRAFFIC CAMBUNG - GARDINER RAILWAY BATES - TRAFFIC ORRONG RD TO CLEARING PUNT ROAD |
| | DN | 8:13 9:11 | 6/14 | LATE FROM "UP" TRIP. |
| GLENN IANIS | UP | 8:05 9:06 | 4/9 | TRAFFIC APPROACHING CHAPEL STREET AND PUNT ROAD. |
| | DN | 8:33 9:04 | 3/6 | LATE FROM "UP" TRIP |

Part of a Traffic Inspector's Headway Report for the morning peak at Domain Rd and St Kilda Rd on 15 October 1980.

Kevin Stanes

Radio Centre

The 1956 Olympic Games hastened the need for improved communications. When the state government allocated money to the State Electricity Commission to purchase a new radio system, this provided the opportunity for the M&MTB to purchase the former SEC equipment. Radios were highly regulated in those years.

Two way radios were fitted to more than a dozen vehicles and each unit allocated a call sign beginning with 'R'. The 'breakdown wagon' was designated 'R10'.

Radio Centre was located on the first floor of M&MTB head office close to the Traffic Manager. There were two desks and three radio centre officers working in shifts.

During the 1960s, a progressive decline in passenger numbers and an increase in mobile patrols equipped with radios brought a restructure of many services and a reduction in the number of traffic inspectors.

Radio Centre closed in 1986 after the new Fleet Operations Centre in Fitzroy South was established for the AVM system.

My thanks to Alan Bailey, Warren Doubleday, Alan East, Kevin Stanes, John Whiting and Richard Youl for their assistance.

Geoff Brown

References:

Automatic Vehicle Monitoring System, Melbourne & Metropolitan Tramways Board (August 1979)

Automatic Vehicle Monitoring (AVM) Operating & Instructional Manual, Melbourne Transit Authority (c1989)

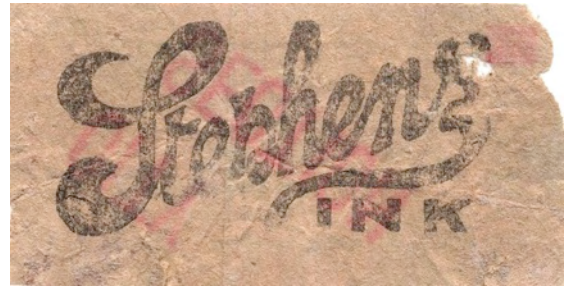
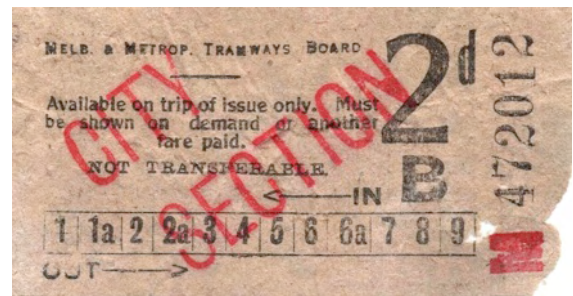
Keeping Time: Bundy clocks in the M&MTB, Russell Jones, Melbourne Tram Museum (2011)

Melbourne's Automatic Tram & Bus Vehicle Monitoring System, Evans S Craig, computer engineering services PTC (March 1992)

The Wire, Yarra Trams newsletter (various issues)

Yarra Trams website

Mysterious Ticket



A M&MTB ticket was recently donated to the museum. Both sides are shown above. It is unusual in several ways.

Firstly, it was found in an archaeological dig in Melbourne during construction of the Queensland Investment Corporation's new office tower at 80 Collins St. The ticket was found near a torn sheet from *The Age*, 3rd May 1928 – but this may not be relevant.

Secondly, its format is landscape rather than portrait like most M&MTB tickets and there is only one list of sections used to record trips IN and OUT. Our ticket consultant advised that he had not seen one like this before including the use of a section 6a.

On the reverse is an advertisement for Stephens' Ink. Stephens' Indelible Ink was registered in 1832 and used in the signing of the Treaty of Versailles in June 1919, bringing a formal end to World War I.

One suggested explanation is that it is a pre-purchased ticket bought in bulk by businesses for staff travelling within the city. Please let us know if you can assist with further information or suggestions.

Warren Doubleday



A cable tram set at the Johnston St, Collingwood terminus (cnr Clarke St) awaits departure for Lonsdale St (late 1930s).

