Oral History Program

Traffic Management Initiatives

SUMMARY REPORT

Researched and written by Cinetel Productions

June 2003

ISBN 071305380X

Published June 2003

RTA Pub. 03.091

Researched and compiled from interviews conducted by:

Frank Heimans,

Cinetel Productions Pty Ltd, Cremorne NSW.

for:

RTA Environment Branch

Level 6

260 Elizabeth St

SURRY HILLS NSW 2010

Telephone	(02) 9218 6083
Fax:	(02) 9218 6970

About this oral history...

Oral history has been described as *"a picture of the past in people's own words"*. It is based on stories by people who were involved in life's events, told in their own, passionate words. It adds to the official written history and gives us a more intimate and personal perspective on how, when and why things happened. Oral history is a means of communicating how individuals perceived and dealt with challenge, achievement and failure. It often reveals the unsung heroes - those actually responsible for innovations and important changes, and provides them with an opportunity to evaluate their actions in a wider occupational, social and political context.

The RTA Environment Branch established its Oral History Program in 1997, to investigate various topics of historical interest. *Traffic Management Initiatives* is the eighth thematic oral history to be undertaken as part of the Program. As with previous projects, this oral history did not seek to present a definitive history of developments in this field, rather it involved a recounting of interesting stories and insights, told by those involved.

The project was based on 47 hours of digitally recorded interviews with 37 participants - current and former staff of the RTA and its predecessor organisations the Department of Motor Transport, Traffic Authority and Department of Main Roads. It discusses the many innovative ideas and new technologies which have been utilised over the years to manage traffic on the road network, and the various methods and techniques employed to improve the safety and efficiency of the transport system, such as traffic signals, SCATS, traffic control cameras, signposting, line marking, clearways, roundabouts, moveable medians, bus priority, driver aid systems and electronic tolling.

This report is a summary of the key themes and findings revealed in the course of research, investigation and interviewing. It is one part of a project that includes the original interview tapes, logs, photographs, research materials and an edited compilation CD. Compiled excerpts from the original interviews may be accessed on the RTA website at www.rta.nsw.gov.au. Click on "Environment", then "Heritage", then "RTA Oral History Program".

The author would like to acknowledge all who contributed to this oral history project: the thirty-seven interviewees named at the end of this document and the staff of the RTA Environment Branch who assisted with the project.

Contents

Traffic lights are not the panacea for all ills, but there would be a fearful mess if you suddenly removed them from all intersections. After all, look what happens when they stop working.

- article in AUTOSAFE magazine, January 1973

Beginnings

Of all the RTA's activities, the management of traffic is probably closest to every motorist's experience. Everyone who drives has an opinion on the subject of how to avoid traffic, what back roads to take - how to get around traffic by using different routes - there seems to be no limit to what humans can creatively construct in their quest to get from A to B in the shortest possible time frame. With the growth of motor car and truck use at between four and six percent per year since the end of the second world war, traffic was becoming an increasingly difficult problem to manage.

The very first recorded instance of traffic management may have been in the ancient Middle East. According to John Bliss, General Manager, Traffic Systems Branch at the RTA:

> Perhaps the first instance of a parking restriction in recorded history was in fact in Babylon, back in the year... whatever, about 2000-odd B.C. I guess, where the king issued an edict which was evidently signposted on one of the roads of Babylon and it read something along the lines of *'The King's Highway - let no man hinder it on pain of Death'.* I think some who complain that the fines nowadays are a bit rich ought to go back and look at history - your head was on the line then. (Bliss, Tape RTA-TMI:FH58, 06:38)

Jack Winning offers another interesting fact of history:

> Line marking, or line delineation was started way back in the Roman days - they used to put coloured bricks in the middle of the road to separate the traffic going north and south. (Jack Winning, Tape RTA-TMI:FH11, 34:02)

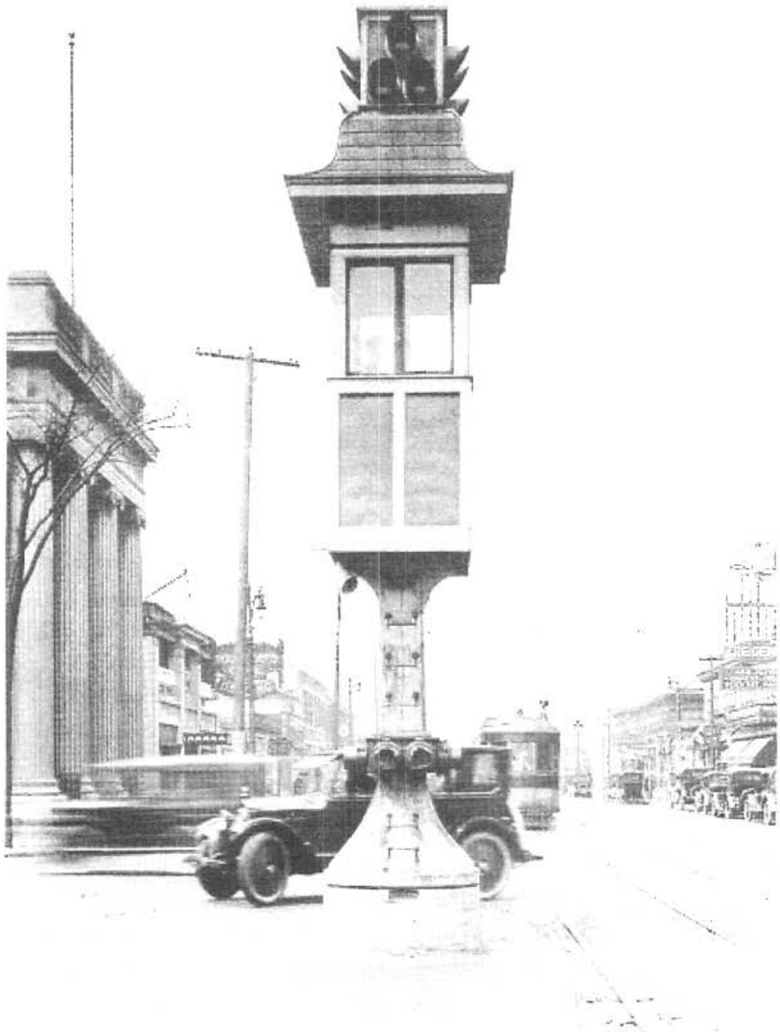
The job of managing traffic was traditionally assigned to the Police. Arthur Sims recalls that in 1961:

> There were 250 Policeman employed purely for controlling traffic in the Sydney CBD – the guys that got out on the intersection and waved their arms, but these Policemen weren't coordinated, so one Policeman at one intersection would call the traffic through and the one at the next intersection would stop it. (Sims, Tape RTA-TMI:FH1, 16:06)

The invention of the first traffic signal to relieve the burden on the Police was erected outside Parliament House in London on 10th December 1868. It comprised a semaphore arm with red and green gas lamps. Police changed the lights from red to green by pulling a lever at the foot of a pole, moving the semaphore arms at the same time. The structure was almost seven metres high. A Police announcement relating to the sign boldly exclaimed:

Early [illegible] World War II traffic towers or "crows nests" in Detroit. The "stop" and "go" instruction were supplemented by accompanying red and green illuminations.

Traffic tower in Detroit USA, 1920s



This highly prominent traffic tower was in vogue in the early 1920's at Detroit's Woodward and Boulevard intersection. The tower shown here has 12 - 250 watt lamps to illuminate the red, amber and green upper signals and used 8 - 86 watt lights at a lower "drive-eye" level to also indicate red and green indications to drivers.

Traffic tower in Detroit, USA, 1920s

> *"The 'proceed with care' signal warns every vehicle driver or horse rider to cross the crossing carefully and to pay attention to the safety of the pedestrians. The 'stop' signal is only used when it is necessary to completely stop the traffic of both vehicles and horses on both sides of the crossing in order to enable pedestrians to cross over. In this way, every driver of vehicles or horses is warned that he has to keep the crossing free."*
>
> *(Dept of Main Roads publication, September 1983, pp.2).*

Londoners, intrigued by the new device, came out in great numbers to view this new apparatus and the Police had difficulty in controlling the crowds. Furthermore, horses were frightened by the arm movements and the gas light at night. Unfortunately, several Policemen were killed when gas from a nearby main filtered into the hollow semaphore pole and an explosion occurred when they tried to light the gas lamps. Not long after, it was reported that the gas-operated signals finally exploded and self-destructed. Some cynics said that this might have been due to an excess of 'hot air' from Parliament! (Main Roads Magazine, June 1977, pp.102-105).

In 1908, semaphores were installed at several intersections at Toledo, Ohio, USA. They had red and green lenses, illuminated at night by kerosene lamps, with the words 'Stop' and 'Go' in white on a green background, with the arms two and half metres above the level of the pavement. A Police officer operated the signal by controlling a handle and blew a whistle before changing them. It was no coincidence that this method of operating signals soon fell out of favour.

In 1918, the first electric light signals in three colours were installed at intersections in New York and were manually operated by Police officers at each intersection. They were followed by a similar installation in England two years later.

On Friday the 13th of October 1933 in an eventful day for the citizens of Sydney, the first traffic signal was ceremoniously switched on by the Minister for Transport, Colonel Michael F. Bruxner at the intersection of Market St. and Kent St. in the CBD. The equipment, imported from England at a cost of £390 and supplied by Automatic Electric Telephones Ltd (AET) was vehicle-actuated. Installation by the Electricity Department of the Sydney County Council cost a further £183/6/4d. Not surprisingly, the Commissioner of Police was very much against the idea of having traffic signals, as he faced the prospect of having his point-duty men superseded by machines. (*Ref: Article in Sydney Morning Herald, 14 October 1933)*

The decision to erect a traffic signal in Sydney had not been an easy one. It was Bob Filmer, an enterprising young salesman at AET who had convinced the Government to install the signals for a trial period of three months. Rae French, who was in charge of the Department of Motor Transport's Burwood Signals Workshop two decades later, remembers Filmer well. He recalls that Filmer told him:

don, M...
[redacted] J. B., M.L.C. (nominated by J.
M.L.C., and J. Ashton, M.L.C.).
[redacted] V., M.L.C. (nominated by
W. E. ... and W. F. Foster,
Jarvie, M.L.A., and W. F. Foster,

[redacted] (nominated by A. S. Henry,
and W. Bennett, M.L.A.).
[redacted] M.L.C. (nominated by H. E. Man-
M.L.C., and H. M. Hawkins, M.L.C.,
Minister).
[redacted] RE, T. M., M.L.C. (nominated by
..timer, M.L.C., and W. F. Foster.

.).
LAD, E. C., M.L.C. (nominated by
Drummond, M.L.A., Minister for
[redacted] n, and H. F. White, M.L.C.).
[redacted] (nominated by A. D. Reid, M.L.A.,
W. F. Ross, M.L.A.).
R, A., M.L.C. (nominated by W.
[redacted] M.L.C., and J. G. Farleigh,

[redacted] H., M.L.C. (nominated by M. P.
..p, M.L.C., and G. D. Bassett,
.).
[redacted] N, T. C. (nominated by G. Black,
and J. Keegan, M.L.C.).
[redacted] AN, A. K., M.L.C. (nominated by
Bruxner, M.L.A., and M. Kilpatrick,
.).
[redacted] F. E., M.L.C. (nominated by J.
[redacted] M.L.C., and F. H. Bryant,

I. G., M.L.C. (nominated by J. W.
val, M.L.C., and G. Wrench, M.L.C.).

[redacted] STATE LABOUR.

..H, W., M.L.C. (nominated by J.
oncannon, M.L.C., and G. S. Archer.
.).
[redacted] A., M.L.C. (nominated by J. W.
..n, M.L.C., and C. B. Bridges.
..).
., G. S., M.L.C. (nominated by W.
worth, M.L.C., and J. M. Concannon.
..).
[redacted] C. B., M.L.C. (nominated by J. W.
..rn, M.L.C., and A. A. Alam, M.L.C.).
RN, J. W., M.L.C. (nominated by A.
Alam, M.L.C., and C. B. Bridges.

[redacted] ON, J. M., M.L.C. (nominated by
Ainsworth, M.L.C., and G. S. Archer.
.C.).
[redacted] J., M.L.C. (nominated by J. B
[redacted] M.L.C., and J. J. Graves, M.L.C.).
[redacted] J. M., M.L.C. (nominated by G.
Sinclair, M.L.C., and C. Tannock.
.C.).
[redacted] P., M.L.C. (nominated by E. J.
[redacted] agh, M.L.C., and J. F. O'Reilly.

IGHAM, T., M.L.C. (nominated by D.
nt, M.L.C., and W. J. Gibb, M.L.C.).
[redacted] M.L.C. (nominated by F. Roels,
[redacted] and R. A. King, M.L.C.).
[redacted] J., M.L.C. (nominated by T. J.
..th, M.L.C., and T. Falkingham.
.C.).
[redacted] D. M., M.L.C. (nominated by T.
..gham, M.L.C., and R. Pillans.
..).
AGH, E. J., M.L.C. (nominated by T.
Doyle, M.L.C., and J. F. O'Reilly.
..).
[redacted] A., M.L.C. (nominated by F. Roels,
[redacted] and J. Fox, M.L.C.).
R, P. M., M.L.C. (nominated by Mrs.
Webster, M.L.C., and R. E. Savage.
..).
[redacted] H. E. C., M.L.C. (nominated by T. J.
[redacted] M.L.C., and R. Mahony, M.L.C.).
NY, R., M.L.C. (nominated by T. J.
..ell, M.L.C., and E. C. Magrath.
[redacted] G., M.L.C. (nominated by D.
[redacted] M.L.A., and D. Rees, M.L.C.).
N, J. B., M.L.C. (nominated by J.
..bert, M.L.C., and J. J. Graves, M.L.C.).

[redacted]

be unreasonable for any member to seek election and then have to ask for such long leave of absence.

TRAFFIC CONTROL.

Automatic Device.

IN USE AT CITY INTERSECTION.

Sydney's first experiment with automatic traffic control was begun yesterday, with the inauguration of an "electro-matic vehicle-actuated controller" at the intersection of Kent and Market streets.

The Minister for Transport (Mr. Bruxner), the Chief Secretary (Mr. Chaffey), and the Commissioner for Road Transport (Mr. S. A. Maddocks) were present to see the device put into operation.

Four posts, each carrying three sets of three-coloured lights, have been erected at the street corners, and broken "stop" lines have been painted in yellow on the roadway. Signal changes are effected through special "detectors" fitted in the road surface. These register the passage, speed, and direction of every vehicle passing over them, and the appropriate light signals are shown automatically, being exactly adjusted to the traffic flow at the moment.

Motorists took to the innovation surprisingly quickly, and a number of policemen who had been detailed to help educate motorists in the system had little to do. The lights worked automatically, and streams of traffic halted or moved on rapidly in compliance to the red and green lights. Between each movement of traffic, the lights were amber, indicating a breathing-spell for the clearing of traffic from the intersection.

There were occasional incidents which temporarily marred the evenness of the system's working. An elderly lady, who had several children in the back of her motor car, stopped in the middle of the street and halted traffic for some minutes while the operation of the lights was explained to her.

A number of men, evidently pleased to see that the traffic policeman was missing from his accustomed spot, drove gaily across the intersection in defiance of the red lights.

The Superintendent of Traffic, Superintendent Carter, said that motorists could not be expected to fall in with the system at once, but the result of the first day's working was satisfactory. He said that the system was especially applicable to right-angled intersections with even flows of traffic in both streets. He did not believe that traffic policemen would no longer be needed, because constables would still be necessary to detect offenders against traffic regulations.

It is claimed that statistics show a considerable diminution of accidents wherever this system has been installed, and that, since no continuously moving parts or delicately adjusted mechanisms are used, the installation functions indefinitely without attention or maintenance. The meaning of the signals was explained in yesterday's "Herald."

The directors of Automatic Telephones, Ltd., suppliers of the apparatus, entertained the Ministers and other guests at Romano's. A working model of the apparatus was displayed on one of the tables. Mr. Bruxner congratulated the company on its enterprise and confidence in installing the equipment for a test without asking the Government to bind itself to purchase.

It is thought that the equipment will cost about £1 a week for each street intersection.

diseases result from abnormal activity of ... adrenal glands and the increased success ... gland surgery were presented at to-night ... session of the American College of Surgeons ... leading American authorities.

Dr. George Crile elaborated a theory ... the inter-relationship between the thyroid gland and the nervous system. He said that the over-functioning of the gland affects every organ and tissue of the body. In ... cases he had linked such a condition with tuberculosis. In most cases the disease improved or disappeared with the removal ... the thyroid gland.

UNITED STATES.

Inflation of Currency Opposed

NEW YORK, Oct. 12.

The convention of the American Federation of Labour to-day approved resolutions opposing inflation of currency, declaring that ... would bring the "greatest possible harm" ... wage-earners.

The resolutions criticised some of the policies of the National Recovery Administration, and demanded more Labour representation on the N.R.A. boards and committees. They also asked for adequate unemployment relief this winter, and urged that President Roosevelt should restore the equivalent of the salary reductions of Government workers ... the earliest possible moment.

ENGLISH TEAM IN INDIA.

CALCUTTA, Oct. 13

"No one could be more sensible of the honour done me by the M.C.C. when it asked me ... lead the English team in the land of my birth," declared D. R. Jardine, captain of the English team touring India, on the arrival of the tourists at Bombay, where Jardine was born.

RIFLE CLUBS

Praised by Ministers.

The Assistant Minister for Defence (... Francis) and the Minister for Lands (... Buttenshaw), in speeches at the official luncheon at the Anzac rifle range yesterday, praised rifle clubs for their national service.

Mr. Francis expressed the hope that ... clubs would co-operate with the Federal Government in its efforts to improve the defence system.

Rear-Admiral Dalglish, responding to ... toast, "The Navy, the Army, and the ... Force," proposed by Mr. W. Sproat, of Victoria, emphasised the importance of the association's prize meeting from a national standpoint.

MALABAR.

The Minister for Lands (Mr. Buttenshaw) has announced in the Government "Gazette" ... that the department has consented to ... that the name of the village of Brand (the ... residential section of Long Bay) to Malabar ...

A recommendation of the Randwick Council to this effect has now been adopted ... the postal authorities, the Education Department, the Transport Commission, the Water ... and Sewerage Board, the City Council, ... the State Government.

Extract from SYDNEY MORNING HERALD, 14 October 1933

> Because the signal (at Market & Kent streets) was vehicle actuated, Bob Filmer used to stand along the controller with a (concealed) switch in his pocket, which he would operate to keep the signals green until the horses and carts got through, and as a consequence of that, signals started to be installed all over (French, Tape RTA-TMI:FH7, 13:32)

The NRMA's journal Open Road of 26th October 1933 ran this article under the heading: "We Flirt with Eva":

> *"It looks as though our Eva has come to stay, even though the wife looks coldly upon us when this lively lass winks flirtingly. Eva is a girl with a mind, and her flirtations are quite impartial and all in a good cause. There can't be many motorists in Sydney now who have not been winked at by this lively lass of the triple eyes who is so well regarded in the whirl of traffic control. If you are still unacquainted with Eva, meet her at the intersection of Market and Kent Streets, and if you think Eva is too familiar for a first meeting, call her Miss Electromatic Vehicle Actuated Traffic Controller. Quite a mouthful? That's what her makers said when they christened her Eva."*

By 1937, four more 'Evas' had been put in service at intersections on the corner of York and Margaret Streets, at Erskine and Clarence Streets, at Pyrmont Bridge Road and Booth St, Camperdown and at Wattle Crescent and Jones Street, Forest Lodge.

The then Department of Road Transport and Tramways (later to become the Department of Motor Transport) was charged with the responsibility for the maintenance and subsequent installation of additional signals, largely because it employed people with electrical skills (for the tramways). This tiny seed, which can be said to have led to the development of SCATS, was nurtured by the decision to undertake maintenance in-house rather than leaving it to the equipment suppliers. (Ref: Lowrie, technical paper: SCATS - The History of its Development).

Detectors and controllers

From the earliest times, traffic signals in Sydney were vehicle-actuated by a detector in the road. Rae French comments:

> The first vehicle-actuated traffic signal was in Chicago outside a funeral parlour and the proprietor of this funeral parlour had fixed-time signals outside – they didn't have actuation, it changed automatically from one street to the other - and he was kept awake by vehicles stopping and he arranged to have detectors put in and they were noise (activated) like a microphone, for starters, to make them respond to vehicles. (French, Tape RTA-TMI:FH7, 21:37)

The first vehicle detectors Rae French came upon were contact-plate detectors. They were either six or eight feet long, made up of two steel plates and held apart by two pieces of rubber. When a vehicle passed over them, the plates would come together to form an electrical circuit. They needed constant maintenance, often resulting in road closures:

> Being in a harsh environment, out on the road, water would get in you would get short circuits between the plates and that led the company to substitute them with pneumatic tubes which had two chambers in them and as the vehicle passed over, it would send a little pulse of air to a little capsule, which was located in the footpath, and that was the detector for the vehicle. (French, Tape RTA-TMI:FH7, 19:19)

But these pneumatic detectors also had their problems. Grahame Davis explains:

> Vehicles accelerating across them would eventually wear a hole in the top - water would get in to run into the tube to the contacts and everything would fail. (Davis, Tape RTA-TMI:FH50, 7:50)

Peter Lowrie adds:

> The detectors were enormously unreliable, but unlike in other parts of the world, we persevered with detectors because we felt that the advantage of a signal that responded to the variations in traffic was worthwhile. (Lowrie, Tape RTA-TMI:FH33, 15:58)

Alan Short explains how detectors work:

> They determine that there's a car there – the rubber (detectors) count in the cars and the controller notes these facts and says 'right-oh, if we've got a red facing that road, we need a green' – that puts in what's called a demand. Whenever it's a suitable time to leave what's on

> green then, it will proceed through amber, which is a fixed time, and red, and go to green on the new approach. With the rubber detectors, it then allowed a fixed period, which is a minimum green – generally about six seconds or thereabouts, and then another period that's resulted from the counting of vehicles, because the rubber detector was a fair bit back from the stop line and it would count up till about half a dozen vehicles, generally at about two seconds per vehicle (had passed) and they'd add that to the minimum green, and the green would not go until that total time had passed. Then, they would start looking for gaps in traffic. The gap was generally about four seconds that was allowed – if nothing turned up for that time, it would say, 'OK we can leave green and go to wherever else is required'. If there were no gaps, in a very heavy traffic situation, it went to a maximum green time that we set - it may be a minute, for example – when the minute was up, it'd say 'OK, too bad - we're going somewhere else now and give them a turn', so it'd change to the new approach. (Short, Tape RTA-TMI:FH28, 18:38)

The decision to change green time allocation was performed by magnetically operated relay counters in the controllers, which were housed in boxes near the intersection. The first controllers came from the UK. In the 1950s when Frank Hawes worked at the Department of Motor Transport (the DMT) Signals Workshop, A.T.E. Type 37, an electro-mechanical camshaft-driven controller was still in use:

> They were called Type 37 because they were designed in 1937 in England. The components were of the same ilk as then, so even though this was in the late 1950s, there was no advance on the type of technology. So they were robust, certainly, but limited in their reliability and their ability to maintain a setting for too long. The next one was Type 54, presumably designed in 1954, and that saw the use of telephone-type relays replace the old contact-style of relay. It also saw a significant amount of electronics come in, in the form of timing circuits, which made it more complicated and more sensitive to traffic parameters than the early ones were, so in that sense, a considerable step forward. (Hawes, Tape RTA-TMI:FH17, 13:22)

In his early days as a trainee at the DMT's Traffic Signal Workshop in 1970, Doug Quail recalls:

> That ancient type (of controller), Type 37 was gradually being replaced by other equipment, manufactured by AWA, called the UNITAC controller and Eagle, which manufactured the CT-500. These controllers were electro-mechanical - they had valves and relays and lots of wiring. (Quail, Tape RTA-TMI:FH43, 35:17)

The UNITAC controller allowed a small level of coordination between signals to begin, as two intersections could now be linked by one UNITAC controller.

Traffic signal coordination

An early form of coordination was known as *sister linking* whereby two controllers were interconnected by a cable and synchronised the timing of the main road signal's green phase. The first system of coordinating multiple intersection controllers was supplied by Siemens and installed in the Parramatta CBD in 1961. One of the controllers was the *master*, coordinating the timings of the other cable-interconnected controllers using fixed time control. (Ref: Lowrie, technical paper: SCATS - The History of its Development).

The 'father' of traffic signal coordination is generally accepted to be Arthur Sims.

Sims was born in Ramsgate in 1928. The suburb was then semi-rural, with Chinese market gardens and dairies. Sims' father was an iron moulder and core maker who worked at the Eveleigh workshops in Redfern. He made cylinders for steam trains. Sims attended Sydney Technical High School and at an early age, showed a flair for invention. He built the first ski tow at Perisher, then found himself a job at IBM as Customer Engineer, although he had no formal Engineering qualifications. He learnt about IBM equipment, which at that time consisted of electric typewriters, Bundy clocks and master clock systems. He also invented and built what was probably the world's first illuminated digital clock that showed both the time and temperature and a conveyor belt system to move telephone punch cards for a taxi company. At the Accounting Machines Division of IBM Sims met someone who was to determine the future direction of his work:

> There was a salesman at IBM called Bruce Cliff and he was their crash-hot, best salesman. In those days, there was only one set of traffic lights in the Sydney CBD and Bruce had the idea that it was a good opportunity to put 150 sets of traffic lights in 150 sets of intersections in the Sydney CBD and program those lights, so that if you got a green on one, then there was a high expectation that you'd get a green at the next one. There were already coordinated traffic light systems working in a couple of cities in the world ... anyway, he went and talked to the Chief Engineer of the Department of Motor Transport in those days - Rae French, who was a very astute engineer - and somehow or other, Mr French cottoned on to the idea and he was enabled to go on a world trip with the Superintendent of Traffic in the Police Force to inspect these systems overseas. (Sims, Tape RTA-TMI:FH1, 16:06)

French had never left Australia and went to New York and London, but it was not until he reached Frankfurt that he discovered the use of closed-circuit television cameras and the means of crude coordination of traffic signals by use of rotary timers in a master control system to which individual traffic controllers at intersections were connected. French came back quite excited at his discovery. He and Frank Hulscher wrote specifications for a master control system to coordinate eight intersections in Pitt and Castlereagh streets in the CBD and called for tenders.

Left to right: Commissioner H.A. Barnes, Dept of Transit & Traffic, Baltimore USA,
M.W. Chaseling, Superintendent of Traffic, NSW and
Rae French, Chief Traffic Signal Engineer, Department of Motor Transport, NSW.

Photograph taken 17 March 1961 in Baltimore, USA.

French named it the Inner-City Pilot Scheme. IBM was the successful tenderer and Sims started work on the project in 1962. He was given only six months to make the system fully operable:

> Mr French designed the actual grey boxes that sit on the street corner – the control devices that sit on the intersection – and I designed the Master Controller, using the existing IBM machines, if you like. This is in the days before commercially-available computers, but IBM had accounting machines, which were big machines, full of electronic valves, so I was able to utilise these obsolete IBM accounting machines and re-wire them, and reprogram them via means of plug boards, where you put a wire in through one hole and connect it to another hole in order to create a program effect. (Sims, Tape RTA-TMI:FH1, 18:57)

> Sims built the prototype equipment for the Master Controller, which took up an entire room in the basement of the DMR's building in Castlereagh St and it worked according to DMT specifications. However, the system was limited in that no use of detectors was made, but it was coordinated to the extent that, for the first time, it made use of CCTV (closed-circuit television cameras) to monitor traffic. French decided against the use of detectors for the pilot scheme because at that stage only movement detectors were available and they had shortcomings in that they did not give a true picture of traffic density, so a programmed fixed time-of-day system was used, with plans changed manually. The controllers used in the pilot scheme were known as VC-1 and were designed by Grahame Davis and Frank Hulscher at the DMT. The VC-1 controllers incorporated a Heath-Robinson type of device invented by Davis and Sims - a four-colour light bulb system where a bulb would automatically go on if a traffic signal at any of the intersections failed and a bell would ring at the same time, warning of the event. (Davis, Tape RTA-TMI:FH50, 14:35)

The success of the prototype spurred the development of an expanded system and approval was given in 1964 for a system to control 25 sets of traffic signals in the CBD. This required larger master control premises and a property at No. 4 Brisbane Street was acquired by the DMT for the purpose. The enlarged system had 25 CCTV cameras linked to 25 sets of traffic signals by copper cable, laid in unused underground tram ducts by Phil Kirby, an enterprising contractor. The Police took charge of directing traffic in the new centre, which was given the imposing name of Sydney Traffic Control Centre:

> In those days, the Police were the only people, enabled by law to control traffic, so we had 13 Policemen up at the Control Centre, which we had to train on how to do it all, and it worked very well. (Sims, Tape RTA-TMI:FH1, 22:55)

That equipment took up the majority of space in the new centre:

> It was a big box with revolving drums and pins and myriads and myriads of wires and lots and lots of miniature relays that IBM used in their calculating machines. That machine was huge - it

> filled a whole room with cabinets and each cabinet was as big as four or five large refrigerators and the power that it drew was enormous: the 6.3 volt filaments of the valves drew something like six thousand amps and it again was a myriad of wires and patch boards for programming and uniselectors, and just thousands and thousands of relays which operated every second: in and out, in and out. So the reliability again was a problem and a regimen of routine maintenance had to be carried out on weekends, when all the wires on contact relays were unplugged and replaced with ones that had been repaired, cleaned and adjusted and all the valves were routinely replaced (Lowrie, Tape RTA-TMI:FH33, 21:58)

The system was progressively added to and eventually controlled 150 sets of signals, still using cables in a fixed-time system. Alan Short explains how the controllers, linked by cables, would send on their instructions:

> With the old form of cable coordination, basically, when one controller went to green on a main road, for instance, it would send a signal to the one down the road and say 'right-oh, I'm now green - do what you want to do' and it would be set up with another timer which said 'maybe sixteen seconds after the first ones go green I've got to go green, otherwise I'll finish up with everything jammed up', so it just kicks the next controller along. Then there'd be another cable to another set further down and so on, so you get this progressive movement. (Short, Tape RTA-TMI:FH28, 21:50)

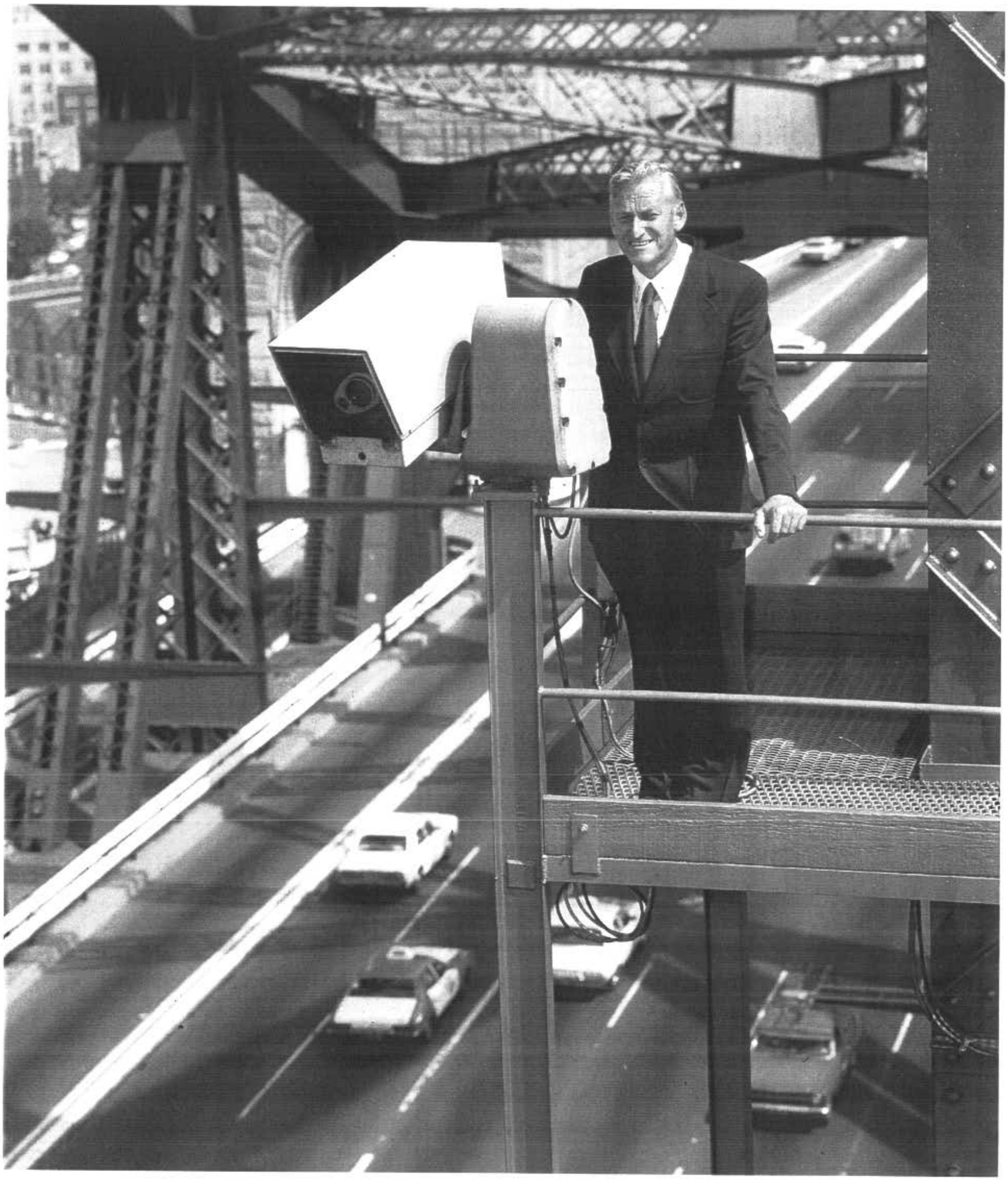
By the mid 1960s, when IBM folded its traffic signals division, Arthur Sims had left them to join the DMT's Traffic Signals Group. There he came into contact with Grahame Davis for the first time. Davis had originally come to Sydney from Rockhampton in 1962:

> I had been doing a correspondence course in electronics - it was the Marconi School of Wireless; I don't know if they're still in existence - and I had a six months' practical course to do, so I came to Sydney for six months and I'm still here. (Davis, Tape RTA-TMI:FH50, 04:04).

Sims and Davis immediately hit it off together, as each of them had complementary talents. Davis recalls:

> Arthur had lots of good ideas and I was good at putting them together (Davis, Tape RTA-TMI:FH50, 16:43)

The collaboration between Sims and Davis was to reap great rewards for the development of traffic signals in Australia and later, the world.



Arthur Sims with the first traffic control camera on the Sydney Harbour Bridge, 1978

The electronics revolution

By the late 1960s a technological revolution was under way when the first solid-state devices, forerunners to integrated circuits, became available. If the DMT was to keep its lead, it would have to adapt to the new technology:

> The first integrated circuits (used in traffic signal controllers) must have been around 1968 – people used to call them caterpillars - they were a little black chip with 50 legs on them, plugged into a little socket, or soldered onto a printed circuit board and we developed an interim Master Controller prior to the advent of computers, using integrated circuits, and we installed those small, remote systems in Broadway, Maitland, Newcastle, Wollongong – they were a device called the VCM – Vehicle Control Master - they were stand-alone: you didn't monitor them from a Control Centre, they were just a little cabin somewhere near the road, being controlled. (Sims, Tape RTA-TMI:FH1, 40:48)

The first VCM system, which became known as the Broadway system, controlled six intersections along Broadway. Although still programmed by patch boards, this system was significant in that it allowed the controllers, which were the same as those used in the city, to operate under *semi vehicle-actuated* control. (Ref: Lowrie, technical paper: SCATS - The History of its Development).

The Maitland system was a modular unit that could control up to 10 intersections and used semi conductors. It could boast a few 'firsts':

> It was a rack-mounted unit, about six feet high – it was the first coordinated system outside Sydney, mostly semi-conductor, still used some relays. We had loop detectors in the street for detecting traffic. It was actually a dual unit: one operational, one on standby in case the main unit failed. That was fairly important, because it was so remote (being in) Maitland – it was several hours' drive to get there. It was the first time that Master Control equipment ran unattended – there were no operators there at all. (Davis, Tape RTA-TMI:FH50, 19:51).
>
> This was a major breakthrough for the world of traffic signals and there was nothing like it at the time. (Davis, Tape RTA-TMI:FH50, 18:06).

In addition to the VCM, DMT engineers developed the Flexible Progressive Control Master (FPCM) and the Mains Synchronised Co-ordination Offset Timer (MASCOT). The former was essentially a smaller and cheaper version of the VCM suitable for mounting in a roadside cabinet. The MASCOT was an accurate crystal-controlled clock, together with storage for eight signal timing plans and a timetable of plan introduction times. By installing MASCOTS in a number of adjacent controllers, coordination could be achieved without the need for expensive cabling between controllers. (Ref: Lowrie, technical paper: SCATS - The History of its Development).

A breakthrough in detector technology also occurred in 1968 with the introduction of the magnetic loop detector. The first units imported into Australia were made by RCA in the United States.

> The system used wires buried in the road, so it's basically like a little radio aerial effectively, but they worked magnetically and picked up any iron that went across the top of them (Short, Tape RTA-TMI:FH28, 24:39)

> Some of the (RCA loop detectors) had a lot of problems – they weren't working well at all – they seemed to have very poor sensitivity in places, which was unexplained, and in other places they were getting a lot of interference and interaction between various loop detectors and loops – you could go to an intersection and it was like a symphony – they were ticking, like tick, tick, tick, tick, all interfering with each other (Longfoot, Tape RTA-TMI:FH40, 09:38)

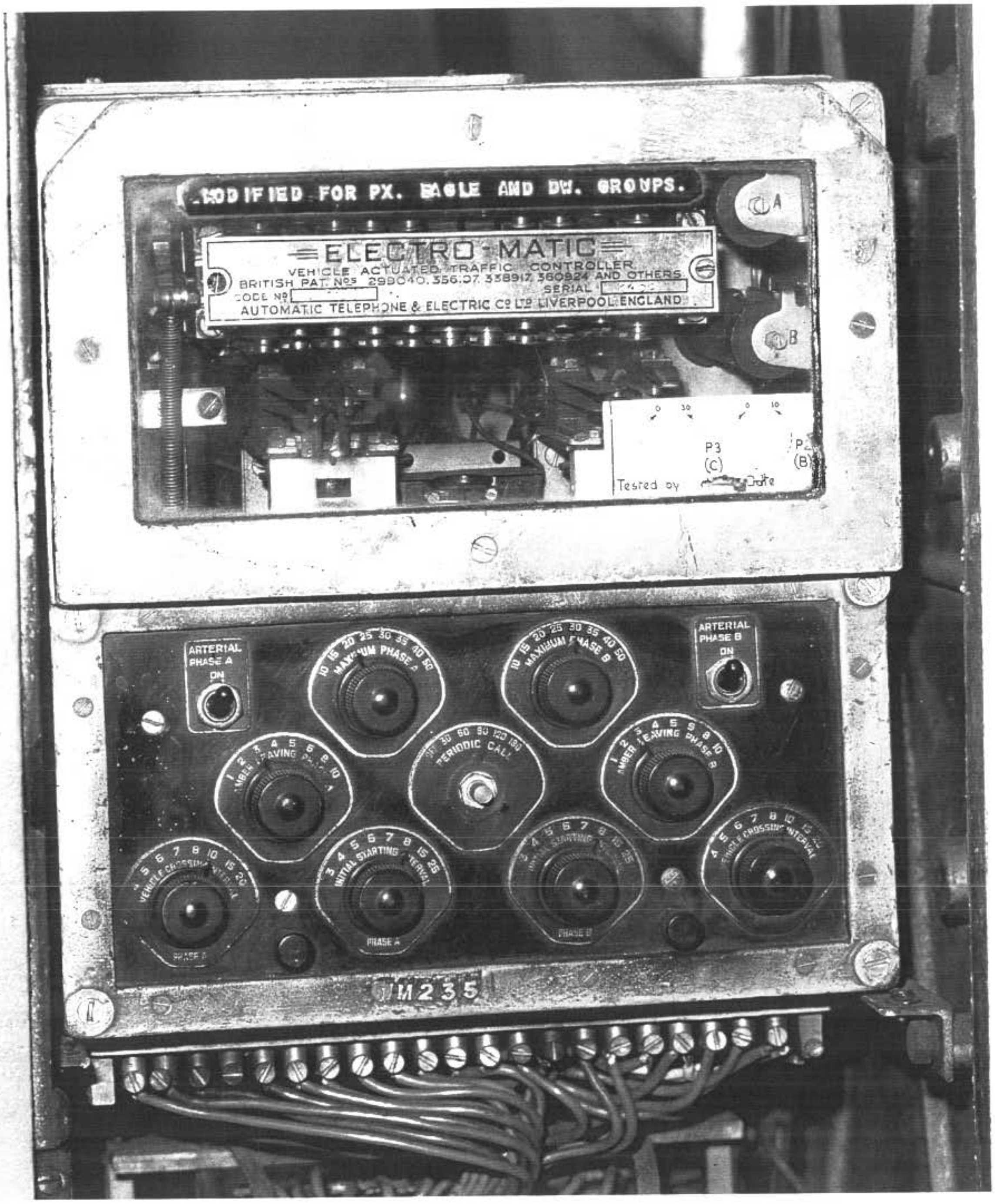
It took the DMT a whole year to find out that the interference problem was caused by tramlines, buried under the road, which were desensitising the loops. With the new detectors now operational, the DMT's next mission was to make the system fully adaptive to traffic conditions:

> So, at that stage of the game, with Frank Hulscher and myself and Grahame Davis we worked on the idea of trying to make the fixed-time system an adaptive system, so we installed fifty loop detectors just outside the Control Centre of varying lengths and so on, so we could analyse the type of output we were getting from the detector and how we could analyse that data to make the system automatically change. (Sims, Tape RTA-TMI:FH1, 25:09).

Then in 1972, the first microprocessor intersection controller was developed by Miniwatt, a division of Philips Industries and it was tested at Artarmon, outside the Miniwatt factory. However, when the temperature inside the control boxes reached more than 50 degrees C., it failed. (Sims, Tape RTA-TMI:FH1, 32:00).

> Similar problems with early solid-state controllers were encountered at Epping, where signals ran very slow in hot weather, giving motorists the impression that they were stuck. In Broken Hill, the problem was temporarily solved by placing wet Hessian bags over the control boxes to shade the controllers from the fierce heat. Later, the problem was solved by upgrading the electronic components to a military grade. (Short, Tape RTA-TMI:FH28, 50:53).

In 1973, Philips won a tender to supply the first solid-state controllers and Grahame Davis had already designed a prototype, but the Philips tender was unusual in that it proposed an alternative offer not based on solid-state design but on the use of a microcomputer. Microprocessors had just arrived on the scene and Philips proposed using Intel's 4004, a 4-bit processor that used 750 bytes of memory. By the time the tender was accepted, an 8-bit processor, the Intel 8008 had become



Traffic signal control box, 1978

available and was used. Doug Quail and Mike Wolf worked on the software for the new computer system with Philips technicians:

> And as a result, the first microprocessor controller in Australia and probably the world came out of the Philips factory and it was called the PSF and they subsequently went on to produce in the thousands of those controllers and some are still operating today in various places in the world. I think we have replaced them all now in Sydney. (Quail, Tape RTA-TMI:FH43, 46:07)

The Computer Age

By 1971 the computer had arrived. Sims and Davis were keen to get their hands on one, but knew very little about them. Neither had an Engineering degree - they were self-taught tinkerers - but they were full of enthusiasm, ready to embrace the brave new world of computers.

> You'd laugh if you look back at them now: the memory available was only 28K- now we're looking at millions and millions of bytes of memory - and it was very slow. Two types became available: one was an 8-bit computer and the other was a 16-bit computer and in 1972, while we were still operating the old valve-type one, Grahame Davis and myself, we attended the only four available computer manufacturers' premises. We went and enrolled and did a school – how to learn the hardware of these computers - each of them, and also how to program them. That's when I got my first introduction to computer programming and you were taught Basic and Fortran, and we went to the four of these manufacturers - two weeks school at each of them, Grahame and myself, and at the end of that, I was in a position to write specifications for the type of computer we wanted. We called tenders and we bought the first computer from Digital Equipment, which was the only one that met our specifications, (a PDP-11) and we bought one of those and I wrote the software for the traffic algorithm types ...... and Grahame wrote what you'd call the DOS, or the System Software, because the computers, when you bought them those days had no operating system in them – you had to program them in machine language or Assembler language and that's very tedious programming, but we did that within six months and we had a prototype (which we called) the DMT System or the Sydney System and we had that operating in six months for seven intersections in Oxford St and it worked. (Sims, Tape RTA-TMI:FH1, 35:39).

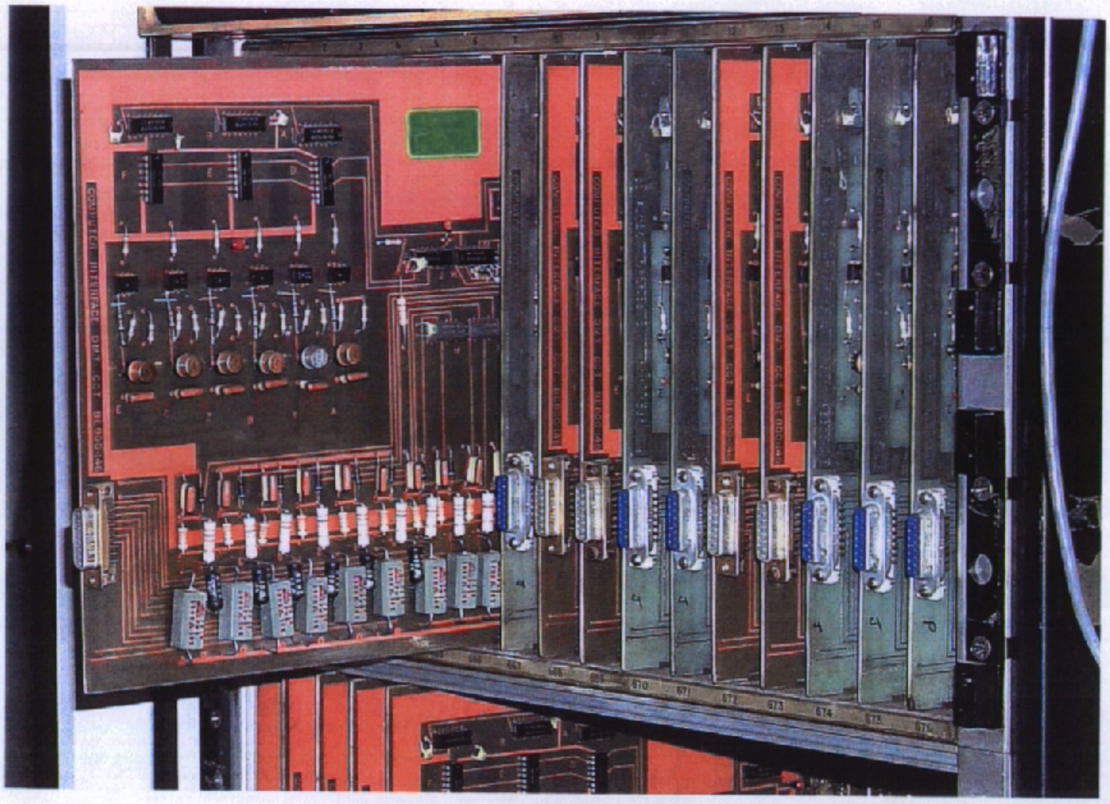
> (The computer) had a teletype as the input/output device, ten characters per second, it had a paper tape, reader on the side and a punch and I think the memory was a 16-k byte......... that was it. (Davis, Tape RTA-TMI:FH50, 22:26).