PHOTO: Wal Jack Melbourne Album, courtesy Ballarat Tramway Museum

About this photo

Cable trams operated from this Johnston St terminus from December 1887 until April 1939 when they were replaced by buses. The route along Johnston St, Lygon St, Lonsdale St and Swanston St was first named the Carlton line then, more accurately, the Johnston St Bridge and Collingwood line. For two years this route terminated in Swanston St then in 1890 was through-routed to Prahran via Domain Rd, Toorak Rd and Chapel St.

In 1925 when Swanston St was converted to electric tramway, this line was terminated along a new section of track in Lonsdale St between Swanston St and Elizabeth St.

A tram shed was located behind the photographer and a tramway workman with leather apron can be seen on the grip car with the gripman. The hotel in the background and grocery shop on the right still stand today, although with some modifications.

Clock

Attached to a utility pole outside the grocery shop is a M&MTB Cincinnati Time Recorder Clock housed in a large metal cabinet. At the correct departure time shown by the clock, the gripman or conductor would insert his table key into a slot below the clock. A brass collar around the keyhole was then rotated to

record the table number and time on a roll of paper for later inspection. (With Bundy clocks, the key itself was rotated – see photos page 5.)

This time keeping method was a late addition to the cable tram system as the original private operator did not use time recording clocks. The Cincinnati clocks were subsequently used to regulate the two-man bus routes.

Run number

Although difficult to see in this photo, a run number plate is attached to the grip car's roof edge to the left of the destination sign (see photo page 4). Each tram was assigned a run number to identify which trips on a timetable it was operating. This assisted roving traffic inspectors who monitored tram schedules.

Run numbers were also a late addition to the cable tram system from c1934. The original operator monitored schedules from the tram sheds usually located at each suburban terminus in conjunction with traffic inspectors. With spare tram sets in the shed and keen standby crews who were only paid for work performed, extra trams could be dispatched to fill unexpected gaps or to deal with heavy traffic.

Museum News

Wednesday open days

A recent open day on Wednesday 25 September was most successful, attracting a new cross section of visitors compared to Saturdays.

The committee has therefore decided to trial eight Wednesday open days during 2020, in addition to the usual two Saturdays each month.

The Wednesday hours will be shorter, 11am till 3pm, and some of the dates will coincide with school holidays. We will also advise groups requesting weekday visits to try to attend on these Wednesdays.

All the 2020 dates are listed on the museum website under the Visitors tab. The Wednesday dates are:

| | | | |
|---------|--------------|------------|------------|
| 4 March | 1 April | 6 May | 3 June |
| 1 July | 30 September | 28 October | 2 December |

As with all open days, we depend on the generosity of our members to volunteer their time as assistants. If you are available on Wednesdays, these dates may be your opportunity to help.

Please mention your interest to a committee member or email info@trammuseum.org.au

Museum committee 2019-20

This year's committee members are:

Rod Atkins (*Chairman*)
 Geoff Brown (*Deputy Chair*)
 Mike Ryan (*Secretary*)
 Carolyn Cleak (*Treasurer*)
 Adam Chandler
 Warren Doubleday
 Russell Jones
 Kevin Taig

Seasons greetings

Merry Christmas and Happy New Year to all museum members and supporters. Thankyou to all who have assisted the museum during 2019. A special thanks to those who regularly attend to assist on open days.

Working bee

Our thanks also to the members who joined our October working bees to clean the windows and panelling of half our fleet. Visitors have commented on the pleasing results. More are planned for 2020.

Museum on TV

The museum was recently featured in a Channel 7 lifestyle program, *The Great Weekend*, aired on Sunday 17 November. If you missed it, you can find it in episode 20 at <https://7plus.com.au/the-great-weekend>

We hope it results in an increase in visitor numbers.

The Melbourne Tram Museum is open on the 2nd and 4th Saturdays of each month 11am–5pm (except the 4th Saturday of December). It is also open on advertised Wednesdays between 11am–3pm.

Upcoming open days in 2020 are:

| | | | |
|-------------|----------|--------|-------------|
| 11 Jan | 25 Jan | 8 Feb | 22 Feb |
| 4 Mar (Wed) | 14 Mar | 28 Mar | 1 Apr (Wed) |
| 11 April | 25 April | | |

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Website: <http://www.trammuseum.org.au>

Telephone (open days only): (03) 9819 6447

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