> It came with nothing except really a bootstrap loader and an Editor, so the program that you wrote had to look after everything...... there were no VDU's, no floppy discs, no hard discs, nothing, and it would take sometimes nearly a whole day to recompile after you had made alterations to the program. (Lowrie, Tape RTA-TMI:FH33, 44:40)

Nevertheless, the advantages of the PDP-11 computer over the old IBM equipment were obvious:

> It was a lot smaller- it was just one single rack, whereas the IMB equipment took up most of a room, and no valves of course. It was certainly a lot more reliable. The RSX operating system came out in 1975 and the main advantage of that was that it supported disc drives. It was an operating system in its own right, so you could have multiple users accessing the system simultaneously. The original (PDP) was a model 1120.... they all increased in speed, the

PDP-11 computer, 1971



Interface cards

ScatsAccess screen

> amount of memory they could hold and they also got smaller. The later ones held four megabytes (of memory), just enough to hold the information at the time. It wasn't only the physical memory - the way the architecture was, any one program could only access a limited amount of memory. (Davis, Tape RTA-TMI:FH50, 29:24).

The PDP-era finally ended in 2002 when the very last one was taken out of service at Campbelltown.

The DMR

While the DMT were pioneering the development of traffic signals technology, the Department of Main Roads had responsibility for designing the intersections they were placed on. The DMR had acquired the reputation of being a powerful organization - the monolith of its day. John Daley recalls the working conditions at the DMR when he joined in 1958:

> We were in a little dungeon office in 309 Castlereagh St and it ended up being a garage for the larger, extended DMR and I can remember it very well – it was hot, and it was cold in winter – no air conditioning - and we were surrounded by Chinese restaurants and the Chinese people used to pluck their ducks in the back lane and the feathers would come floating through the window. (Daley, Tape RTA-TMI:FH12, 02:38)

Brendan White joined the DMR as a Mechanical Engineer in 1974:

> They had what they called the Mechanical Section in Head Office – in the old DMR building, next to the West End Hotel.......... that building actually went right through: it was a rabbit warren – you could walk from Pitt St to Castlereagh St if you knew the way – if you didn't, you might never be found again. (White, Tape RTA-TMI:FH36, 04:01)

The DMR had its own very strict culture. Alan Short regarded it as an organization with rules for everything and a strict hierarchy. All engineers were addressed as 'Mister' when he first arrived, but:

> In six months that died – we ruined that system, but it never got down to a good, personalised environment – it was always fairly restrictive as far as levels of authority were concerned - you didn't step out of line, or else! (Short, Tape RTA-TMI:FH28, 15:22)

Glen Morgan, who joined in 1965 recalls:

> The culture in those days was: you bundied on at 8:30 in the morning and you bundied off at 4:30 in the afternoon. You were not permitted to be in the office prior to eight o'clock; you were not permitted to start work until 8:30. You were not permitted to leave your desk for any reason other than to go to the toilet. Morning tea was a privilege, not a right, as they used to say; it was brought around by a tea lady and you would stay at your desk. You were not permitted to read newspapers at your desk – in the later years, you were able to read a technical journal, but in those days, in a room of probably 28 people, on 14 ft desks, two to a desk, everyone smoked. Everybody had an ashtray at their desk and you could smoke as much as you liked – ashtrays were full and stank. I remember one woman who didn't smoke, a Mrs Rosen, who suffered badly from asthma, went to the boss in charge and said 'I need fresh air'

> and he said "For you, Mrs Rosen, I'll make a special condition, but you're nothing like a trouble maker – you can go outside for 5 minutes at a time on an hourly basis to get a breath of fresh air"... that was the culture. (Morgan, Tape RTA-TMI:FH47, 06:25)

The DMR had little interest in traffic management - their priority was building roads and highways and designing signs to help motorists find their way, as Bob Morris reflects:

> There were only a few engineers at the DMR that knew anything about traffic and what they did know was whether a lane should be ten feet wide or nine feet wide, or what colour the line should be, how bright the sign should be ...... They were not experts in the social side of Traffic: why you need a bus stop and can you put in a pedestrian crossing? By and large, the DMR opposed parking ..... they would always oppose pedestrian crossings because they interrupted the traffic...... they were really spreading roads that were meant to be, giving a level of service to the transport of the State - that was just in their soul: anything that stopped that was wrong. (Morris, Tape RTA-TMI:FH49, 21:40).

Ken Dobinson remarks that in 1951:

> ......you were dealing with traffic problems, but Traffic, as a separate entity in Engineering was not recognised as such – it was just part of your job and you were solving problems on the road. It was quite interesting, because you went out with a pad, with a sheet of carbon in it and you formed solutions with people and just wrote it in handwriting and just left them with the solution to implement. (Dobinson, Tape RTA-TMI:FH5, 24:56)

By the mid 1950s, with phenomenal growth in the use of private motorcar traffic since the war, the DMR could no longer ignore the traffic problems and decided to set up a Traffic Service Section. Earl Johnston, an engineer at the DMR was appointed to head up the new Section and as a first step, was sent to Yale University for 12 months to attend a course in Traffic Engineering. Upon his return in 1956, he set up the new Section. Murray Fairlie, who had joined the DMR in 1939 became Johnston's assistant. Fairlie and Frank Mullin, a road design engineer were sent on a 3-months overseas study tour of Continental Europe, England, Scotland, the United States and Japan. They attended the Seventh International Study Group of Traffic Engineering, a worldwide meeting of Traffic Engineers, opened by the Lord Mayor of London. Murray Fairlie casts his mind back to that overseas trip:

> In Italy, I learnt a lot about pavement markings. Early on, in Australia we painted centre lines, but we made them as narrow as possible so that we'd use as little paint as possible and with the money available, we could keep extending the line. In Italy, they made sure that the line was wide enough and distinct enough for traffic to be able to see it and follow it – that was one of the first things I did when I returned: I started to paint channelised intersections, having no traffic islands on the road, except painted ones....... and some of the lines we painted were

> up to 18 inches wide. In England, I was amazed that I knew more about Traffic Engineering than they did in those days and they were very much behind other countries. In the States, they were leading the world in Traffic Engineering.......Japan was an amazing revelation and they were ahead of us in many things – their bridge designs were quite amazing and they were doing such things as building an interchange – they built one underground near the Royal Palace and I asked the engineer with me 'Why did you build it underground?' and he said" We didn't want to offend the view of the Emperor'. I also asked him "How did you get so much open space here for handling all this traffic?' and he said 'By courtesy of the American Air Force'. (Fairlie, Tape RTA-TMI:FH53, 20:11-23:07)

On his return, Fairlie wanted, above all, to train engineers in Traffic Management and contacted Ross Blunden, Professor of Traffic Engineering at the University of New South Wales. Blunden and Earl Johnston set up a 3-months Traffic Engineering course known as 'Traffic Planning and Control'. The first course was held in 1957.

> After the course, Earl Johnston, the new Traffic Service Engineer concentrated on setting up a new Traffic Data Collection and took over traffic counting from our Urban Planning Section and extended the counting to all roads in the State. (Fairlie, Tape RTA-TMI:FH53, 30:43)

Traffic counting had been carried out by the DMR since its founding. John McKerral, who started at the DMR in 1957 was involved in this activity.

> (It was done with) mechanical counters on the roadside and of course, the old-fashioned way – we used to do it on the side of the road with a pad of paper and a pencil and you'd tick cars – you could do that when there were not too many of them around, or you could get manual counters in your hand and you could click them, like counting sheep through a gate. (McKerral, Tape RTA-TMI:FH26, 16:59).

Ken McCallum was involved in Number Plate Surveys:

> We did one on the Harbour Bridge, getting number plates that came through the toll booths and from those number plates, we got the suburb at which the vehicle was registered and then we tried to trace the suburb it originated from, coming into the city. (McCallum Tape RTA-TMI:FH45, 28:25).

Barry Pennell spent 42 years with the DMR. He joined in 1948 as a Junior Draftsman in the Petersham Office, then known as the Outer Metropolitan Office. His area of interest was intersection design.

> All of these intersection designs would finish up determining future road boundaries and that was very important, because you're going to resume properties to acquire the land to fix those boundaries (Pennell, Tape RTA-TMI:FH10, 32:45)

It was an exciting time for the new Traffic Service Section as they experimented with new ideas. The data gathered from surveys formed plans that looked up to 20 years ahead at projected annual increases in traffic volumes and influenced future road and intersection design.

Setting the standards

The 1960s was a time for setting standards. Australian Standards had not yet been adopted and there were no consistent designs. The DMR would design an intersection but then:

> .....the silly part of the whole thing was that the traffic signals were designed by another Department – the Department of Motor Transport, so that the intersection design by the DMR had to be compatible to allow the DMT to design signals (Pennell, Tape RTA-TMI:FH10, 14:48)

That did not always happen and often changes to plans had to be made, causing much duplication of resources. George Vassallo produced many plans for intersection designs and a few innovations as well in the case of the first left-turn islands:

> I started off trying to work out the turning movements of a semi-trailer. I made up a model of a semi-trailer out of Meccano with a pencil on the inside rear wheel and then I would steer it around a semi-circle on the right-hand front wheel and then the pencil would draw out the track, and I did that for a number of curves and I came up with the standard for left-hand curves, which the Department at that time adopted. From that I worked out the best design for the left-turn islands and how to design the left-turn islands. They were the first left-turn islands, they were. (Vassallo, Tape RTA-TMI:FH16, 10:49)

> Given that we didn't know much about traffic, we really had to start defining our own job and doing a lot of fundamental research. We'd do a lot of studies – a thing I can remember was the Average Car Study. Obviously, for designing roads, you needed to know (about cars) – how long they were, how wide they were, what their wheel base was, how fast they could stop, how fast they could accelerate, so we actually tried to define what the Australian car was. (McKerral, Tape RTA-TMI:FH26, 11:25).

Having determined what Australian cars were, the next study looked at which part of the road they occupied:

> We did Placement Studies where you basically tried to work out where drivers drove on the road – did they drive close to the kerb, or in the middle, or all over the place, because at that stage, lane lines weren't in use; centre lines were fairly scarce also, so one of the things that we were trying to do is decide on whether we should spend money painting lines on roads, and if so where? I was going out there, measuring where people drove and then painting lines on roads and see if it made any difference to the way they drove, and by and large it did (McKerral, Tape RTA-TMI:FH26, 14:19)

Some methods used for setting standards were somewhat unorthodox:

> We started to look at overtaking and we found the theory of overtaking which was vehicle acceleration wasn't necessarily the human's ability to do so, and so my Senior Draftsman of the day did an experiment and I had the difficult task of authorising an order for two dozen eggs, because he set up this system of one vehicle overtaking another and as the overtaking manoeuvre started, he dropped an egg, and when he finished it, he dropped an egg and they measured the distance between them and that, I can assure you, despite all the theory in the world is the basis of overtaking theory today. (Dobinson, Tape RTA-TMI:FH5, 19:52).

These were also the days of designing freeways, for which no precedents existed. Ken Dobinson recalls that:

> When you had no solutions, you invented them and the whole of the F3 was invented. We wrote specifications that had never been written before – my wife and I wrote the first landscape specification in the world for the F3, because there wasn't any and what you have up there is the outcome of that and today, I realise we left those Mohawk islands as part of that interesting design to make it fit into the landscape. (Dobinson, Tape RTA-TMI:FH5, 20:40).

The section within the DMR that designed new roads, intersections and traffic management devices was the Drafting Office. In April 1964, the DMR offered Geoff Amos, then fresh out of school a position as Junior Traffic Survey Draftsman at a salary of £11/8/9d a week:

> It was a relatively new breed of Draftsman in those days. The role of the Traffic Survey Draftsman was essentially to design road signs. As cars were improving and roads were improving, we tended to follow America in a lot of the technology in road design and road construction and we used a lot of American manuals to produce our road signs. We did all the designs by hand: they were all on thin paper on which we roughed out the sign design and there were certain standards about spacing, above words and below words, and arrows and route markers and those sorts of things. They were all in pencil, very carefully lettered and for at least half an hour every day we had to practise our lettering - we had lettering guides. John Lymbery, who was the Senior Draftsman at the time insisted that we spend the time perfecting our skills and I have to say that I can still write neatly if I put my mind to it. (Amos, Tape RTA-TMI:FH20, 08:03)

John Daley also worked as a Draftsman on sign design. He recalls the state of signs in the late 1950s:

> We became involved in the Standards work, designing signs, getting ready for the Australian Standards.... like a curve right sign, curve left sign, winding road sign, place name signs, deciding on the series of letters – from Series A right through to Series E, and they were a different shape, different stroke thickness and all the decisions had to be made on what letters to be used on what signs. There weren't consistent sign designs – they were all over the place.

A lot of the old signs were engraved signs in timber – a lot of them were still around - and of course, they switched to aluminium signs then. (Daley, Tape RTA-TMI:FH12, 11:57).

Early on, the DMR decided to set its own standards:

We designed our own alphabet: the height of the lettering and the width of the lettering was all done internally. I was involved in the drawing up of the lettering; from there, when it came to freeway signs, the decision was made to go to lower case – everything was in upper case at that point – but the whole lot would have been drawn up by hand and that was a slow process, but we had standards on that as well. (McCallum, Tape RTA-TMI:FH45, 14:12).

The lower case letters were preferable, because if you couldn't read the whole of the word, you'd get the shape of it and you could probably recognise it from the shape. (Lymbery, Tape RTA-TMI:FH18, 28:30)

At the time, I think the Department was producing about 15,000 signs a year and 2,000 required separate drawings, so we were reaching a stage where we couldn't cope. (Lymbery, Tape RTA-TMI:FH18, 35:51)

By the early 1970s, computers came to the rescue:

We eventually got a plotter in the computer room - a big flat-bed Gerber plotter, very accurate, and one of the programmers there - I can only remember her first name, Diana – she was very interested in writing software to do graphical work and we convinced her that signposting was just the job for her and she designed the signposting software where we could tell her program what type of sign we wanted, what font size and style and what the words were and it drew up the sign to scale, and that would then be sent off to (the workshop at) Granville to be made into the real sign. (McCallum, Tape RTA-TMI:FH45, 15:33).

The computer could draw a sign in about 10-20 minutes, compared to 3-4 hours by hand. (Lymbery, Tape RTA-TMI:FH18, 37:57)

Now I suspect that when they got to the workshop, the professional sign writers looked at the drawing and said, 'I know what they want', picked the relevant letters out of a box and stuck them on the sign where they thought they looked best (McKerral, Tape RTA-TMI:FH26, 53:22)

At the same time, reflective signs were undergoing somewhat of a revolution:

In the 1950s there was reflective sheeting available – immediately prior to that, various road signs had been designed to be visible at night with glass eyes reflectors embedded in the wooden signs, but in the early fifties we moved over to aluminium sign faces and reflective

> sheeting and the choice in reflective sheeting was Scotchlite or Scotchlite – there were no competitors. (McKerral, Tape RTA-TMI:FH26, 50:09).

> Some of the reflectivity was too severe and it used to blur the signs and we tried various measures to combat that (Lymbery, Tape RTA-TMI:FH18, 27:43).

> We really broke a lot of ground in those early days...... we used to test the different reflective materials to see which was best- you'd go down to the basement of 309 Castlereagh St, turn all the lights off and get a car headlight, a certain distance away and we'd get people to look at the signs under different lighting conditions and tell us which was the best colour combination; black on yellow, yellow on black, black on white, white on black, all of those combinations we tried and tested (Amos, Tape RTA-TMI:FH20, 10:06)

> At that stage, green backgrounds were introduced, which were more pleasing and easier to detect, reflective – many years back, it was black, non-reflective, which is completely dull at night. Class 1 has better angularity – it means that if you see a sign at a certain angle, you'll still recognise what is written much better than Class 2. We started doing more overhead signs, which means that they are cantilevered over the road, which requires a huge structure, which is always a problem if you hit that post. (Dimitric, Tape RTA-TMI:FH 41, 32:45)

It was around this time that John Lymbery recommended that the yellow colour on Chevron curve marker signs be replaced by white. In one of the more memorable internal DMR memos ever issued, John McKerral wrote:

> I agree with his recommendation. The question then arises as to whether the white should be Class 1 or Class 2. As indicated in my minute of 12th March, 1982, Class 2 white is whiter than white while Class 1 white is grey but bright. I know it sounds trite but as the light from the white must be sighted at night to do it right we should use Class 1 white. We seek your approval for the complete removal of Class 1 yellow (which is warm and mellow) and its replacement, of course, with an alternative source (if this is all right), Class 1 white.

The Chief Engineer (Traffic and Design) did not approve the proposal.

> Sasha Dimitric had trouble persuading John Lymbery that freeway signs needed to increase in size to be able to read them at speed, but the people in the Drafting Office did not think that was necessary. Dimitric, unfazed, arranged for Lymbery to come with him on a drive along a newly-opened freeway. Lymbery took the wheel and Dimitric asked Lymbery to keep his speed the same as cars around him and to read the signs. When Lymbery had to glance through his side windows and slow down because he could not read the signs in time, the point was proved and from then on, signs for freeways became the size they are today. (Dimitric, Tape RTA-TMI:FH41, 42:28).

> Some of the freeway signs are fantastic: you're looking at 30ft signs and the design of the footings and steelwork required for those were done by the mechanical engineers. (Daley, Tape RTA-TMI:FH12, 34:53)

> Signposting can be very expensive. The sign design cost is really only 2% or 3% of the hardware costs. If you look at some of the large freeway signs, they can cost $ 40,000 to $50,000 to manufacture and erect (Anyon-Smith, Tape RTA-TMI:FH 3, 34:15).

In 1974 with the introduction of metrification, all existing speed and destination signs and all mileposts were converted from miles to kilometres per hour. With tens of thousands of signs and posts in existence, it was a gargantuan task, but as usual, the DMR rose to the challenge. In July 1974, during a 30-day period, all signs in the State were converted.

Advisory Speed Signs

An area where the DMR became an innovator was in determining the correct speed of vehicles for posting on Advisory Speed signs. During the late 1950s under Traffic Engineer Earl Johnston, the Department fitted out a special vehicle that would record the correct speed for curves:

> The Advisory Speeds on the main State highways – they always end in a 5km value: that's the regulation – and they're determined by a survey vehicle, and that survey vehicle is driven by a specialist team that negotiates each corner as they come to it, and fitted in that vehicle was a primitive avionic device which was measuring the acceleration, or the side acceleration. In fact, it was a glass tube filled with liquid alcohol, I believe, with a steel ball in it – it was a ball-bank indicator - and these were actually ball-bank indicators out of Tiger Moths which had presumably crashed, and the indicator would swing with the corner. If it was a sharp corner, then the ball would swing out to a greater angle and the operator would record the maximum angle of swing and that computed to an advised speed appropriate for that corner. (Peter Lardner-Smith, Tape RTA-TMI:FH24, 15:52).

> They were able to measure the amount of centrifugal force acting on the vehicle – they could calculate the radius of the curve and they could calculate then what the safe speed was going around that curve, irrespective of whether they travelled at that particular safe speed or not, so that was quite an achievement. (Fairlie, RTA-RTMI:FH53, 37:01)

> They used a typical car of the period, fitted out with a special instrument panel, which contained two ball-bank indicators, a gyro compass, a calibrated speedometer, a curve counter, a photograph counter and an odometer. All of these were placed on this instrument panel and there was a 35mm automatic single-shot camera mounted behind the front seat of the car so that it had a view through the windscreen and it would record the instrument panel plus the gear that was outside: signs and the road ahead Several runs were made for each curve and later, when the photographs were developed, the advisory speeds were calculated in the office. (Lymbery, Tape RTA-TMI:FH18, 29:15)

The camera, however, presented the greatest challenge:

> We set up a camera and what it had to do was to take a photograph of the board inside the car and a photograph of the outside of the curve, so you had different lighting conditions and also you had different focusing positions, because you had close-up inside the car and infinity outside the car. (Vassallo, Tape RTA-TMI:FH15, 21:27)

> I was involved in developing a fairly Heath-Robinson arrangement........I had this hare-brained scheme and everyone said that it wouldn't work - that we needed to put a supplementary lens in front of the camera. For the bottom half, we'd have a close-up lens and for the top half we'd

> have a light filter, which is great, of course, except that lenses are circular and we only had two semi-circles, one at the bottom and one at the top, so we very bravely bought a fairly high quality close-up lens and Karl Reisz, one of our draftsmen went over to Anthony Horderns where they had a hardware section that sold glass and cut window glass to size, so he gave them this high quality lens and said 'Can you cut that in half for me?' and the guy looked at him and winced and said 'Do you really want this cut in half?' And Karl said 'yes'. (The man said) 'I may break it'... (and Karl said) 'Well, you know, if you break it, you break it'. (The man said) 'I don't really want to cut it' and Karl said 'Just cut it'. So he got out his diamond and cut this thing in half and then we cut an orange filter in half, mounted the two in an external mount in front of the camera and it worked like a dream, really marvellous, and we used that for many years. (McKerral, Tape RTA-TMI:FH25, 21:05).
>
> Eventually, after that was accepted as a good way of producing the Advisory Speeds, we needed to automate it to get away from so much work in the field, so John (Lymbery) bought a camera with a 250-negative back, so we could take 250 photos with one roll of film. (McCallum, Tape RTA-TMI:FH45, 20:17).

Finally, Peter Lardner-Smith was able to automate the readings from the ball-bank indicator:

> So I experimented with a ball-bank indicator and gauged out the plaster of Paris behind the glass tube and set an array of very tiny 1mm diameter phototransistors in a line which were soldered on to a blank piece of printed circuit board and shining what was hopefully linear light straight through the front of the ball-bank angle, you could switch the phototransistors with the ball as it travelled out over the path, so when this was fitted back into the car, you were reading electronically the angle of the forces in the car and this was recorded as a reading and then printed onto a miniature printer within a cabinet that was fitted to the front passenger seat. (Lardner-Smith, Tape RTA-TMI:FH24, 17:43)
>
> We did things in that office that we were never, ever supposed to touch or do, and yet they became standards for the Department of Main Roads and standards for NSW and the rest of Australia, as most of Australia followed what NSW did as a standard and once we developed these methods, they just became the norm. (McCallum, Tape RTA-TMI:FH45, 24:32)

Marking the road

Line marking as a concept did not really take off until the late 1950s. Sydney's busiest stretch of road then was the Sydney Harbour Bridge – it had only one centre line down the middle and no lane lines at all until late in the 1950s, when the tram tracks on the eastern side of the bridge were removed. John Daley recalls:

> I remember a famous expression: 'It's trial - we're taking the trams off as a trial' and I remember the same night they were covered over with bitumen or concrete or excavated out, so it wasn't a very long trial. (John Daley, Tape RTA-TMI:FH12 06:14)

The removal of the tram tracks provided two extra lanes for traffic, and with so much traffic now using the bridge, it became apparent that lane lines were required. They were duly painted in:

> We were concerned that, because the lanes were very narrow, there could be accidents - sideswipe-type accidents - and there were some. The Police Dept was very concerned and they decreed that there should be no lane changing on the bridge for safety reasons, and that later became a problem in that we had to get them to change their minds. When we couldn't talk the Police into changing their minds, we got onto the arch of the bridge in the morning peak period and I took a series of photographs at 5-second intervals of the traffic on the bridge from which we were able to demonstrate that a very high percentage of vehicles were already changing lanes without causing any hazard and the Police accepted that as evidence and agreed to allowing lane changing to be carried out on the bridge. (Fairlie, Tape RTA-TMI:FH53, 43:50).

While lane changing on the bridge itself presented no problems for motorists, the first merging lane did:

> The concept of the merging lane was introduced in the early 1960s. The very first one, to my memory, was on the Bradfield Highway on the northern approach to the Sydney Harbour Bridge.... this is before the construction of the Warringah Freeway......what's known as a continuity line was introduced to assist merging and I remember the operation of this, watching as a young fellow, and it was very, very confusing to motorists......they didn't know what to make of it: whether to keep left or right of it – what does it mean? (Terry Winning, Tape RTA-TMI:FH57, 16:02)

Painting lines on roadways was not a complex operation, but drawing letters and arrows on them presented a problem for the Design Office draftsmen.

Railway Square reconstruction and traffic reorganisation, 1980s

> To give a driver's eye appreciation of what the pavement marking would look like, they bought a piece of apparatus from a disposal store, from a tank - you could look into the top of it and through reflective mirrors you could see along the roadway (Pennell, Tape RTA-TMI:FH 10, 40:08)

George Vassallo recalls:

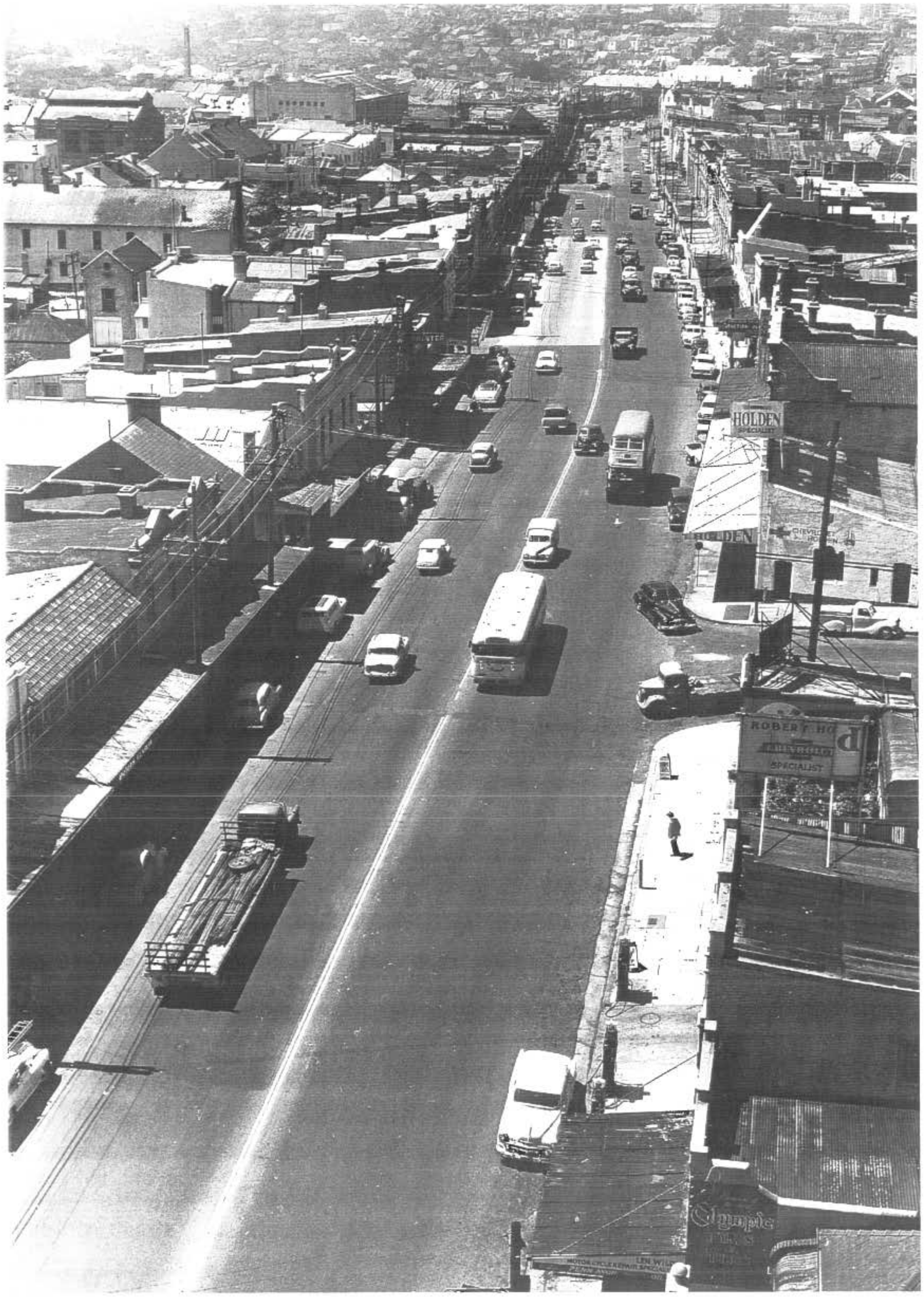
> I've got a periscope from a tank and I used that for drawing pavement arrows – you could get down to eye level that way – and I did the pavement arrows and the lettering for 'Buses Only' lanes, etc. I had the periscope on the desk and I had a bit of cotton at what I considered to be my eye height and then when I got down, I could see the view presented by the periscope and of course, everything that you put down in normal lettering had to be elongated, but not only was it elongated, but it had to be slightly widened as it went along to give you the feeling that it was the same width all the way. I was down on my knees for weeks, I think, drawing that alphabet up. (Vassallo, Tape RTA-TMI:FH15, 25:51).

At the same time a minor revolution was taking place in line marking and pavement markers:

> (Before the 1970s) lines on the road were not reflectorised: they didn't have the glass beads dropped into the paint and people were trying to develop better and better glass beads – and still are – and pavement markers: those are the little stick-on things that you stick onto the road were coming into vogue and we developed systems for putting those on the road to replace lines and they went on the F3 freeway, and it was probably a mistake because we were putting non-reflective buttons led by a reflective button and that was very expensive- much more expensive than painting lines. It's interesting to see over the years that we now paint the lines and put a reflective button on the start of it – it was evolving in those years and we were trying everything (Dobinson, Tape RTA-TMI:FH5, 38:21).

> (Today) the markings are much more durable – they're much more visible under bad weather conditions ...... and the durability has been enhanced by using more modern materials. Instead of paint, nowadays they use thermo-plastic materials and that has enabled them to build texture into it, so that you get rumble strips on the edge of the road that vibrate the tyres so that you know when you're running off the road, or over your lane line. (Camkin, Tape RTA-TMI:FH22, 17:45)

Parramatta Road, looking west at Flemington, Nov 1956 – note absence of painted centre line and lane lines



Parramatta Road, looking east at Taverners Hill, March 1957 – note absence of lane lines

Posts and rails

By the 1960s, an understanding of drivers' needs was beginning to develop within the DMR:

> I started introducing chevron hazard markers, reasonably high, so you could see them, especially at night, one following the other and then you could receive information about angular change in your vision to the degree of curvature, so that you can adjust your speed. (Dimitric, Tape RTA-TMI:FH41, 58:42)

There were also advancements made in the design of guideposts and guard rails:

> When I joined the DMR (in 1950) we had big wooden guideposts and we had protection fencing, which was chain-wire fencing and right at that stage we were even using old ferry ropes, stretched across posts as guideposts. I remember a period in my very early days where a motorcyclist was beheaded by these ferry ropes used as guide protection and they rapidly disappeared from the NSW scene after that, thankfully, and we went into protection fencing...... but of course, people were starting to develop a thing called guardrail – a steel guard rail, and we were trying that out and it became very successful and the norm in that period. That was around in the sixties, but there wasn't very much of it, so we developed standards for that and then we found problems with the standards in that people would run into the ends of the guardrail and do a lot of damage to themselves, so we started to develop processes for protecting the ends and turning them away and putting special devices on, so that if you ran into the end of them, you wouldn't kill yourself. And guide posts - wooden posts - were massive: some were 300mm in diameter, so we were evolving plastic posts and looking at smaller pieces of timber, because essentially, we realised that guideposts were only there to put a reflector on ...... so we went into the plastic posts and people invented plastic posts that you could run into – they'd drop down and you would take your car off and they'd pop up again, and all of those things were in our agenda at that particular time. (Dobinson, Tape RTA-TMI:FH5, 40:07)

Design from above

The DMR owned a helicopter and it was to play an important role in the evolution of design of roads and intersections.

> The aerial photography came about all of a sudden – there was always a need in the DMR to have photographs of selected intersections, either for the purposes of design or for planning, and even to show vehicle movements, because from the air you could see the rubber on the road, showing the rubber that the vehicles left. It was very expensive to buy an aerial camera at the time, and I remember John Lymbery, who was my boss at the time talking about a Wild camera, I think it's Swiss and it was very, very expensive and there was no way we could ever afford to buy one of those. (McCallum, Tape RTA-TMI:FH45, 06:42)

As luck had it, John Lymbery was fond of browsing around in Army disposal stores and one day, in Oxford Street, he came across an old war surplus Model F-24 aerial camera in a grey box. He bought it for a song:

> We bought it from a disposal shop for £13/10/00 – I'll always remember that. The camera took overlapping pictures in a 5-inch by 5-inch format. The aircraft flew at 3,000 feet at a 40-knot speed.... at that time, the camera had a hand winder, so the operator had to wind the handle for each exposure. (Lymbery, Tape RTA-TMI:FH18, 42: 40 & 45:40).

Noel Dodwell, the pilot, was rather taken aback by the next request:

> The next stage was to convince the DMR and the pilot that we wanted a hole cut in the floor of the helicopter so that we could mount it and get better photos and finally, we got that approval and the hole cost thousands of dollars....... and we fitted it in the back of the helicopter and then it was my job initially to sit in the back with gloves and a scarf and a warm coat and have the cold air rushing up through this hole and I would have to hold this camera vertical, and do so while the person in the front took the photos. (McCallum, Tape RTA-TMI:FH 45, 09:55).
>
> We also had a sight that we mounted in front of the camera – in that way, we could instruct the pilot in the direction we needed to go, but we found, after a while, when Noel got used to it, he hardly needed the sight - he was very good at it. (The photographs were used) mainly to look at routes for deviations and for intersection design - the road design draftsmen would use them – get them enlarged and look at redesigning the intersection, so it acted as a preliminary design tool. (Daley, Tape RTA-TMI:FH 12, 46:24).
>
> The intersections had to be designed, in those days to facilitate traffic signals and the silly part of the whole thing was that the traffic signals were designed by another Department - they were designed by the Department of Motor Transport - so that the intersection design made by the DMR had to be compatible to allow the DMT to design the signals. (Pennell, Tape RTA-TMI:FH10, 14:53).

Lamps, lenses and things

At the DMT's Burwood Traffic Signals Group, the engineer who looked after traffic signal design was Frank Hulscher. He was passionate to have the best traffic signals, controllers and loop detectors in the world. Frank joined the DMT in 1959, a time when improvements in all areas were desperately needed:

> All the equipment was imported from the UK and traffic lights were pretty dim: something like 70 candelas, woefully inadequate, really, but nobody knew any better in those days – that was all that was available. It was supposedly all based on British standards. ......they were vacuum lamps, 60 watts, that tended to darken with age and they got dimmer with time until they failed catastrophically.......but we had a constant battle with life of these lamps - their life tended to go down. We started off re-lamping every eight months and we found that the lamp failure rate was steadily climbing. (Hulscher, Tape RTA-TMI:FH31, 15:28 & 38:54).

For those reasons, lamps were routinely replaced every four months by maintenance technicians, who, in addition to traffic had yet another hazard to contend with:

> ... at the same time as that was done, they'd clean the lenses and clean the reflectors... the technician would check the controller and make sure it's alright and that all the spiders in the controller are dead. You'd get a lot of redbacks, particularly – they're not under the toilet seat: they're in the traffic signal controller. (Short, Tape RTA-TMI:FH28, 49:07).

Lenses were also evolving:

> Lenses were made of glass – enormous variability of colour density, reflectors were chrome – they corroded and got dirty......later on we used silver-glass reflectors and that made a big difference. Today, of course, we've got quartz-halogen lamps and the intensity and optical efficiency of the system is so much greater that we've gone back to aluminium reflectors (Hulscher, Tape RTA-TMI:FH31, 35:31).

The signals themselves also looked quite different from today:

> They were smaller signal heads, no side screens or backboards, they were all painted black and yellow, 12-inch wide bands... (Hawes, Tape RTA-TMI:FH17, 07:26).

The posts for part-time signals at school crossings were painted in blue and white bands, according to British practice. The placement of posts to carry traffic signals also caused some consternation:

> Monier came up with an idea of concrete mast arms as an alternative to metal mast arms and Frank Hawes did a lot of tests on those...but the one test they didn't do was the torsional test .... if a very solid vehicle hit the concrete arm and twisted the entire device the vertical section would fail in torsion – the concrete would just splinter away and the whole thing would just be held by a few wires of reinforcement in the middle and it would just fall over with an enormous thud and it was just a miracle that nobody was ever hurt or killed by these things falling over. (Hulscher, Tape RTA-TMI:FH31, 51:47).

Monier then designed traffic signals that were suspended over the road by cables strung from posts:

> (The Monier company) designed some very strong posts that enabled us to suspend a catenary system across Pacific Highway, which was quite wide, about eight lanes across at that point and we put some lane control signals there and it stood there for quite some time until a vehicle came along that was too high, got caught up in the cables and, well, we decided that maybe that wasn't such a good idea. (Hulscher, Tape RTA-TMI:FH31, 53:56).

By the 1950s, pedestrian lights were also changing. Initially, they were fairly rudimentary:

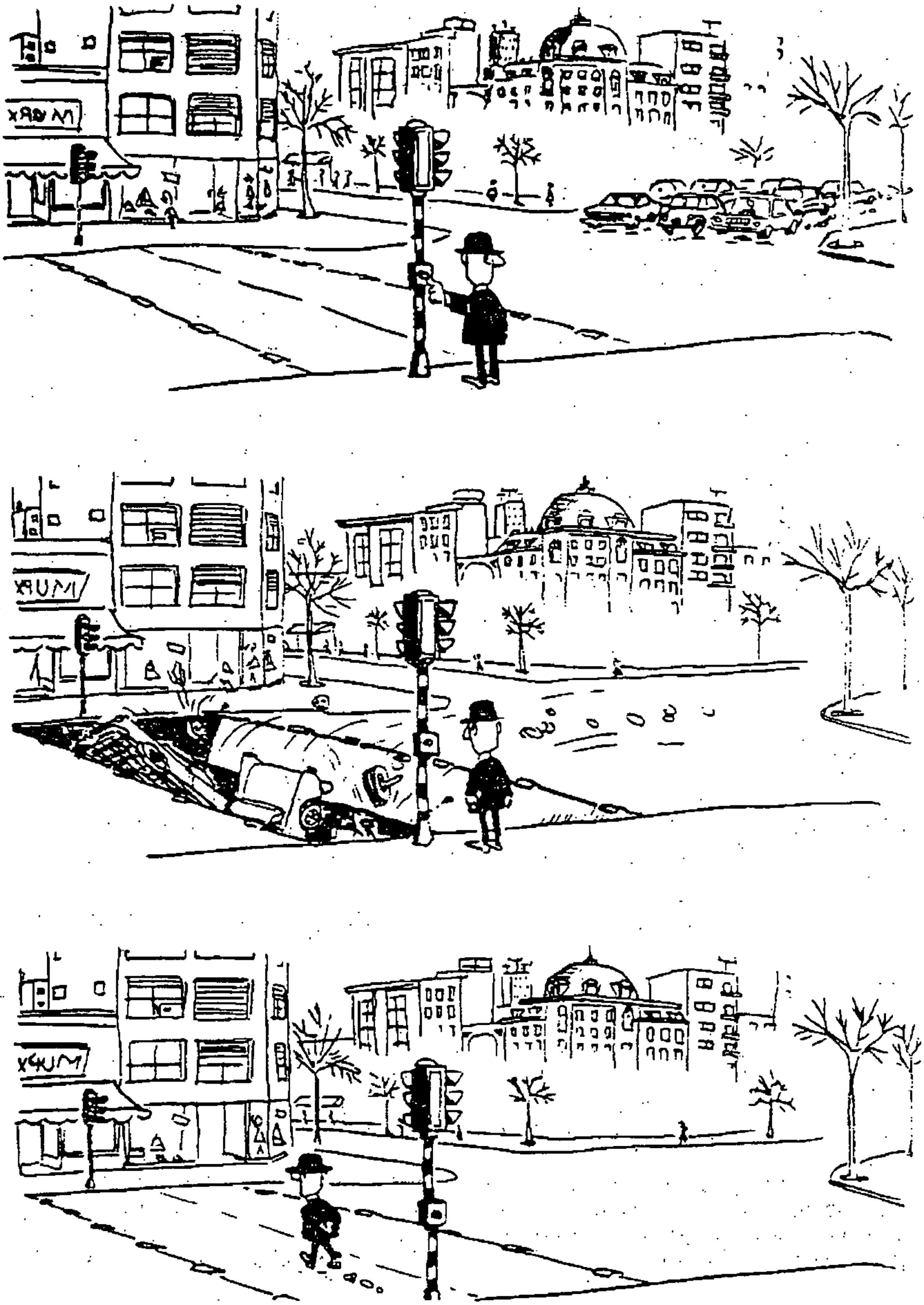
> We relied heavily on British practice and they started off with militia beacons – just a yellow, flashing bulb, flashing constantly to highlight where the zebra crossings were – there were a number of those around Sydney, but motorists didn't take much notice of those. They were not very successful, so they were abandoned (Hulscher, Tape RTA-TMI:FH31, 45:00).

Don Hughes remembers another type in the city:

> The one I can think of was near the Sydney Hospital and it just had a little round, black background with a white, illuminated 'Cross Now' that came up. It was white lettering on a black-coated lens. (Hughes, Tape RTA-TMI:FH23, 18:30)

The first pedestrian-actuated signal controller for school crossings was designed by Rae French at the DMT in 1953 and fifty sets of signals were installed, replacing booms across the road. They were manually switched off outside school hours and during school holidays.

The first 'Walk-Don't Walk' signals were installed on the Pacific Highway at St Leonards in 1959 - by 1961 these lights were flashing and in 1967, the 'Call Recorded" facility on push-button detectors was added. Pedestrians could now cross with a greater degree of security than they had ever done before.



The Merger

By the mid 1970s, through its research activities and innovation, the DMT had secured its place as the pre-eminent organization to develop and maintain traffic signals:

> The DMR looked after the standards of the highways, but it was the DMT who were really giving effect to the regulation on the roads........they absolutely knew the ins and outs of traffic, they had power as to where lights went in and they ended up, really telling the Police administrators how that worked and they'd had a boom time, and they had gone from being a small operation to a big group. (Morris, Tape RTA-TMI:FH49, 16:12).

In contrast, the DMR then had little interest in Traffic:

> There were only a few engineers at the DMR who knew anything about Traffic and what they did know is whether a lane should be ten feet wide or nine feet wide, what colour the line should be, how bright the sign should be and whether you should use diamond grade reflective material on a night sign or whether standard grade was good enough – it was in the technology of the appendages and the size of the road. They were not experts in the social side of traffic: why you need a bus stop and can you put a pedestrian crossing in? By and large, the DMR opposed parking.... they would always oppose pedestrian crossings, because they interrupted the traffic.......they were really spreading roads that were meant to be, giving a level of service to the transport of the State - that was just in their soul - anything that stopped that was wrong. (Morris, Tape RTA-TMI:FH49, 21:40)

In 1976, the government reviewed the activities of the DMR and DMT and made a decision that was to have far-reaching consequences for both organizations. It decided to merge the DMT's traffic signal activities into the DMR and to establish a new body, the Traffic Authority, to take over the regulatory role. Ken Dobinson, who was with the DMR, recalls:

> We had to merge (the DMT people) into the DMR organization and they all came in to the Traffic Section of the DMR and so the Traffic Section of the DMR expanded to more than double its size overnight with these people coming on board and then we had to merge them throughout the State into the various components, which again fell to the Traffic Section, so we brought in all this work and we brought in all the management and arrangements with traffic signals. But it also brought on a lot of things that needed to be merged: for example, the DMR looked after road warning signs and direction signs, but the DMT looked after regulatory signs ....we painted white lines down the middle of the road to guide people and the DMT painted lines across the road to guide pedestrians across it – it was quite a silly differentiation between two organizations, so it was quite logical to bring the whole thing together. (Dobinson, Tape RTA-TMI:FH5, 28:29)

How did the DMT staff react to the change? Jim Giffin casts his mind back to 1976:

> It was very traumatic. We went from being a very exclusive organization in the traffic business, where we had a reasonably high profile within the DMT to working with the DMR, (where) the incumbent DMR people felt that they built roads and bridges and tunnels, etc. and that traffic signals were maybe a nuisance to them. We also came to the DMR with a whole set of working conditions that were better than the DMR had. The DMR wanted the traffic signals guys to assimilate – we didn't want to do that. (Giffin, Tape RTA-TMI:FH19, 25:47).

> They were being merged with what was a very large organization – one that had quite a different culture, which thought that Traffic should be seven or eight rungs down the organization pyramid and that's where the tension began. (Morris, Tape RTA-TMI:FH49, 17:32).

> The merger was difficult, because the 430-odd people that were transferred to the DMR were essentially not in favour, which signifies once again that people do not like change. (Hawes, Tape RTA-TMI:FH17, 38:51).

> The DMT people would probably have preferred to stay where they were, but they were told to move across to the DMR, not asked. The other differences occurred because of differences in salary scales – people in the DMT at the time, with less years' experience were getting paid a lot more because they were moved on to DMR scales, which put them higher than equivalent staff in the DMR, so there was a little friction there. (Mudford, Tape RTA-TMI:FH55, 14:16)

> We then worked pretty hard with the DMT guys and got a good relationship going, but it was long and hard........ but slowly, but surely it all came in and it was essential to the evolution of the DMR to become, not just a road builder, but a transport manager, that it is today. (Morris, Tape RTA-TMI:FH49, 18:56)

> We inherited the traffic signal work of the DMT and we inherited the people...... the traffic signal work went ahead fairly smoothly in terms of the changeover, but the big thing that came across to us was Arthur Sims. Arthur was one of the few geniuses that I have met in my life and he brought across the concept of computerising signals. The signals of the day were electro-mechanical – and he brought across a contract that had been let to Philips Industries to develop a computerised signal controller to go on intersections and he brought across a little trial of a computerised interlinked system out in Newtown – and so, very early days, nothing proven, nothing sure, and we had to take this forward. (Dobinson, Tape RTA-TMI:FH5, 44:04)

The start of SCATS

After the former DMT employees had more or less adjusted to being in the DMR, the push was on to develop a fully-coordinated system for Sydney's increasing traffic, ultimately to be known as SCATS (Sydney Coordinated Adaptive Traffic System).

> SCATS really developed out of the original program - that was called the VCCM (Vehicle Computer Controlled Master). At that stage, Arthur (Sims) came up with the name SCATS because he thought it sounded better. (Davis, Tape RTA-TMI:FH50, 25:37)

The prime movers and shakers who became instrumental in the development of SCATS were Arthur Sims, Grahame Davis, Peter Lowrie, Ken McCallum and Ken Dobinson:

> Arthur Sims was a tremendous ideas man- Grahame Davis was a guy that could pick up a plan, a circuit diagram – whether it was electronic or ordinary relay-type of circuit diagram – he could read it like a book...... he designed little bits and pieces of equipment that made the whole inner-city system work. (French, Tape RTA-TMI:FH8, 35:28).

Peter Lowrie had started with the DMT in 1961 and had designed the first solid-state devices used for traffic control. By the time that the first minicomputers became available, Lowrie was well into the technology, writing programs and traffic algorithms.

Ken McCallum had joined the DMR after receiving his Leaving Certificate in 1966. He collaborated with Grahame Davis on the very early SCATS versions and wrote off-line software programs and the first manuals for SCATS.

Ken Dobinson, as the Senior Traffic Engineer, was instrumental in urging the DMR management to finance the development of SCATS.

> You were entering into an area that was pretty well unknown and where the investment you were committing yourself to was huge, and you had to be sure about this and we were not sure about the future of a computerised controller, we were not sure about interlinking the signals in a new way that responded to the traffic that was there, whereas coordinated signals in London and in other places were all fixed time, so timing of the signals was pre-set to different times of the day and times of the year, but we were going another step, a giant step forward and that became a huge challenge. (Arthur Sims) wanted to do two things: he wanted to bring in a computer in the box at the corner that would control the signals and change every cycle to respond to the traffic going through.... and secondly, he wanted to link all the signals so that the signals could choose for themselves how they linked at different times of the day and different times of the year - it was quite revolutionary stuff. But while everybody was

> concerned with what Arthur was doing and had a high regard for his ability, the main concern was the cost – there was huge costs involved in this and if you were wrong, you had to scrap it all and start again and go back to electro-mechanicals and fixed-time signals, so it was a big step in the direction that had to be taken and that was my personal challenge. And so I sat on Arthur's desk day after day after day until I understood what he was about and was convinced that we could run the risk of going into this investment. (Dobinson, Tape RTA-TMI:FH5, 46:04)

It should be noted that this vision for SCATS occurred when the consensus of world thinking was that traffic responsive/adaptive systems were unlikely to outperform a well tuned fixed time system. The development team, however, understood that, in most cases, fixed time systems operated with sub-optimal plans, which resulted from the difficulty of formulating the signal settings in the first place, the ageing process as traffic demand patterns change and the inability of such systems (with no detectors) to warn the user that the settings needed to be updated. The goal, therefore, was not to produce a system that outperformed a fixed time system with optimal plans, but to outperform a typical fixed time system over its life. (Ref: Lowrie, technical paper: SCATS - The History of its Development).

Fortunately, at that time, an interesting event occurred that would give the SCATS project added impetus:

> Up until 1972, there was a plan for a complete freeway system of something like about 400-odd miles it was in those days, and all the road reserves existed for the metropolitan area, but one of our politicians went to America – he went to San Francisco - and he was talking to the Mayor of San Francisco and he was there at the official opening of a freeway system.... and the Mayor made a speech, which the politician heard and said "That's the last freeway we're building'. And this politician came back to Sydney and in Parliament said 'The Americans say freeways are no good – they're not going to build any.' He omitted to consider the fact that the Americans already had 4,000 miles of freeways. At that stage, we had – I think it was 4.7 miles of freeways. The Minister for Transport then said 'We've got to do something with our existing road system, because we're not going to build any more freeways – any freeways at all, really' and the Commissioner of Motor Transport, a chap called Dave Coleman, who was a very good Commissioner decided that I should have the job of quickly, and as economically as possible, take what I'd done on the design of the early master controllers and put coordinated traffic lights right through the Sydney area. So the plan was to go from something like 300 sets of traffic lights to where we are now, where we've got 3,000 sets of traffic lights .... so I was given that job and it all worked well: we had a target of installing 150 sets of traffic lights a year, all connected to SCATS and I was given special orders to get into it and get it done.(Sims, Tape RTA-TMI:FH1, 42:17)

To accomplish the task, the DMR needed to upgrade its original Brisbane Street Traffic Control Centre. Ken Dobinson rented new premises in Oxford Street and built a showpiece - the Sydney Traffic Control Centre, or STCC, as it became known. John Longfoot was its first Manager:

> For traffic, it was high-tech. It was up-to-date with the computer technology of the time.... Ken Dobinson, who was the big boss at the time realised that you needed something with a little bit of show about it to get the attention to Traffic Management that it needed and to get the funds....They designed a pretty swish-looking place and they designed rather fancy fibreglass consoles, so that the whole thing looked very space-age and very high-tech – I think Ken was really the one who wanted it to look like that and he knew psychologically the marketing advantage of doing that. (Longfoot, Tape RTA-TMI:FH40, 33:02).

The SCATS system was to become the first fully-detected traffic management system in the world and the new STCC would, for the first time, be able to access controllers at intersections through the use of telephone lines, rather than cables. But Ken Dobinson needed to clear yet one more hurdle:

> The big issue that I had in my mind at the time was that even if it was successful, NSW would not be buying enough signal controllers to put on intersections in any way near to keep in business in Australia – there just wasn't enough market, and so I then spread it through the NAASRA system and talked all of the other states into coming on board - except Queensland, we didn't convince Queensland; we didn't convince them – and we also talked to New Zealand, and that expanded the market and gave us the impetus to let contracts to Philips Industries and later AWA to build these computers, with a high degree of risk that they would work...... That was the first time that computers were used in a signal box - the Philips people in Holland had tried for years, but had not got any to work. Philips Australia developed this, but it was largely, almost 90% the personal thoughts and drive of Arthur Sims who brought that to fruition and put it on a street corner and made it work. (Sims, Tape RTA-TMI:FH147:13).

By 1978, the first Central Monitoring System (CMS) was installed in the Traffic Control Centre and the first VAX computer, a VAX 11/780 was purchased in 1981, progressively taking over many of the development and SCATS support functions, which had been previously provided by a PDP-11/45. The VAX was subsequently connected to the CMS and provided data file back-up for the regional SCATS computers and collected traffic count and other traffic data from the regional computers. (Ref: Lowrie, technical paper: SCATS - The History of its Development).

The acquisition of a RAMTEK graphics display system in 1982 provided the first graphical display of SCATS related data. Operators in the control room could now display a picture on their screens of an intersection, showing traffic movements. The screen showed blue rectangles in place of traffic detectors, which changed colour as vehicles moved over them. (Ref: Davis, Tape RTA-TMI:FH50, 38:15).

What was so remarkable about the SCATS system?

> The key word is adaptive. No other system in the world would change the signal timings at an intersection on the basis of flow through that intersection in the previous three or four minutes – they were all fixed time, so traffic at 3 o'clock in the afternoon was based, in the systems around the world, on what it was at 3 o'clock last year, which might be quite different. Arthur used a loop detector, which was buried in each lane of the road on all of the approaches to the intersection which recorded the vehicles going across each cycle and modified the settings for the next cycle; only slightly, but modified them, and so you could put an Arthur Sims system into an intersection, make no settings on it and just run the loop detectors and that would feed into the computer and the computer would work out what the settings should be. It was absolutely revolutionary. (Dobinson, Tape RTA-TMI:FH5, 51:59)

John Bliss gives an explanation of how SCATS actually makes its calculations:

> The more traffic demanding a slice of the action – a slice of the pie, so to speak - then the higher the cycle length that you have to drive the traffic signals at. The cycle length is simply the time that it takes to go from a particular point in the sequence of signal operations right through the whole range of operations that it's capable of and round to that point again, so it can work through servicing the main street, then the side streets, then any turning phases that are demanded and then back to the point where it services the main street again – that's known as the cycle time. The more traffic in the offing, the higher the cycle length - the more traffic that is offering for a particular movement, the larger the slice of the pie, if you like, of that cycle time that has to be allocated to that traffic. So with SCATS we're measuring, through measuring the volume and that density, or degree of saturation - we're measuring that demand and we're constantly changing, at that intersection the amount of green that's given to each movement and the cycle time – the sum of all those greens, if you like. We're also keeping an eye on what's happening at the nearby signal-controlled intersections and trying to coordinate what they are doing with what's happening at the most critical of the intersections in that group and what happens is that basically, each intersection is placing a vote for what it thinks should happen at the next cycle. Some intersections carry a bit more weight in their voting than others - if it's a critical intersection, then it will carry the day, because at the end of the day, if you want to coordinate a group of signals, they've all got to operate on the same cycle time, otherwise they just get hopelessly out of step. If you want to co-ordinate things, if you want to try and achieve a green wave within the limits that that can be achieved, you've got to have a common cycle time, so the most critical one will drive that particular part of the argument. Strategically, for what happens on the main road, SCATS is working out what that group needs to accommodate the demands, but it is leaving the individual intersection controller some degree of freedom to cut short the side street time that can be allocated.

SCATS will say 'Well, you can have up to so many seconds', but if the local intersection says 'I don't need that much' then it can cut it and reallocate it back to the main street, so SCATS is quite clever in that regard. I came across a description of the information systems that power SCATS that I think is probably most illuminating – it illustrates really how much you can do within a sense with how little information. This fellow said 'Imagine if you have a ping pong table and you draw a map of your road network, or part of your road network on that table, and everywhere that we have a loop detector in the road, you drill a hole in your table tennis table. You then lie underneath the table – what you see is spots of light through each of the holes that you've drilled. Now, each of those holes represents a detector in the SCATS system, or in a SCATS sub-system, and every time a car passes over that loop detector, or a toy car, if you like crosses over the pinhole in the table, you don't see the light any more, so you see a pattern of light going on and off'. That is what SCATS sees and it is out of that pattern of lights going on and off, each one of which represents a vehicle that's just crossed the detector and how long it stays on and how long it's off, which represents the density of traffic, that SCATS gets its picture of demand and what it needs to do to change the signals. (Bliss, Tape RTA-TMI:FH58, 44:47).

The Traffic Authority

In 1976, at the time of the merger of the DMT traffic signals group into the DMR, the government created the Traffic Authority to take over the regulatory functions previously held by the DMT. Harry Camkin, who had been with the DMT, became its first Director.

> The government of the day was in a mode, as they do from time to time in streamlining the machinery of government, ... they wanted an overarching authority, one that would also bring other community perspectives and the perspectives of other transport agencies to the traffic management task, so they established the Traffic Authority. The Traffic Authority was really a council comprised of the Chief Executives of various transport authorities, plus people appointed on the recommendations of the NRMA, the Health Department and some industry concerns appointed by the Minister......... The Authority's role was to set guidelines - they had the statutory responsibility, but it was agreed that they would delegate that responsibility for the nuts and bolts of traffic management, traffic engineering, to the Department of Main Roads and also, to a degree to Councils, but they had the statutory responsibility for coordinating everything, for developing policy, establishing a strategic framework for traffic management and fostering the development of new approaches like local area traffic management, like priority roads, clearways, transit lanes, By this time, people were starting to realise that we should broaden traffic management to transport management – we should not be just talking about cars and trucks, we should be talking about moving people and goods and this had to be done in a much more cohesive way. (Camkin, Tape RTA-TMI:FH22, 41:08 & 47:06).

To help get local area traffic management on its way, John McKerral put forward a suggestion:

> I believe I was the one that snuck in the idea of the Traffic Committee and the concept was that for each council, there's be a committee that would have delegated authority from the Traffic Authority. This committee would have three persons on it, each being empowered to speak for their authority ....so we wanted to have people on these committees who could speak for the Council, the DMR or the Police. Council was given authority to erect these traffic control devices and have them reimbursed by the Traffic Authority, provided they got the Traffic Committee's agreement. So it was an interesting concept in power sharing and I believe it worked – and I believe it still works. Since then, I worked out a few weeks ago, Traffic Committees have approved well over a million traffic devices in the State over the years. (McKerral, Tape RTA-TMI:FH27, 11:20)

The Traffic Authority operated from 1976 to 1989 when the Government combined it with the DMR and DMT to create the Roads and Traffic Authority.

New directions in Traffic Management

Soon after Traffic Committees were formed, traffic calming devices such as speed humps and chicanes, roundabouts and entry thresholds sprang up all over Sydney.

> The early ones were all installed in temporary materials, because we were never sure how they were going to work. Some remained and are now in permanent materials; some were dismal failures and were removed, but it was quite a contentious issue in those days of: 'how dare we cut off public streets and put in these stupid devices in' as they were called. And there was a lot of concern by the Police about the safety of them, but we could see that this was a move that local communities wanted and we had to support it. (Amos, Tape RTA-TMI:FH20, 35:50).

As resident groups discouraged traffic on local roads, it forced more traffic onto arterial roads and by the 1970s, these were becoming choked at peak hours. The situation was becoming intolerable:

> I was involved in a Traffic Flow Analysis along Parramatta Road, the first Clearway. It was an enormous debate about what was going to happen – imagine, they were going to prohibit parking in the kerbside lane during peak hours. It was a major step in freeing road capacity, which we needed badly. Of course, it was very successful, because it is enough to have one car parked, just one, and you drop capacity from three lanes in one direction to just two...... and gradually, after that, Sydney just realised that on radial roads, like the Pacific Highway ands Military Road, we had to introduce Clearways, not only in the morning peak, but the evening, in particular, and some 8-10 years later it was developed into having peak on both directions for the evening peak, or for the morning peak, like now on Parramatta Road, for example. (Dimitric, Tape RTA-TMI:FH41, 24:57)

Soon, Clearways were no longer enough:

> During '75, I was at Milsons Point and the Minister of Transport at the time was Milton Morris. He'd been overseas and had seen Bus Priority and High Capacity Car Priority in Europe and came back, determined to put it on to Sydney's major routes - and the one that was chosen was the Spit Road route, and it was going to come hand-in-hand with car pooling, which actually got knocked off because the bus unions opposed it at Government level, but the Transit Lane went ahead, more or less against the DMR's wishes. I got the job from the DMR to actually put the stuff in on Spit Road.......It was an amazingly controversial thing in Sydney - to take a kerbside lane and to make it only available for three people in the car, motorbikes and buses and it was controversial because people said that they were losing their road space, and it was also difficult because it actually caused congestion. The queues went back for kilometres up Spit Hill, out along Balgowlah Road, up towards Wakehurst Parkway, and in fact, the very vehicles that we were trying to get higher speeds for just couldn't get to the Transit Lane, because of the queues, so we then put tidal flow arrangements out to Balgowlah Road and on the way to Manly, also up through Wakehurst Parkway. So in fact, the lane ended up

> going kilometres and kilometres more than ever intended in the first place. But despite the controversy – the NRMA fought it and slowly, but surely the DMR half got on side – Ken Dobinson, I must say was enthusiastic: without Ken's backing on this it would always be in trouble - it slowly, but surely became a feature of Sydney's road network. (Morris, Tape RTA-TMI:FH49, 10:08)

The conversion of the DMR to accepting Transit Lanes was not an easy one, as Bob Morris recalls:

> The DMR thought that they really were the champions of the motorist and this was a misallocation of their road – if you had capacity problems, you should build more lanes. It wasn't appropriate that you could regulate so that access could be there for buses, that sort of thing. To give you an idea of the depth of feeling, in 1978 I left the DMR and went to public transport and worked for Sydney's buses, and at that time the DMR was just opening up the Western Distributor and the Traffic Authority was operating, and we recommended to the Traffic Authority that the Western Distributor be changed from two lanes to three: the same size of road, but you'd make the lanes narrower, so that rather than having a shoulder and two lanes, we were going to have three lanes and one of them was going to be a Bus Lane, so that western buses could come flying into the city. That was approved by the Traffic Authority and all the bus lane markings were just begun down Druitt Street to get the buses going, and at midnight that entire ramp that was going to serve Druitt Street got concreted off. It was a giant power struggle between organizations. (Morris, Tape RTA-TMI: FH49, 13:20)

Then, in the 1980s, the S-Lane proposition was floated.

> The S-Lanes concept was around in the seventies in the Traffic Section, but hadn't really been thought through – it stayed with us, but governments of the day and even our own organization, the DMR were very reluctant, because the S-Lane took a lane away from motorists in peak hours and a parking lane away from the shopkeepers in the off-peak and it had a lot of downsides in terms of the political impact and it wasn't until the latter years when I was in a much more senior role, as Deputy Engineer-in-Chief and then Director that I was able to convince the Minister, which happened to be Brereton, to trial the S-Lane concept in Sydney, largely because he was looking for something to be done quickly that would show it was a new government, so we offered him the S-Lanes and he embraced it, and of course, they happened in Sydney almost in a rush. (Dobinson, Tape RTA-TMI:FH6, 13:49).

S-Lanes were introduced so quickly that they took everyone by surprise:

> It was a time when we were given a bit of carte-blanche to make the traffic work......The instruction was 'just make it work' and I hate to say it, but we went out in the middle of the night, put in 'No Stopping' signs in areas where there used to be parking and created S-Lanes. The idea of the S-Lanes was to create a turn bay in the centre lane by deviating the centre and the next lane across towards the kerb and terminating the kerbside lane........they worked and some of them are still there, but after the first outcries, we actually went back and reviewed a couple of them and found that we could build proper right-turn bays and maintain 3 lanes of

> traffic in each direction and that's we did. But they certainly proved the point and you'll find that there are now S-Lanes along most of the length of Parramatta Road, and we then did the Pacific Highway and I designed the system for the Pacific Highway. If I recall, there was something like 40 gaps in the median between Pacific Highway and Hornsby. Every one of those we saw as potential for an accident, whether a rear-end or a right-turn accident and the accident history demonstrated that, and the impedance caused to traffic flows, so there was quite a bit of negotiation with Local Government about which ones we'd close and where we would close a median and where we would put in an S-Lane. The early ones (appeared miraculously) – because in those days we weren't into consultation and we thought that this might cause a bit of ruckus with the local community and we actually did it in the dark of night, painted in the S-Lanes, restricted the parking along the kerbside where there had been one-hour parking in business hours, and of course, the shop owners come to work the next day and find that there's not only 'No Parking', it's 'No Stopping', which means that nobody can stop - not even their suppliers can stop to deliver goods to their business. That created a bit of a ruckus and we had to go out and spend time talking to the shop owners........There were times when, even in local Traffic Committees that local shopkeepers got pretty irate about some of the parking restrictions that we put in and I actually got death threats on one occasion over some parking restrictions that we put in.... death threats are never light-hearted, but (they were) more along the lines of 'I know who you are, and I know where you are, and I'm going to get you' (Amos, Tape RTA-TMI:FH20, 44:34 & 49:24).

The introduction of S-Lanes and Priority Roads necessitated a change in traffic rules:

> If we go back to before the days of Priority roads, everything either relied on traffic lights or the good old 'Give Way to the Right' rule. You approached an intersection and you had to give way to traffic on your right. Now that didn't do much for traffic on Parramatta Road, for example – here was a major artery, carrying an awful lot of traffic, interrupted at every side street by anybody who wanted to join it and who had traffic approaching from his right. So Priority Roads had been introduced and that was a program of signposting every junction with a major road with either 'Stop' signs or 'Give Way' signs which overrode the 'Give Way to the Right' rule. But there were still on all the minor streets a lot of uncontrolled intersections where the 'Give Way' rule applied and there were on the major roads an awful lot of T-junctions where instinct would tell you that if you were coming up the stem of the 'T', approaching the cross-bar, so to speak, you tend, automatically to give way to everything on the cross-bar rather than enforce the 'Give Way to the Right' rule, so it seemed to us a logical step to go to what we called 'The T-Junction Rule' and that basically said: 'If you're approaching up the stem, give way to all traffic on the cross-bar of the 'T' ...... and then came 'T-Junction Day' when the law changed and we all sat back with baited breath and crossed fingers and hoped that it all went well. As it turned out, it went very well. (Bliss, Tape RTA-TMI:FH58, 22:52).

Roundabouts

Roundabouts were yet another traffic device being considered by the DMR in order to reduce accidents and improve traffic flows. By the time Rod Tudge started with the DMR in 1980, they were still largely a novelty:

> Well, one of the first assignments I was given was to look at the introduction of roundabouts in New South Wales and so I called for the file, and the file was called 183/46M, which basically meant that the file was started in 1946, and I opened the file up and there was a letter in it from the then Commissioner of Main Roads which said that he just returned from serving in the Air Force in the United Kingdom – he'd seen roundabouts and thought that they were a very good idea and that we should pursue them as a matter of urgency. I checked the record: at the time he wrote that letter, there were five roundabouts in New South Wales - in 1980, when I came to look at them, there were three, so obviously, instructions from Commissioners of Main Roads meant a lot in the Department. (Tudge, Tape RTA-TMI:FH38, 05:58).

Those few existing roundabouts looked very different, as Alan Short recalls:

> There were at least three out in the Pendle Hill area, in the back of Parramatta that had been in use for many, many years. They were built out of railway sleepers, of all things and filled in with dirt in the middle. (Short, Tape RTA-TMI:FH28, 39:29).

> They were frowned upon, because they didn't work very well and people didn't use them very well.......they had virtually gone out of favour. In 1972, I went to England and it was only after a large experiment in England, where they'd altered the way roundabouts worked, so that they worked on people packing gaps in the roundabout, that they were starting to work over there much more successfully and not having to be so big as they were – the early ones in England were huge – so they came out here. That was quite a fascinating little exercise because they had a bad name and you were trying not to introduce a new concept, but to get over a bad one. And again, Arthur Sims came into this – we worked out one place where you could put a roundabout in an area that was not working: it was in a little spot out at Eastwood, near the station. We had a series of roads coming in and a huge area of asphalt in the middle and people didn't know where to go, so we thought that was a great space. (Dobinson, Tape RTA-TMI:FH6, 15:23).

> It was a thing we called a poached egg: it had a yellow, raised concrete circle – just a lump – no kerb around it, and then white paint around that, so it looked indeed like a poached egg. People were most unfamiliar with it – it was interesting to see on bowls days to see a carload of ladies in bowls uniforms drive over the hump, their mouths open as they went up and came down again. (Short, Tape RTA-TMI:FH28, 38:26).

> One little old lady approached the intersection very confused and drove straight over the top of it, leaving tyre marks within the middle of the roundabout. (Terry Winning, Tape RTA-TMI:FH57, 14:53).

Peter Lowrie designed that first little roundabout:

> I was directly involved in designing and having installed the very first little roundabout at Eastwood railway station and also, I toured around local councils, trying to convince traffic engineers in local councils, particularly in the back streets, where safety through residential areas was an issue that roundabouts was a good solution. We had some success there, but it was a long time before we saw any big roundabouts on main roads and I shall never forget one engineer in the DMR at the time who said 'Over my dead body will an obstruction like that be installed on one of my highways' and now of course, we see hundreds and hundreds of them throughout New South Wales. (Lowrie, Tape RTA-TMI:FH34, 24:27).

With the proliferation of roundabouts in the 1980s, some changes to road rules became necessary:

> We always had to give way to the right, but we changed the law to give way to vehicles already in the roundabout. (Tudge, Tape RTA-TMI:FH38, 11:29).

> Driver behaviour at roundabouts continues to be erratic. The laws about entering roundabouts has been changed – in which lanes you can be when you enter a roundabout, depending on where you want to exit..... there's one not far away from here at Five Ways, Miranda - it's been the number one insurance accident blackspot for some years and the RTA is now removing the roundabout and installing signals. (Amos, Tape RTA-TMI:FH20, 51:44).

Bob Mudford, presently the RTA's roundabouts spokesperson expresses the view that in recent times, design standards for roundabouts have slipped, infuriating some drivers of long vehicles:

> They'd run up on kerbs or over the central island – we've had cases, it caused a lot of aggro - it was on Appin Road, between Appin and Campbelltown where the heavy vehicle drivers were so incensed that they came down Appin Road and drove straight across the central island, flattened all the hazard markers and went straight ahead. There were wheel tracks straight across the central island as though there was no roundabout there at all. (Mudford, Tape RTA-TMI:FH55, 38:44)

Bob Mudford also noticed problems in other areas:

> I started to notice on city and country roundabouts tyre marks on kerb lines and a lot of rubbish that would build up opposite splitter islands because vehicles couldn't get out

> there......and I thought that there's got to be something wrong in the way vehicles were entering and exiting roundabouts – where was the problem? I came back to the office and looked at things with turning path programs and with the assistance of a junior fellow under me we started to unearth what was wrong and we came up with a very crude system of roundabout design at that stage...... after we refined that process and looked into it a bit more, that generated the geometric method of roundabout design that we prepared. (Mudford, Tape RTA-TMI:FH55, 33:29)

Bob Mudford thinks that Councils have gone mad with roundabouts:

> Councils put in a lot of speed humps, which are vertical obstructions and I believe that a lot of councils use roundabouts as a horizontal speed hump. The way they put them in with splitter islands, they're an obstruction, even to cars. (Mudford, Tape RTA-TMI:FH55, 51:25).

In contrast, Rod Tudge praises the virtues of roundabouts:

> Roundabouts are good for reducing accidents because (1) they tend to slow speeds down and (2) they tend to cause a glancing accident, rather than a right-angled accident if they do occur.......we got quite large reductions in accidents. I monitored the first 300-400 built. It is now my understanding that there are somewhat in the order of 3,000 roundabouts in NSW, so when we started from three twenty years ago, it probably shows that they caught on fairly well. (Tudge, Tape RTA-TMI:FH38, 08:42).

Driver Aid Systems

An interesting early experiment with Driver Aid Systems that the DMR was involved in was begun in the 1970s with the development of a computer-controlled fog warning and variable advisory speed signs system for the F6 Freeway, then a 23-km long tollway from Waterfall to Bulli. The F6 is a particularly fog-prone road with fogs that can last from half an hour to more than a week. John Bliss, Special Projects Engineer, developed the project. The scheme was:

> a system of changeable message signs, lights and matrix displays with fibre optics technology lighting them up that gave advance warning of the existence of fog, or lane closures ahead and an advised speed through that situation. It was all controlled by computers back at the Waterfall Toll Office........ information on fog conditions was either through people phoning or radioing in, saying 'hey, there's fog down at Bulli' ......or through information received from a weather station at Bulli which constantly monitored wind speed, the wind direction, the relative humidity and the temperature, and on advice from the Weather Bureau on what combination of those variables to look for, it would send a signal or alarm back to the toll office at Waterfall when the combination circumstances were such that it was conducive to fog forming. That would give anything up to half an hour's warning that something was coming. (Bliss, Tape RTA-TMI:FH58, 15:05).

The F6 system had yet another feature, innovative for its day:

> Another safety feature of the driver aid system is the vehicle detection devices installed along the Tollwork. These devices calculate the percentage of vehicles exceeding the advisory speed. At the control centre, the computer monitors this information and warns the supervisor when a significant proportion of motorists are not heeding the direction. From the information supplied by the detection devices, the supervisor is also alerted of abnormal traffic flow such as an accident would cause. The supervisor can then adjust the advisory speed or take other appropriate action. (Ref: Article in MAIN ROADS, September 1975).

The Sydney Harbour Bridge

Sydney's icon has long been fertile ground for experimentation with new traffic management devices. Because peak hour flow on the bridge in one direction was much higher than in the other direction, it was decided to introduce a tidal flow system - four lanes in one direction and two in the other - and markers were needed to inform drivers of the change. These took the form of silver-painted rubber flaps:

> They were annoying, because they were fairly solid. They made a row, because you knew when you hit one and occasionally, you'd get them stuck under your car. (Daley, Tape RTA-TMI:FH12, 08:06)

> Occasionally, (the men who placed the rubber flaps) would go on strike and we'd win the job of filling in for them on a strike day and I don't envy their job at all. Pulling up those rubber flaps, I've got to say, with an iron rod with a spike on the end of it, or an L-shaped hook got very interesting on wet days, because those flaps tended to be sucked down onto the surface and if you'd try to lift one off slightly the wrong way, you'd darn near dislocate your shoulder. It wasn't fun at all. (Bliss, Tape RTA-TMI:FH58, 14:10).

Another evolution of traffic management on the bridge was the introduction of one-way tolls in July 1970. The idea had been long in coming - it was first suggested in the 1950s. George Vassallo was told that David Lloyd-Jones first thought of it, but Murray Fairlie maintains:

> In the university days, talking to Ross Blunden, the Professor of Traffic Engineering, he casually mentioned to me one day that if we collected our tolls only in one direction, we'd improve our traffic flow considerably and talking about it one day with John McKerral, and I think George Vassallo was in on the discussion of one way tolls – what would we have to do if we only raised the toll in one direction, and George and John produced some plans showing what could be done. But one of the problems was that during the period when we were collecting no toll for traffic travelling north, how could we get them to travel quickly through the booths without stopping and trying to pay toll? And I think John McKerral at the time said "Why can't we just fold the tollbooths up and get them out of the way?" and I thought that's not as revolutionary as it sounds – it should be a possibility. That same afternoon, I rang our Mechanical Engineer out at Rosehill, explained to him what the problem was and I said 'Can you design me a set of collapsible toll booths which we can use in the morning and then push out of the way?' and he said 'Of course we can – we can design anything'. (Fairlie, Tape RTA-TMI:FH53, 50:39).

> I put up the suggestion in my layout that the tollbooths would be on rollers and they would move out of the way. (Vassallo, Tape RTA-TMI:FH15, 53:18)

Jack Winning, the Chief Draftsman at the DMR's Central Workshop had started with the DMR in 1946. He became 'Joe the Gadget Man', fixed all sorts of equipment and devised the changeable signs on the Sydney Harbour Bridge, which were moved by electric motors from one position to the other. Winning was asked if he could design the moving tollbooths and he and a colleague, Jack Bradshaw, came up with the final design. It was a first for the DMR.

> They'd never been done before anywhere, to my knowledge. (Jack Winning, Tape RTA-TMI:FH11, 30:49)

> It worked like a charm, except for the fact that on the first night, when people were getting accustomed to the new traffic arrangements – and usually we had trouble on those first nights - the Minister for Highways was held up in the traffic going home and he made an awful fuss - that the scheme was no good and that – I think he felt that he'd been talked into something he shouldn't have approved. He made some suggestions about how to cure it, but fortunately, I didn't have to adopt them. (Fairlie, Tape RTA-TMI:FH53, 56:00).

With tidal flow arrangements in place on the bridge and the impending opening of the Western Distributor, a more permanent solution was needed to channel traffic on the bridge and its approaches into defined lanes. The idea of median strips that could be moved was suggested to Jack Winning:

> They said to me: 'They want a moving median, do you think you can dream one up?' and I became immediately interested and I dreamt one up. (Jack Winning, Tape RTA-TMI:FH11, 19:53).

Jack first experimented with an air-propelled system similar to that used by Hovercraft, but the system was unreliable on the asphalt surface and the idea was abandoned. Then he chanced on the idea that would finally succeed:

> The idea came to me through a little child's toy snake, which was built sometimes in six sections and when the kiddie pushed the snake, number one section would work on number two section and so on, and the thing could move and that's how we got the thing to move from point A to point B. There was an electric motor, which actuated a gearbox and shifted the first lot of wheels and the other wheels just went along for the ride, sort of thing. I had doubts if I was doing it the right way and that's why we built models and we built an actual moving median strip which was 100 ft long out of timber at our carpenter's shop out at the Central Workshop and once it worked with the timber structure, my doubts started to diminish (Jack Winning, Tape RTA-TMI:FH11, 22:36)

Jack tested his timber model with a truck, laden with 15 tons of sand.

Warringah Expressway moving signage, 1970s

Moveable median, 1986

Moveable Median for Sydney Harbour Bridge (Photo: Jack Winning)

Sydney Harbour Bridge electronic signage, 1986

> I became emotional, really, when it did work properly – well, I was really in tears, really, I was so pleased that it worked. (Jack Winning, Tape RTA-TMI:FH11, 22:03)

The first one that Jack built was moved manually by an operator for southbound traffic directed to the Cahill Expressway. Later, they were remotely controlled and connected to SCATS. The movable medians were a first in the world. The DMR was so pleased with their new invention that they took out a world patent and Jack was recognised for his efforts. He was given a dollar note, framed and signed by the Commissioner of Main Roads - the cost of taking out the patent.

> They're very effective – particularly required in a situation on the bridge where you've got a limited number of lanes – you don't have opportunities for opening and closing total areas, where sometimes you've got to use an area as a northbound area and then later on as a southbound area – they're excellent for that, but they're also excellent for traffic filtering where, if you want to control the volume of traffic going to a particular lane to get maximum efficiency out of the bridge. They're also used where you partially close a lane and cause a partial merge, so they tend to be very effective for that. (White, Tape RTA-TMI:FH36, 16:44)

Brendan White was also part of a committee set up to design and install the overhead variable lane-changing lights on the Harbour Bridge and the installation of the steel gantries that supported them. The lights have built-in back-up systems:

> There's actually a double light in each one and there's also reserve power – there's generators backing up that reserve power and there's duplicated computers to support them. (White, Tape RTA-TMI:FH36, 22:10)

The movable medians and overhead lane-changing lights eliminated rubber flaps forever and saved valuable time:

> The time savings: I would be guessing at the exact number, but I would say it'd be 10 to 15 minutes every time there's a change. (White, Tape RTA-TMI:FH36, 19:13).

SCATS takes off

In 1976, Arthur Sims was working on extending SCATS' capabilities and one day he came up with a very bright idea:

> When the Dept made the decision to install 150 sets of traffic lights a year, it was obvious that if you could use the helicopter to sit over the top of a section of road which was going to have 10 new sets of traffic lights commissioned – while you were up there, you could talk quickly over a radio to someone on the ground who had a SCATS terminal to change the settings in order to make the road system work better. It was a method of observing the SCATS operation and fine-tuning while you were sitting above it. So we started that way and then Grahame Davis, in his usual way said: 'Why don't we have a SCATS terminal in the helicopter - we can use a radio link directly from that terminal to the SCATS computer, we can sit up there and we can do it ourselves' - so he went ahead and designed that and it worked well. It was probably the first computer control of something from the air to the ground to do something automatically without relying on someone else, and we were overheard talking on the radio system in the air by a Qantas 707 pilot who rang us up and said 'What are you doing up there?' and I said 'Well, we've got a computer terminal up there'. Soon after that, Qantas went ahead and fitted a similar facility so that they could relay information, say to Hertz or Avis that someone in the plane wanted to hire a car when they got to Sydney. I used to fly three hours in the morning peak period and three in the afternoon peak period in literally what felt like for years and it was too – every day I'd be up in the chopper. (Sims, Tape RTA-TMI:FH2, 12 :05)

Peter Lardner-Smith perfected the SCATS system for the helicopter:

> (The aim was to) trim signals to the optimum traffic flow, so to communicate directly with the SCATS host computers – the VAX computers at the Oxford Street office in those days – they needed a radio link and a terminal. The terminal itself was straight forward: it was a Texas Instruments computer terminal, but I had to install the UHF radio links within the helicopter and hook these onto a frame so that the traffic observation officer could sit there, make his judgements and enter the data that he needed into the terminal, which would then be reflected by changing the settings over that part of the road he was looking at. (Lardner-Smith, Tape RTA-TMI:FH24, 23:14).

In 1980, a number of road authorities in other states and New Zealand expressed a willingness to install SCATS. A meeting of interested parties was held in mid 1980 and the SCATS Management and User Group (SMUG) was formed. Terms for distributing and supporting SCATS and cost sharing were set up. SCATS was soon installed in Melbourne, Adelaide and Manukau (NZ) and is now deployed in most major cities and towns in Australia (except Queensland) and New Zealand.

The wide acceptance of SCATS by these users paved the way for SCATS to go international. (Ref: Lowrie, technical paper: SCATS - The History of its Development).

> We decided to sell it to the world.....it was rather tenuous – we endeavoured to market it in the Philippines and Singapore – Singapore was the first one we tried. I remember quite clearly putting it to the Government that we market it in Singapore and getting permission for Arthur to fly over there to do this and it got knocked back by the Premier of the day, and so we put it up again and it came through the second time and we got it approved. I remember remarking, when I was shown the approval 'Thank goodness for that: Arthur is just flying over Darwin'. (Dobinson, Tape RTA-TMI:FH5, 53:40).

Earlier, the Singaporeans had questioned Arthur's credentials:

> A group of people had come out from Singapore to Australia to see what we were doing in Traffic Engineering and one was the Minister for Transport and he met Arthur and knew Arthur, and when he went over there, of course you get caught up in a bureaucracy - they have bureaucracies - and so they queried the credentials of the various people that were here, and I remember sending a telegram back with Arthur, who couldn't quote any real technical qualifications, and I sent back a single telegram to these people: QUALIFICATIONS: GENIUS, CONSULT YOUR MINISTER and they did, and he went. (Dobinson, Tape RTA-TMI:FH6, 06:01).

After Singapore, China beckoned:

> In 1983 or 1984 there was a big study being done in Shanghai, in China. It was mainly an infrastructure study...... but a small part of the project was to do with traffic in Central Shanghai and some Australian consultants were involved, and of course they had good knowledge of SCATS, so whilst their initial job was to look at things as one-way traffic systems and re-routing buses and trolley buses and so forth, they said 'what we really need here is a modern traffic control system', because the delays in Shanghai are caused by the Police manually operating the signals that they had. Delays were enormous – a story I'd like to tell is when we first went there, we'd be driven by a government driver and when we came to a red light, the driver would turn off the engine, put the car into neutral, put the handbrake on, get out his newspaper and pour a cup of tea. He would have time to attend to all of that, do a bit of reading and sip some tea before the light would turn green again and I'm jumping the gun a bit here, but SCATS was eventually installed in Central Shanghai and we judged the system's success on the basis that the driver no longer had any time to do all these things. (Lowrie, Tape RTA-TMI:FH34, 02:40).
>
> That was a big feather in our cap: to have the traffic management software in a country that was well away from Australia, but there was a big problem at the time, and that was they were American computers and the rumours flying around was that they would use them for missile

> guidance systems and it took a long time to get approval from America to have the computers shipped across – not only were they the PDP-11s used for traffic management, but also the VAX computer for the central management function and it was the VAX that was the worry. (McCallum, Tape RTA-TMI:FH45, 44:05).

> It took over a year to get approval from the US Government to take a PDP-11 computer into Communist China - they were very sensitive about it. (Lowrie, Tape RTA-TMI:FH34, 05:23).

> I helped create a market for SCATS in China and other places – we only put 28 sets of traffic lights (in Shanghai) in the initial system: I think there's about 14 cities in China now that have got SCATS. (Sims, Tape RTA-TMI:FH1, 48:25).

Of those 14 cities, the Kowloon and the New Territories traffic systems installation contract was the largest in the world at the time. It was a daunting task:

> The contract, for 500 intersections, was actually to replicate the aging system that they had, which was fixed-time, so we actually had to modify SCATS to have another mode of operation and that was the primary aim.... The traffic mix is completely different: you have a high percentage of double-decker buses, taxis and commercial vehicles – very few private vehicles, and also you have a mix of handcarts, bicycles and other assorted wheeled vehicles being pushed along the road, which don't make for a smooth movement of vehicles, particularly in the congested areas. (Lowe, Tape RTA-TMI:FH37, 15:38 & 23:03)

> (The contract) was up around twenty million U.S. dollars, so a huge job, spread over four years.......it involved over 580 traffic signal controllers, a new control centre, loop detector installation... we did a lot of work in supporting AWA/Plessey in that installation. We did a lot of training there, a lot of acceptance testing of equipment and a lot of fine tuning work was done – in fact, during the project, over four years, there were over 88 visits to Hong Kong by RTA staff. (Giffin, Tape RTA-TMI:FH19, 34:44 & 39:10)

> The contract has been expanded and there are now 850 intersections in Kowloon operating and we've recently won the contract to install SCATS in Hong Kong Island, which is traditionally a SCOOT installation. (Lowe, Tape RTA-TMI:FH37, 25:55)

SCOOT was the system developed by the Transport & Road Research Laboratory in London. It is the biggest competitor to SCATS.

> I guess SCATS and SCOOT have been running neck and neck in competition with each other since the early days...... One could say that SCOOT has got the European market about as sown up as any English system can be in Europe........there is SCATS of course, in Dublin, on the UK doorstep. SCOOT has a bit of a presence in the United States, SCOOT has a bit of a presence in South America, where SCATS has none – SCATS is dominant in Asia and South-

> East Asia – SCOOT hardly gets a look in there: indeed there was a SCOOT system put in to Bangkok a few years ago. We understand that the company that did that has now withdrawn from the Asian market to all intensive purposes. (Bliss, Tape RTA-TMI:FH59, 08:57).

SCATS now operates in 70 towns and cities around the world, including the United States, the Middle East and South-East Asia:

> Sydney's still the largest, but I can see a day arising where Sydney, perhaps, won't be. For example, just in the last couple of weeks, Tyco have sold an expansion of a system in Mexico City which will take it from 300 up to 1,000 intersections and we know there's another 2100 intersections out there that potentially could be connected to SCATS, so who knows where it will take us in the future. (Bliss, Tape RTA-TMI:FH59, 07:06).

> It ranked amongst the best in the world. The research we had done in Australia demonstrated its overwhelming utility as both a traffic management and road safety tool Arthur Sims won International Road Federation Man of the Year Award for it, which was a bit ironic, because I remember telling him a couple of years ago – he and I were talking in our cups one evening and I said "Oh, come on Arthur, you're a traffic signals guy – you're not a traffic engineer; you're not a traffic engineer's bootlace!' and Arthur since has made me eat my words a few years later when he won that international award. (Camkin, Tape RTA-TMI:FH22, 39:02).

In addition to winning that prestigious award, Arthur also received the ANZUS medal and the 1997 Engineer of the Year Award. He has also accepted as a member of the New Zealand Institute of Engineers, despite having no formal engineering qualifications. (Sims, Tape RTA-TMI:FH2, 22:14).

The birth of SCATS-6

By the mid 1990s, the RTA had decided to develop a new version of SCATS and negotiations were commenced with tenderers to outsource this work. However, when negotiations broke down with the preferred tenderer, the RTA, faced with a long delay in developing the new software, finally decided to develop it in-house. It set up a new team of computer experts, but excluded Grahame Davis and Ken McCallum, who had done most of the development work on previous SCATS versions. Meanwhile, the old PDP-11 computers were starting to outlive their usefulness and parts were becoming more difficult to obtain:

> PDPs had been around since the early seventies and the things that people had asked us to do on the computer was getting so varied and numerous that it nearly an impossibility to add anything to the code. In fact, one of the biggest jobs we did was Kowloon, where we introduced a new type of signal controller and that just about used up every available bit of space in the PDP-11. Two things happened at that time – one was that PC's were becoming the norm and DOS was the operating system, but a new operating system, Windows NT Version 3 had just been released and it looked very interesting....... so I said to Grahame 'If you can write software that connects a VAX computer to about 12 regional computers, would it be possible to use that software to connect a PC to 128 intersections?' and Grahame said 'I think that's possible', so that started him going and he re-wrote his software so that he would come up with a system that talked to intersections. (McCallum, Tape RTA-TMI:FH45, 49:01).

> I started on it about 1996: I worked on the basics for about five months (in my spare time). (Davis, RTA FH50, 49:06).

> Then (Grahame) merged that into the existing structure, and so he had a computer on his desk that looked like a PDP-11 to the VAX computer, would connect to intersections, allowed you to log on and log off, but didn't do anything. There were no displays and it didn't control traffic, because Grahame's expertise is not traffic and he said to me: 'I've got my bit done, now it's over to you'. And I said 'Alright, I'll start working on the traffic' and at that time, I received a letter from RTA management that, unless I used up my accrued holiday recreation leave, I would lose it – I had been putting it off for so long that I had accrued twelve weeks..... and I went home – and I already had a PC at home, which was one from the office that they were throwing out – and I convinced the boss that if I used that at home, it would help me with my work. So I took home all of the PDP-11 source code, listings and Grahame's new program and I then spent the next twelve weeks – much to my wife's disgust – probably averaging twelve hours a day, sometimes longer and I wrote from scratch the complete traffic management system for a PC. (McCallum, Tape RTA-TMI:FH45, 52:40).

> Ken and Grahame made a conscious decision that we think we can upgrade SCATS-5 from a very old program where they used assembler language on a PDP-11 computer – they felt that

> they could do better and they could convert it into a PC operation, and they did that, away from the organization, they did it at home, they did it at weekends, at night time, unbeknownst to senior management in the RTA and one day they turned up and said 'Come and have a look at this' and there it was – and that was the birth of SCATS-6. (Giffin, Tape RTA-TMI:FH19, 49:00)

Davis recounts the RTA's reaction when he and Ken McCallum divulged that they had produced a workable SCATS version that could run on a PC:

> The one I did would run on a notebook computer, for example. It could run and control up to 250 intersections off a notebook computer. (The RTA) did not want to know about it... I got the impression that they weren't very happy about it. (Davis, Tape RTA-TMI:FH50, 46:24 & 49:38).

> It was completely unofficial - unwanted, I would say. It caused great concern in some quarters – John Smith from CSIRO who was involved in the new SCATS Generation 2 Design at the time labelled it 'skunkworks' – that was a term they used inside CSIRO for software that should never have been written. (McCallum, Tape RTA-TMI:FH46, 00:18).

Davis and McCallum's version not only put SCATS on a PC and a notebook computer – it doubled the capacity. The PC could now control 250 intersections, versus the PDP-11's limit of 128.

> We were told not to advertise the fact that we had it: 'Don't tell anyone, don't mention it', but we kept testing it to make sure it all worked and we were quite happy with it and eventually I was asked to do a presentation to some engineers from the Netherlands brought in by Philips. I did about a one hour presentation on SCATS and towards the end of that presentation, a hand went up and said 'Well, this is very good, but why a PDP-11, why don't you have one that works on a PC?' and I said 'Well, it's funny that you should ask that, we do have one that works on a PC'. All the eyes lit up and they said 'Is it available?' and I said 'No, it's not available, no-one wants to know about it'........ I think that was the catalyst and decisions had to be made and with AWA and Philips both saying at the time that SCATS marketing was very difficult with PDP-11s, PC is the way to go, eventually it was decided that we could use it....... History has now proven that the decision Grahame and I made back in 1997 .... to have that now accepted as the most successful traffic management system in the world today – not only has it been a victory for Grahame and me, but it's a victory for the RTA. (McCallum, Tape RTA-TMI:FH45, 54:53 and Tape RTA-TMI:FH 46, 17:20).

SCATS-6 was finally vindicated during the Sydney Olympics:

> It was so successful that the senior management of the RTA said ' we will install SCATS-6 in all Olympic critical areas, because they could do a lot more with it, have more control, be able to provide green waves, etc. and they did that, and there was not one failure. (Giffin, Tape RTA-TMI:FH19, 44:14).

To SCATS-7

Although SCATS 6 has filled the gap left by the demise of the PDP-11 hardware, the need for an all new SCATS based on the latest technology in hardware, software, architecture and spatial information systems was under consideration long before SCATS-6 emerged. (From technical paper: The History of SCATS by Peter Lowrie).

> SCATS-7 starts from scratch. It includes, as its basis a spatial view of the world. In other words, features in the world like roads, intersections, lanes and so on are represented spatially. SCATS-7 will be able to take that information and calculate things which currently have to be entered manually, and SCATS will know where traffic is coming from and going to, because it knows that this street is connected to that street, and this street is connected to that intersection and so forth. At the moment, early versions of SCATS, including SCATS-6 have no concept of where anything is –it's blind if you like, its controlling based on what humans have entered into the system, but in the future we have plans for the system to be able to determine itself a lot more things that people currently have to enter and have to program, if you like. The key underpinning is this spatial database – some people call it a GIS – a Geographical Information System. That then also leads you to think about how do operators interact with the system. Now operators in SCATS-5 used to communicate with the system by typing commands and they would get text coming back. In SCATS-6 they have added a User Interface that enables people to see things graphically. In SCATS-7 the basic starting point is a map, and that's probably the most familiar to most people - they see the map and start with the map, and if they want to look at an intersection, they click on an intersection; if they want to look at what's happening on a piece of road, they click on a piece of road; if they want to see what a detector is doing they click on a detector on a map, and they can zoom and pan, and so forth around the map – navigate their way, using a map and do most things, the starting point being the map. So the spatial database gives you that capability of having the map and the two are linked together, and the other thing that SCATS-7 provides is the facility for integrating with other systems. SCATS is just one of many intelligent transport systems. SCATS is about urban traffic control – it's still only about signals, really, but there are all sorts of other systems out there and SCATS needs to be able to work with those in order to give a total management picture. (Quail, Tape RTA-TMI:FH44, 36:45).

> (SCATS-7) will take a lot of decision-making away from the traffic engineer – it will all be done by its own expert system. So, whereas in SCATS-6 each intersection is controlled independently of any other intersection in the system, even though they may be side by side, SCATS isn't aware of that fact – it doesn't know where the traffic from one intersection is coming from, it doesn't know where it's going. SCATS-7 is aware of all that – it in fact puts a human element into the design so it can determine the paths through a city and the routes that are taken by people and it will monitor and adjust and optimise. (McCallum, Tape RTA-TMI:FH46 , 08:15).

SCATS-7 is due for release in late 2003.

ANTTS

One of the intelligent transport systems that SCATS-7 will interface with is ANTTS, the Automated Network Travel Time System, developed by John Longfoot.

> The Traffic control system, SCATS, controlled traffic lights. The only information that was got was from loop detectors into the system and the only information people were getting was by the colours of the red, green and yellow of the lights, and while that can do a lot, there's a limit to what that can do, and it works as a localised system, but obviously in a larger traffic control system you have to manipulate and manage people's intentions and routes and things like that. So obviously a higher level was needed where the overall patterns are taken into the system and decisions made, either automatically or manually, or with a bit of both to do with the whole area, rather than just smaller areas, and this information got out back to people in their cars in some way, to influence major decisions they were making on the routes they were taking, so that was something that really had to be laid over the top of SCATS. The idea was to gather information on travel times, rather than just using information from the detectors and the ANTTS system was developed to do that. ANTTS has three components: it's got a small transponder which sits in a vehicle, which is really a little radio transmitter/receiver with a digital data thing and an identifying code in it – it has base stations which are set in traffic signal controllers, it works in the VHF frequency band and when a vehicle fitted with a transponder comes to within 50 to 100 metres of one of the base stations, it has an interaction and talks and the digital data identification of the transponder is sent out to the base station. The base station sends that data serially back to the central computer, the SCATS or the management computer, and that's archived and travel times, through links are worked out, through links of road. It's a good thing for buses – it could be used quite widely for giving information to bus passengers. It was actually used on the green and yellow airport buses to give information on which buses were coming and when they will arrive. Those green and yellow buses are fitted with the ANTTS transponders – it traces them down through the city and tells the people who are waiting in Eddy Avenue how long the bus is likely to take before it arrives. That was put in back around 1990. (Longfoot, Tape RTA-TMI:FH40, 45:40).

> That technology is still being made today – it was made and it was installed at a number of sites and we managed to get probably about 80% of the taxis in Sydney fitted with these tags, and interestingly today, we're now looking at a new system using the toll tags on the Harbour Bridge to provide travel time measurement as a replacement for ANTTS. (Quail, Tape RTA-TMI:FH44, 15:54).

PARAMICS

The use of microsimulation programs has grown as the power of PCs has increased in recent years. In the quest to facilitate the management and flow of traffic the RTA is constantly evaluating the latest available traffic modelling software, and has recently adopted PARAMICS to facilitate the modelling of complex traffic management scenarios. This program is capable of modelling drivers' behavioural patterns in response to changing traffic conditions. Rod Tudge is both an engineer and an economist and has been active in producing these complex and interesting models.

> PARAMICS is a vehicle-by-vehicle simulation model. To understand PARAMICS, what you have to understand that what we do in most of the other models is we predict how many people go from A to B and then we assign them on a route and then all those people simultaneously appear on that route for a given time period and we use several methods of spreading them around, but basically it's a statistical method of determining where people are..........The next step were models like PARAMICS which said 'Why don't we take the packet down to an individual vehicle..... each individual vehicle is given an origin and a destination and it is given a route to start moving along. And it has ascertaince of rule – it has gap acceptance and speeds, acceleration and de-accelerations; it has things like aggressiveness – how small a gap it will take, how much it will change lanes – it has awareness, it knows some parts of the network better than others.... So you build a series of things into the network, which enables vehicles to navigate through the system. (Tudge, Tape RTA-TMI:FH39, 02:52).

> It's a real time traffic simulation model. The graphics is... the presentation is absolutely fantastic. It was developed in Scotland. We've put models in for everyone of our major projects now - we're hooking it into SCATS, so you can use simulated vehicles in real time on the network to drive SCATS settings to put into the simulated traffic signals in the network, to look at traffic diversions, etc. so it's all interactive. PARAMICS has been a boom for us – we've got the biggest PARAMICS models in the world and we've got most of Sydney under PARAMICS at the moment – we bench tested the M5 East and made a lot of adjustments to that, the Cross-City Tunnel, the Lane Cove Tunnel, the Western Sydney Orbital, a large number of other projects, both in Sydney and outside of Sydney have been proven, if you like, using PARAMICS. It's been invaluable. PARAMICS actually predicts traffic volumes on the road in real time on a screen – it actually has driver behaviour models, different models for different drivers........ it simulates trucks and buses – we can identify vehicles and track vehicles using PARAMICS – it's a very, very powerful model. (Ford, Tape RTA-TMI:FH51, 54:50).

Electronic tolling

New South Wales now has a world-class tolling system. It had its genesis in the cash toll collection on the Sydney Harbour Bridge, which had been operating since 1932. In that system, toll collectors at booths would collect cash and hand a receipt to passing motorists. But it wasn't the motorist so much who was avoiding paying the toll - in some cases it was the toll collector:

> They were handing out tickets and when you'd come up to the toll barriers, there'd just be tickets all along – everywhere, and I remember one story – when you'd go through, the toll collector would hand you a ticket, but he'd hang onto it: you'd be going through and it would slip out of your hand, so with the same ticket, he'd hand it out to the next one. And John Shaw was the Commissioner then and he happened to be going through one day and the toll collector would do it to him, so he stopped the car, went back and they tried to sack him, but they wouldn't let him, you know, the Union fellows. The ticket was to check on how much money the toll collector took and he'd count up the tickets handed out each day and check that against the money he had, and so if he handed out £50 worth of tickets, he'd have £50 in his bag, but this way, he might be handing out £75 of tickets and there's be £50 in the bag and then £25 in his pocket.....it was a father-to-son job, that's how lucrative it was. (Vassallo, Tape RTA-TMI:FH15, 44:02).

> They gathered so much coin in the process – one of them wrapped his coins up in the DMR toll collector's deception stationery and took it along to the Marrickville RSL and in the poker machine hall, he would just take it straight to the cashier and asked for it to be cashed in folding money and it was the presence of this DMR stationery that alerted the RSL to contact the Toll master on the Harbour Bridge and this is how we first twigged to this. (Lardner-Smith, Tape RTA-TMI:FH24, 38:42).

Peter Lardner-Smith has been involved with the introduction of electronic toll systems and the toll tags now common on Sydney's bridges, tunnels and toll roads. They started as a trial in 1992 on the Sydney Harbour Bridge and it was the first electronic tolling tag system for vehicles in Australia:

> A technology arose out of animal tracking technology – it's called Radio Frequency Identification – and these were little tags, and what's probably used in your pet – that you microchip a pet. A company in America did a lot of the pioneering work and they moved into employing this technology on the North Dallas toll plazas in Texas and they came out in 1989 and demonstrated their technology and this was greatly considered because of the benefits that could be achieved. If a vehicle that was passing a toll plaza could be identified, travelling at normal speeds, then you don't need a toll plaza at all – you don't need anyone there to collect money, you don't have to handle the money, and you don't have a lot of bank fees as well, and you don't need a lot of staff and the traffic is improved – there are so many positives about

> electronic tolling. The system that is now on the bridge I wrote specifications for in '98 and we contracted in 1999. It is a technology based on standards prepared in Europe. This industry of new intelligent transport systems had arrived in 1995 and one of the key drivers of that was electronic tolling application, and so a dedicated short-range communication technical standard was prepared. Our system (now) is world class. We were the first country to have an environment where multiple independent operators, government and private, were able to install an inter-operable system sourced from multiple vendors on both tags and roadside systems. Now, what will happen in the future is that the vehicle manufacturers will build the tag into the vehicle itself and it will probably be invisible – it will just be a stripe integrated into the windscreen of the vehicle and whether it's this class of technology or the next generation, that is how it's going to be. (Lardner-Smith, Tape RTA-TMI, FH24, 49:25).
>
> We're trialing Smart Cards for electronic tolling and that's where you'd have a Smart Card with an electronic purse or electronic cash on it and that would be inserted in the tag, so that you wouldn't have to have an account up front – you'd just insert your Smart card, drive through and it'd take the money off your Smart Card and those Smart Cards, we would see would be compatible with public transport Smart Cards, so when Transport brings their system in, we'll push ahead with that initiative. (White, Tape RTA-TMI:FH36, 47:08)
>
> I think you'll see the cashless society start to emerge there - if you haven't got an electronic toll tag, we don't want you. There will then, arising from that be the situation where virtually every vehicle in Sydney will be equipped with electronic toll tags. I think that will bring the whole issue of how we charge people for the use of the road to a real head. (Bliss, Tape RTA-TMI:FH59, 35:20).

With fifty percent of traffic using the Sydney Harbour Bridge and Tunnel in the morning peak now equipped with tags, electronic tolling is here to stay.

The TMC

By the mid-1990s, the STCC (Sydney Traffic Control Centre) in Oxford Street was starting to show its age. Its technology dated from the 1970s, it was in rented premises, and the Olympics were looming. Rather than replacing the existing equipment in the STCC, the RTA decided to look for a suitable site and build a new Transport Management Centre from scratch. Geoff Amos created the vision for the new TMC:

> Geoff Amos was the key, really. At that time, (1995) Traffic Management had only just become a Branch within the RTA and prior to that, there was no concept of Traffic Management as a discipline within the RTA.....Geoff was the first General Manager for that Branch and was a very innovative and entrepreneurial sort of man and he pushed along a lot of his ideas. (Lowe, Tape RTA-TMI:FH37, 34:40).

Geoff Amos appointed Chris Ruwoldt to be the Project Manager for the new TMC.

> Well, it was quite a search to find the site. We put together a number of criteria.... it had to be close to transport, it had to be convenient to get our fibre optic cable for our close-circuit television systems in and it took over six months to find a suitable site. Eventually we came across this greenfields site in Australian Technology Park, which was the redevelopment of the old Eveleigh Maintenance Yards and that site was deemed very suitable. (Ruwoldt, Tape RTA-TMI:FH30, 14:27)

How did the RTA go about designing an entirely new Transport Management Centre?

> It was quite a challenge because nobody here had the real experience in doing this before. We did hire TRANSCOR, who had worked on previous centres, we benchmarked similar centres throughout the world to see how they were managed, we looked at how other government departments in the other states did it and we slowly put together a plan. Because of the short time frame, we weren't able to do it as a standard building project where you do a complete building design and then let it out to contract: we had to design the building as it was being built. (Ruwoldt, Tape RTA-TMI:FH30, 17:06).

When the building was completed, the differences between the old STTC and the new TMC were evident:

> The Sydney Traffic Control Centre was a backroom operation. All they could do was basically record information about incidents, change the traffic signal timing, tell the radio traffic reporters that there was a problem – they didn't have any Field Response Units, they didn't have an Incident Management System and they didn't have good Incident Response Plans, they

Brisbane St Traffic Control Centre, 1976

Transport Management Centre, 2001

> didn't have a very good CCTV system and they didn't have a very good radio and telephone system, so the TMC upgraded all these systems – it broadened out the range of things that the Control Centre does. The old Sydney Traffic Control Centre was just one of the groups that managed Sydney's road network – there were other groups in other branches of the RTA, and what the TMC did was bring all those people together in the one organisational structure and put them all in the one building, so there was a unified management team for the road network. The old Centre didn't have any form of field response either, so if there was an incident, all they could do was phone the Police and say, 'Go and have a look at it' but with the new TMC there actually were Field Response Crews, Traffic Emergency Patrollers and Traffic Commanders, so if there was a major incident, we could send somebody there to help manage it. (Ruwoldt, Tape RTA-TMI:FH30, 21:15).

The role that the Police had in managing traffic also changed:

> Before the TMC, essentially, traffic was managed by the Police. The Sydney Traffic Control Centre existed and the RTA certainly carried out physical traffic management tasks in that we built the infrastructure, we set up the traffic management facilities but we had no personnel actively involved in managing traffic in the field. We relied on the Police as the response agency and we relied upon STCC to convey any general information to the general public. In the main, (traffic management is not their) core business – at the end of the day, they're more concerned with preservation of life and limb, they're more concerned about criminal activity and so forth, so it comes a low priority in their business and was an area that they were actually neglecting. It used to be an area taught at the Goulburn Academy, but over the years, that particular part of the curriculum was dropped. When I first took up my position at the TMC we negotiated with the Police Service for about 12 months, trying to introduce a Memorandum of Understanding, which essentially shared the workload. We had several meetings with no progress at all, an absolute stalemate – the typical response from the Police Service was 'It's not broken, why fix it, you know, things are going fine, we've been doing this for many years now, why do you want to get involved?' Then one day, while I was on leave, fortunately a B-Double beer truck travelling from Brisbane to Sydney overturned on the F3 freeway near Mt White, completely closing southbound lanes. It was at the height of school holidays and we had 20 kilometre queues southbound, we had similar queues northbound and the incident ended up lasting 12 hours. (Lowe, Tape RTA-TMI:FH37, 35:57 & 44:28)

> It was a really hot day – a lot of people got quite distressed because of the heat, a lot of car engines failed, they stalled, people didn't have water, so they were feeling quite stressed and the Police who were in charge of the incident took quite a long time to get the traffic going again. It was quite fortunate for the TMC because a very senior politician in NSW got caught in that traffic jam, and as a result of that, the RTA were able to sign a new Memorandum of Understanding with the Police about the management of incidents and I think since then, management of incidents has been much better. (Ruwoldt, Tape RTA-TMI:FH30, 48:23).

As to the identity of the senior politician:

It was the Premier. (Ruwoldt, Tape RTA-TMI:FH30, 49:13).

The Traffic Commander was a direct result of that incident. Obviously, you can't just sign a piece of paper taking up responsibility for an activity if you don't have a field resource and the Traffic Commanders are that field resource – they are the TMC's representatives in the field, liaise with the Police at an incident scene, they would negotiate the number of lanes and expected duration of an incident and support the Police in stabilising that incident scene. (Lowe, Tape RTA-TMI:FH37, 46:41)

In addition to Traffic Commanders, there are Traffic Emergency Patrols:

(They) patrol the major road networks in Sydney, so a road like the M4 is patrolled 24 hours a day, the F3 is patrolled 16 hours a day – they're the crews that are generally first at the scene of an incident and the most common incident is cars that have run out of fuel, so the patrollers give the people five litres of fuel, so that they can get themselves to the nearest garage and off they go. (Ruwoldt, Tape RTA-TMI:FH30, 44:12).

Peter Lardner-Smith wrote the specifications for the Incident Management System. He explains how the system, based at the TMC, actually works:

The system is primarily designed and constructed on motorways and you're measuring traffic every 500 metres - you have a Traffic Monitoring System to determine the flow, the speed and the occupancy of traffic over 30-second time intervals and then you have Driver Advisory Systems: variable message signs, variable speed limit signs and other simpler devices, if needed, but within the central host computer systems where the Incident Management System lives is an electronic model of the road network and it's divided into links and segments down to the finest points. An incident can be detected in one of two ways: the traffic monitoring units supplying the data could detect the presence of an incident by the sudden drop of speed – the rapid increase of lane occupancy and a reduction in the flow of vehicles past a certain point - an algorithm will work out that this is probably an incident that's happened here and raise an alarm automatically at the central point. Alternatively, someone could just phone in and say 'there's been an accident, or something's happened here'. When the incident is confirmed, then the operator of the Incident Management System will formally declare the incident and pull out of the computer a recommended, pre-prepared canned response.... all the responses will involve diversions around the incident, or making the road safe...... the tactical response will be wider area diversions and the strategic responses will be the broadcast on radio stations of advice about the incident and wider area responses on variable message signs telling approaching traffic that this route is not recommended at all. (Lardner-Smith, Tape RTA-TMI:FH25, 12:01).

We have on the system at the Transport Management Centre a gadget called IRIS. (It) updates, in real time traffic reports to forty-six radio stations and there are four people in the Transport Management Centre whose job it is to keep a running log of the incident and update that in real time, and so in real time, a crash on the Harbour Bridge can be monitored, it'd be updated every 20 minutes, sorted in 15 minutes and that information is disseminated to forty-six radio stations. The traffic reports you get in the morning come off a screen - that screen's got IRIS on it, and that screen in the studio of the radio station is being updated and refreshed in real time from the Transport Management Centre. That was developed for the (Olympic) Games – that used to be static reports. In addition to that, we have on the Web sixteen images from cameras - the Harbour Bridge, the F3 – which are updated every ten seconds and that's been an absolute winner: the hits on our website the last week has just gone through the roof. (Ford, Tape RTA-TMI:FH52, 11:13).

New motorways that are coming on stream are now all required to have all this infrastructure installed and so every new motorway, like the Western Sydney Orbital will automatically connect in to the Incident Management System with no further input or expenditure of RTA resources to do this - the interfaces are there and these systems must come on stream before they're even allowed to open the motorway. (Lardner-Smith, Tape RTA-TMI:FH25, 16:16).

Changing emphasis in Traffic Management

In recent times, the RTA's focus has changed from managing cars and traffic to moving people and goods, with an increased emphasis on public transport. One of the new public transport initiatives is PTIPS:

> PTIPS is the Public Transport Information and Priority System. What it does is effectively, through SCATS and our ANTTS system, track buses through the network, which are tagged, tie those buses into the timetable and identify, at the bus stop when the next bus is scheduled to arrive, and in the bus the estimated time of arrival at the destination. PTIPS – that part of PTIPS – will go directly into our bus priority packages for Route 400 and ultimately, the Transitways in Western Sydney. Certainly, once we get that package up and full running on Route 400, that'll be a world first – that's never been done anywhere. (Ford, Tape RTA-TMI:FH51. 53:27)

The RTA is also introducing the Bus Priority System:

> If you can manage the road system in a way that fewer cars need, at the end of the day, to use the road system, then you've had a win and that's what some of our Bus Priority systems are aimed at in the future. We're of the belief that if you can make life easier for buses – and one way of doing that is to do what you can to keep them running on schedule - and one way of doing that in turn is to give them priority at traffic signals when we know that they're running behind schedule, then that's one way of attracting more people onto buses and fewer cars on the road. (Bliss, Tape RTA-TMI:FH59, 25:44).
>
> Traffic management has changed quite dramatically in the last ten years in Sydney. We've got much stronger emphasis now on Bus Priority, on Incident Management and detection, on network management. It's gone a long way from the day of a set of traffic signals or some signs and lines on the road and the capability we have today certainly proved its worth during the Olympic Games and is continuing to do so. Our incident response times are continuing downward, our management generally of the network is far better than what it was.... so it's working very well. We've put down an extensive network of bus lanes, the red-coloured bus lanes, and we're going now strongly into Transitways. The emphasis on road-based public transport or public transport in its own right of way, independently of rail, is a major change in the way that the network will operate in the future. We're looking very closely at Light Rail operations in the city, and one of the main benefits of Light Rail in the city is in fact the ability to relocate large numbers of blue buses out of the CBD and hence free up the movement for other vehicles, like taxis and service vehicles. Now we're finding increasingly on our major corridors that the congestion caused to buses is actually driven by buses – the buses are causing their own congestion – and that's simply a reflection that the volumes carried in the buses now are exceeding the capacity of that facility to in fact carry that load, and as a result,

Parramatta Road Bus Lane, 1984

New red Bus Lane in Sydney CBD, 2001

the emphasis on Transitways and dedicated bus roads, etc. We will have to maximise in the future, in traffic management the ability of bus and bus systems to carry an increasing amount of the transport task in Sydney if in fact, we are going to be able to manage the forecast levels of traffic in the future. We will definitely get into higher technology in the future, global positioning – we might even have our own satellite, or Sputnik, or whatever you like to call it – we will extend the capability without a doubt State-wide. Freight is the emerging issue: we've got a freight strategy about to hit the deck, some major freight routes in different parts of Sydney – and not in an isolated sense, with inland ports and Port Botany.... I want to integrate electronically that network with the road network. (Ford, Tape RTA-TMI:FH52, 00:28)

Conclusions

Traffic management now encompasses cars, trucks, bicycles, pedestrians, freight and public transport. Studies have shown that investment in traffic management is repaid many times over and its impact on the economy should not be underestimated:

> From a positive point of view, it must be saving billions of dollars in terms of reduction in pollution, the cost savings, the time savings, the ability for freight to move on time – it must be one of the greatest contributors to savings to the State economy and the national economy. (Morgan, Tape RTA-TMI:FH48, 20:49).

> We've now virtually set a standard for traffic management information for monitoring traffic that other people are trying to copy.... There are so many people involved in Transport Management, writing the software, installing the hardware, looking after the intersection design, installing the lanterns and the posts and the detectors, having people who are employed to optimise the system, having technicians who are employed to fix faults, having people who audit what goes on, having a whole team of people involved in the data collection and the analysis - all of that has involved from just a small group of original people....... to go from that small team in New South Wales to something that is now looked upon by most cities who desire a traffic management system: if they didn't look at SCATS, I would be very surprised. (McCallum, Tape RTA-TMI:FH46, 23:12).

> I've always regretted that I moved out of traffic signals...because for twenty years of my life I lived and loved traffic signals............I'm happy within myself that the contribution that I have made laid the foundations for a lot of the things that are happening now ... that people are still using some of the things I introduced – that makes me happy. Like, I can tell you a story: I was in Pisa in Italy and I went into a church, and there's a candelabra with all the candles on it, and there (once) was a little monk who pulled that candelabra back, lit all the candles and let it go, and it sort of oscillated – and from that, this monk developed the theory of simple harmonic motion... now this is back, I don't know how long........ Now from that, all electrical theory - the Fourier Theorem, the frequency of vibration of springs in motor cars, the whole thing – like, you know, you wouldn't have electricity going around without that little monk thinking that. Now, if I've made a tiny little contribution to Traffic Management, like that man made a major contribution, well I'm satisfied, I feel that my life has been worthwhile. (French, Tape RTA-TMI:FH9, 14:22).

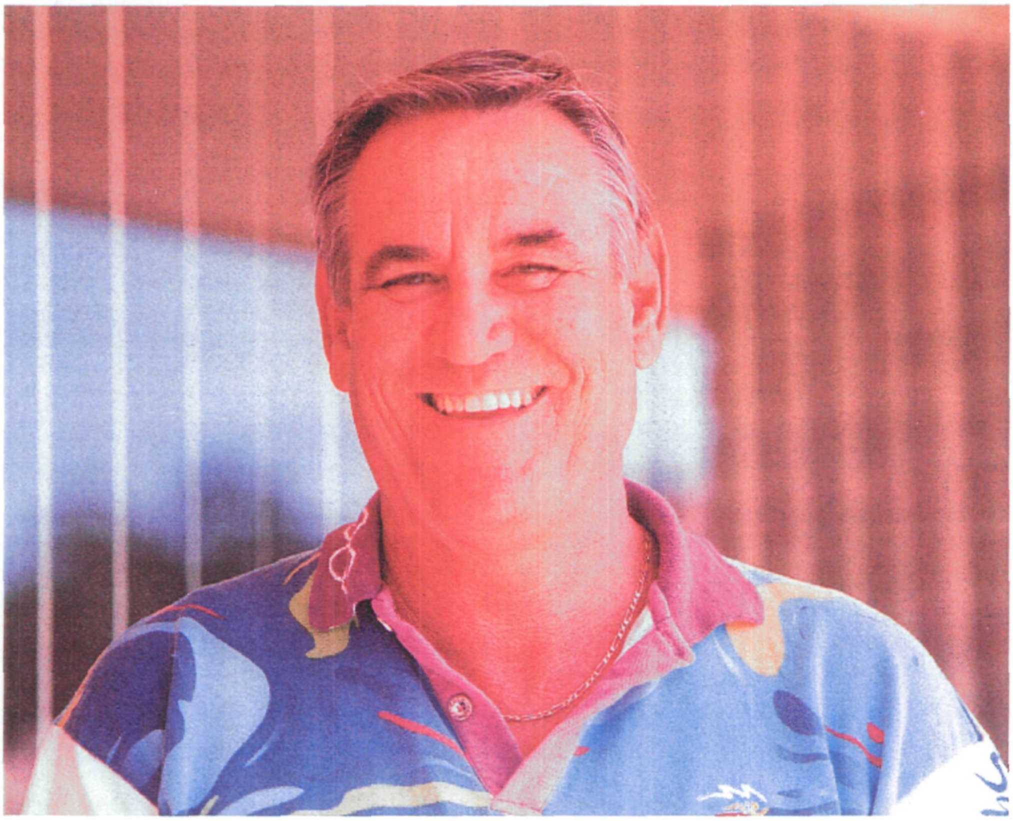
List of Interviewees

Name:	***Tape Nos:***	***Date:***	***Place***	***Duration:***
Arthur Sims	RTA-TMI:FH1-2	18/9/2002	Cremorne NSW	80 mins
Steve Anyon-Smith	RTA-TMI:FH3-4	20/9/2002	Jannali NSW	72 mins
Ken Dobinson	RTA-TMI:FH5-6	24/9/2002	Cremorne NSW	95 mins
Rae French	RTA-TMI:FH7-9	25/9/2002	Roseville NSW	135 mins
Barry Pennell	RTA-TMI:FH10	27/9/2002	Blakehurst NSW	47 mins
Jack Winning	RTA-TMI:FH11	30/9/2002	Chiswick NSW	44 mins
John Daley	RTA-TMI:FH12	1/10/2002	Maroubra NSW	52 mins
John Shattock	RTA-TMI:FH13-14	4/10/2002	Cremorne NSW	108 mins
George Vassallo	RTA-TMI:FH15-16	11/10/2002	Chatswood NSW	95 mins
Frank Hawes	RTA-TMI:FH17	11/10/2002	Cherrybrook NSW	50 mins
John Lymbery	RTA-TMI:FH18	15/10/2002	Connells Point NSW	53 mins
Jim Giffin	RTA-TMI:FH19	17/10/2002	Cremorne NSW	59 mins
Geoff Amos	RTA-TMI:FH20-21	18/10/2002	Caringbah NSW	103 mins
Harry Camkin	RTA-TMI:FH22	18/10/2002	Caringbah NSW	60 mins
Don Hughes	RTA-TMI:FH23	18/10/2002	Kareela NSW	52 mins
Peter Lardner-Smith	RTA-TMI:FH24-25	22/10/2002	Cremorne NSW	85 mins
John McKerrall	RTA-TMI:FH26-27	23/10/2002	Wahroongah NSW	85 mins
Alan Short	RTA-TMI:FH28-29	25/10/2002	Carlingford NSW	87 mins
Chris Ruwoldt	RTA-TMI:FH30	29/10/2002	Cronulla NSW	56 mins
Frank Hulscher	RTA-TMI:FH31-32	29/10/2002	Gymea NSW	81 mins
Peter Lowrie	RTA-TMI:FH33-34	30/10/2002	Avalon NSW	88 mins
Phil Mallon	RTA-TMI:FH35	31/10/2002	Cremorne NSW	60 mins
Brendan White	RTA-TMI:FH36	6/11/2002	Strathfield	55 mins
David Lowe	RTA-TMI:FH37	12/11/2002	Cremorne NSW	60 mins
Rod Tudge	RTA-TMI:FH38-39	14/11/2002	Cremorne NSW	102 mins

John Longfoot	RTA-TMI:FH40	15/11/2002	Chiswick NSW	60 mins
Sasha Dimitric	RTA-TMI:FH41-42	18/11/2002	Beauty Point NSW	116 mins
Doug Quail	RTA-TMI:FH43-44	19/11/2002	Cremorne NSW	114 mins
Ken McCallum	RTA-TMI:FH45-46	19/11/2002	Cremorne NSW	90 mins
Glen Morgan	RTA-TMI:FH47-48	21/11/2002	Cremorne NSW	86 mins
Bob Morris	RTA-TMI:FH49	22/11/2002	Cremorne NSW	47 mins
Grahame Davis	RTA-TMI:FH50	25/11/2002	Cremorne NSW	58 mins
Chris Ford	RTA-TMI:FH51-52	25/11/2002	Surry Hills NSW	75 mins
Murray Fairlie	RTA-TMI:FH53-54	28/11/2002	Cromer NSW	71 mins
Bob Mudford	RTA-TMI:FH55-56	29/11/2002	Eastwood NSW	75 mins
Terry Winning	RTA-TMI:FH57	29/11/2002	Denistone NSW	54 mins
John Bliss	RTA-TMI:FH58-59	17/12/2002	Cremorne NSW	101 mins

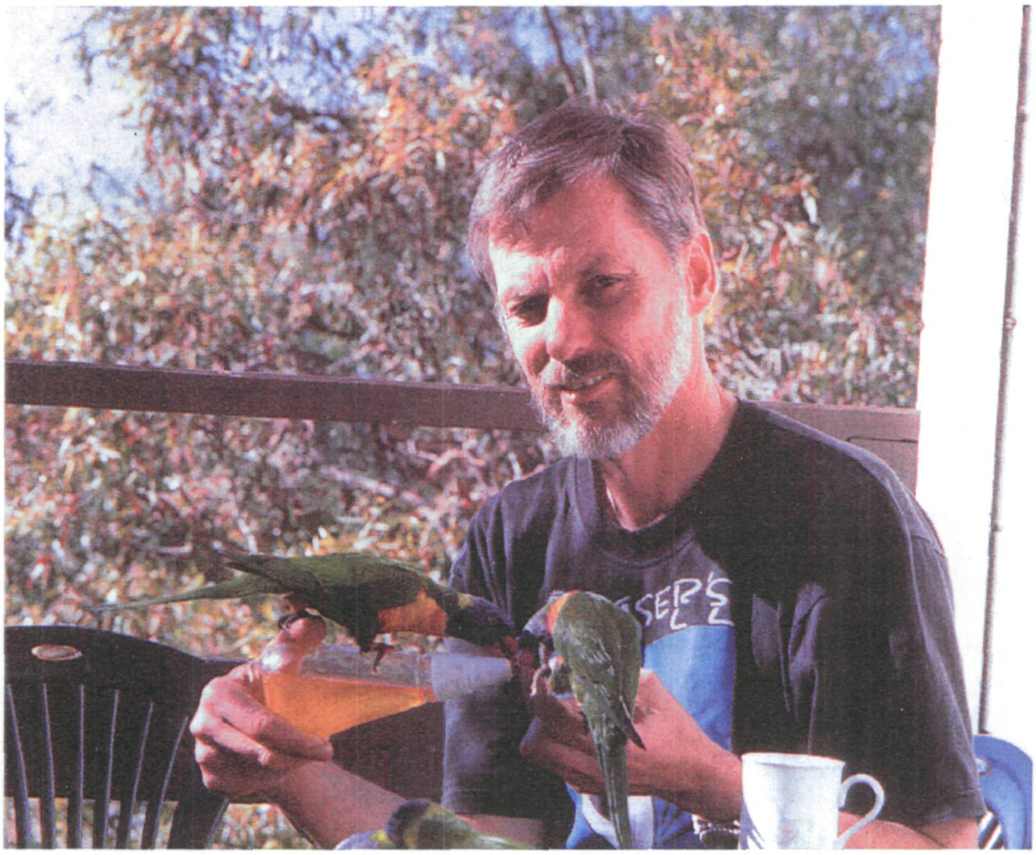
Interviewees' Biographies

Geoff Amos



Geoff Amos started at the DMR as a junior traffic survey draftsman in 1964 He designed signs, worked on the Advisory Speed Sign Determination Project, was involved in the introduction of Clearways and Transit lanes and created the vision for the new Traffic Management Centre. He also played in major role in ORTA, the Olympic Road and Transport Authority during the Sydney Olympics.

Steve Anyon-Smith

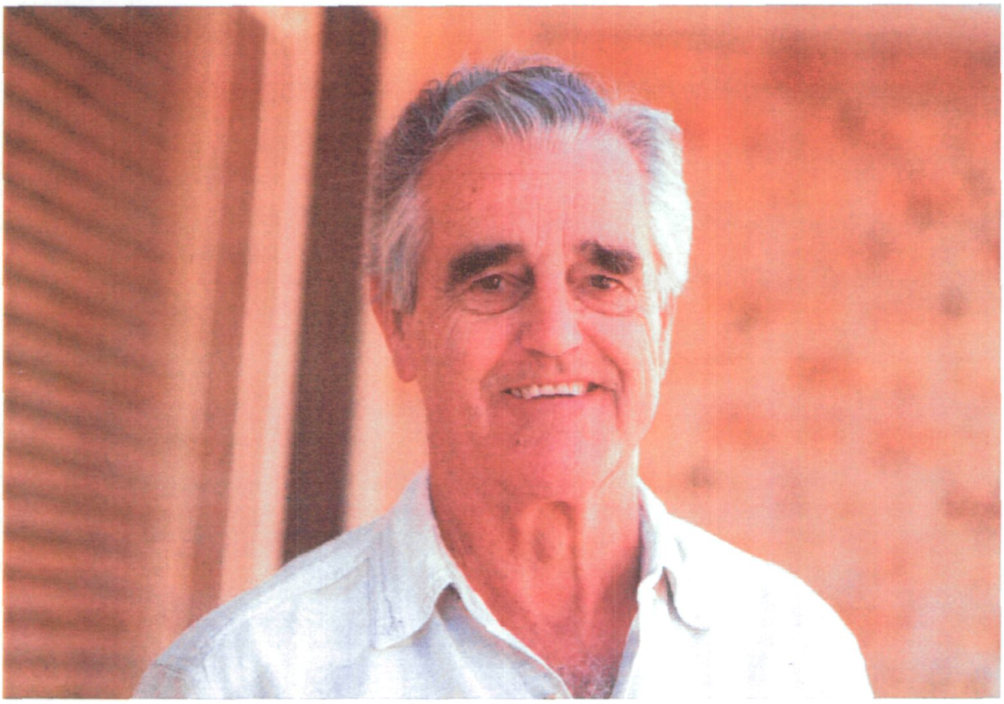


Steve Anyon-Smith has a long experience in signposting, traffic volume data collection and general traffic management issues. He is currently Leader, Guidance Strategy in the RTA Traffic and Transport Directorate. He also has a keen interest in wildlife and has written a book on bird watching in the Royal National Park.

John Bliss

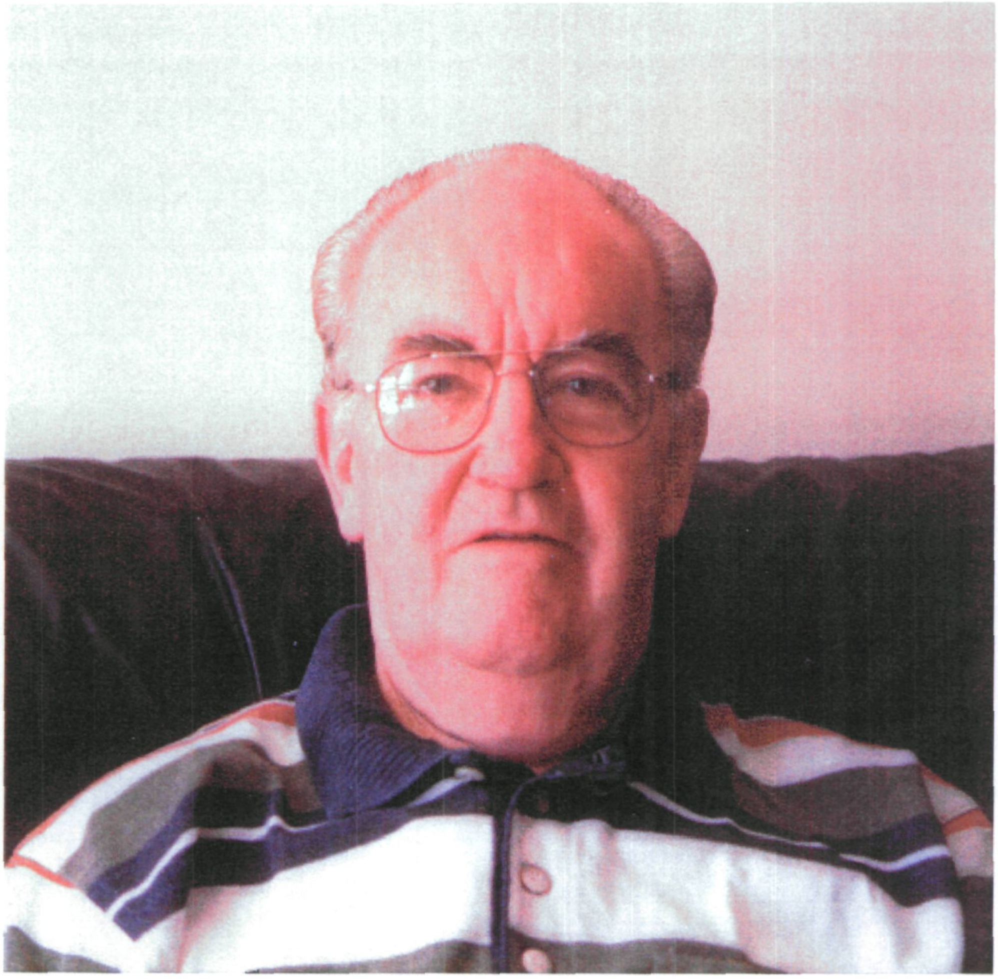
John Bliss has a Masters degree in Highway Engineering from the University of New South Wales. He began his career with the DMR's Bulahdelah Works Office and has risen to hold a range of senior traffic engineering positions in the DMR and RTA. He is currently General Manager, Traffic Systems Branch and has been closely associated with the development of SCATS.

Harry Camkin



Starting as an Assistant Traffic Engineer with the Department of Motor Transport, Harry Camkin played key roles in transport planning, traffic management and road safety. He was Assistant Chief Engineer at the DMT and as the first Director of the Traffic Authority formulated policy and managed research projects. He was then instrumental in setting up and heading the Road Safety Bureau.

John Daley

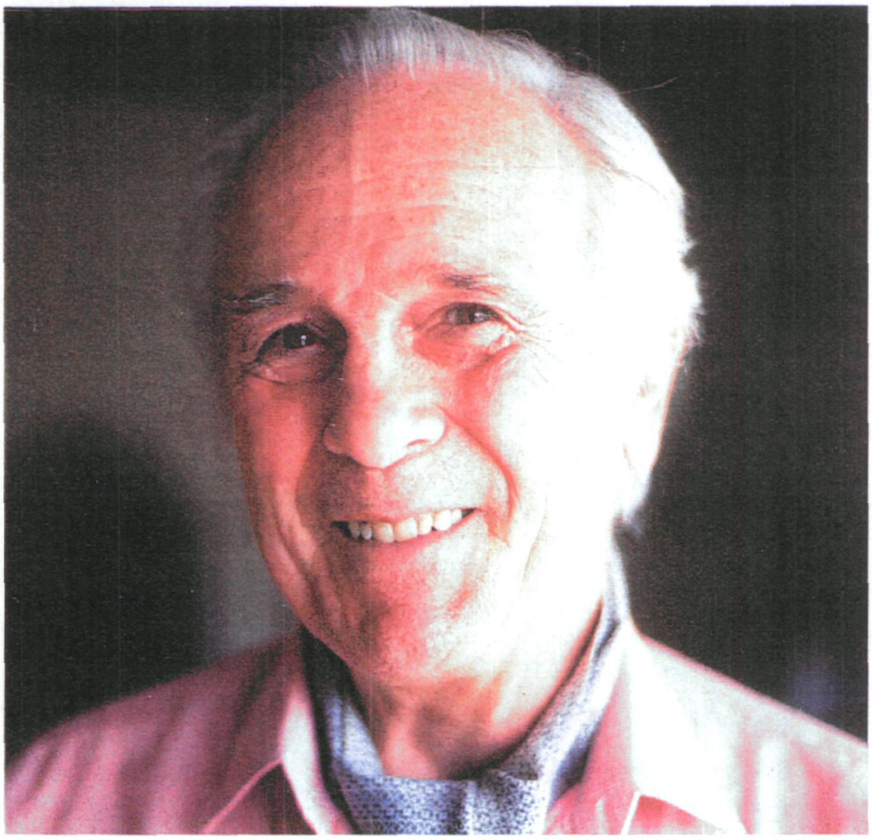


John Daley started with the DMR in 1958. His expertise was in signposting policy, traffic counting, design of road signs, advisory speed signs, field surveys, aerial photography, mileposts and markers.

Grahame Davis

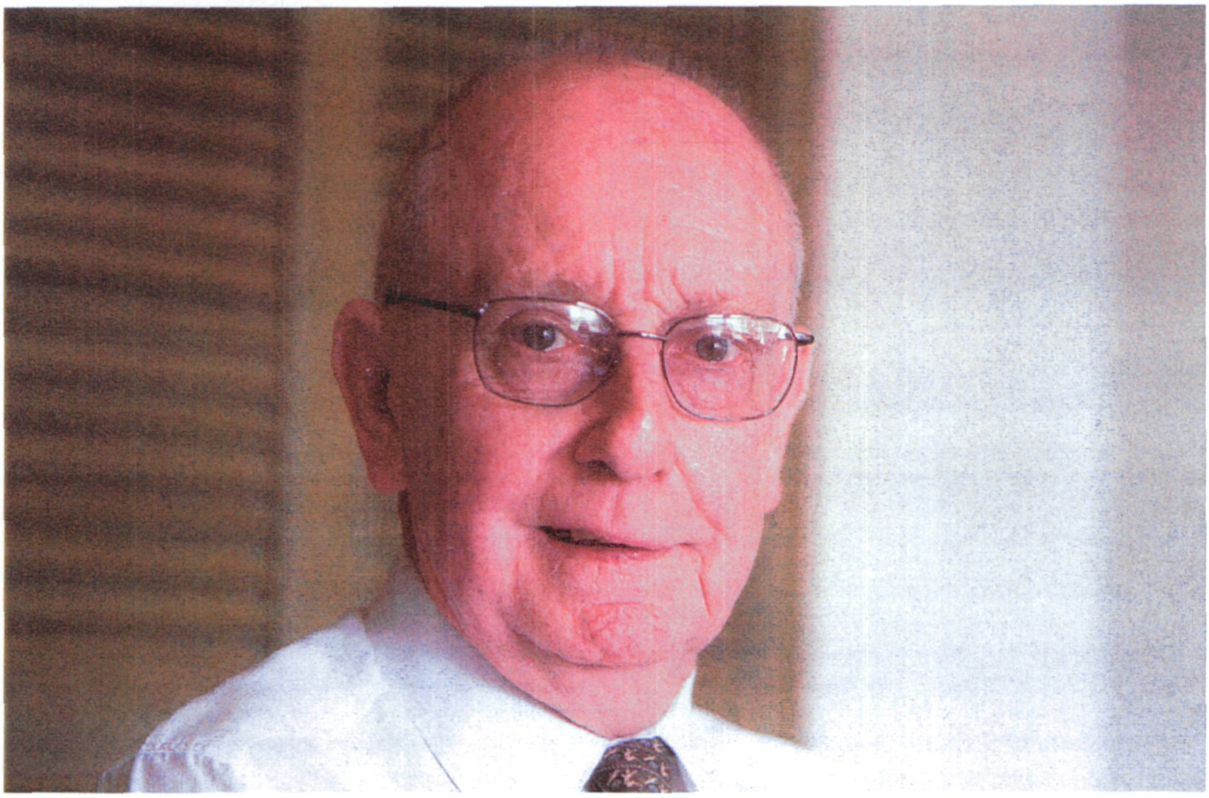
Arriving from Rockhampton, ostensibly to study for six months at the Marconi School of Wireless in Sydney in 1962, Grahame Davis 'stayed forever'. He began as an electrical fitter at the DMT's Burwood Depot in 1962. Davis designed prototypes for many traffic management devices, programmed the first computers used for traffic management and worked closely with Arthur Sims to develop SCATS into a world-class traffic management system.

Sasha Dimitric



Sasha Dimitric arrived to the DMR from Yugoslavia in 1964. He worked on detailed analysis of hourly traffic volumes and prepared travel time contour maps of Sydney. He is an expert in all matters relating to signage, tidal flow and road marking and introduced Sydney's first 'red light' camera. He supervised the Guide Sign System design, developed a project design of enhanced street name signs at traffic signals on major intersections, analysed and achieved parking for the Sydney Entertainment Centre and formulated policy and operational control at Local Area Traffic Management level. Sasha has contributed greatly to the development of standards in Traffic Management and is the founder of Handball in Australia, an Olympic sport.

Ken Dobinson



Ken Dobinson joined the DMR's Bridge Section in 1950 after completing an Engineering degree at Sydney University. He started at the Bridge Section of the DMR but was soon constructing roads. He was involved in the construction of the F3, the first freeway in Australia and, with his wife, wrote the first specifications for freeway landscaping in Australia. He has held a number of senior positions in the DMR and RTA, becoming Head of the Traffic Section and Divisional Engineer and was a prime mover in helping to encourage and finance the development of SCATS. He set policy guidelines and is credited with having raised the profile of Traffic Engineering in Australia. He is currently Director of the Warren Research Centre, a transport issues think-tank and is now working on the biggest project of his career: *Sustainable Transport in Sustainable Cities.*

Murray Fairlie

Starting at the DMR in 1939 as a junior road design draftsman, Murray Fairlie spent four years in Royal Australian Engineers building jetties, camps and hospitals in the Pacific during the Second World War. He then rose to become Traffic Service Engineer and Head of the DMR's Traffic Survey Section. He wrote a textbook for NAASRA on geometric design of rural roads, helped to set up the first course at UNSW in Traffic Engineering and was influential in setting much-needed standards for Traffic Management

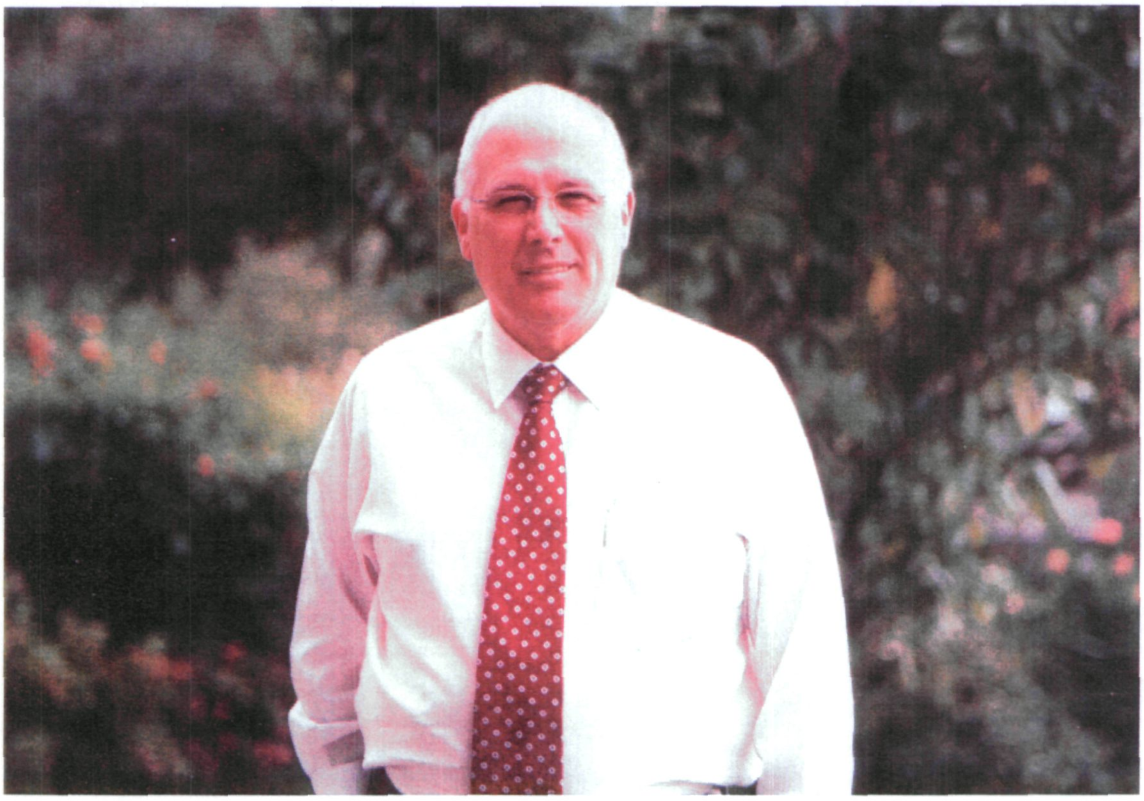
Chris Ford

Presently Director, RTA Traffic and Transport, Chris Ford has had a long and distinguished career with the DMT, DMR and RTA. He has long experience in Traffic Management. He was involved in the creation of Priority Roads, Bus Transitways, PTIPS and PARAMICS and is well placed to see the big picture of Traffic and Transport Management. One of his career highlights was his involvement in the the rebuilding of Darwin after Cyclone Tracey. He is currently overseeing the development of SCATS-7.

Rae French

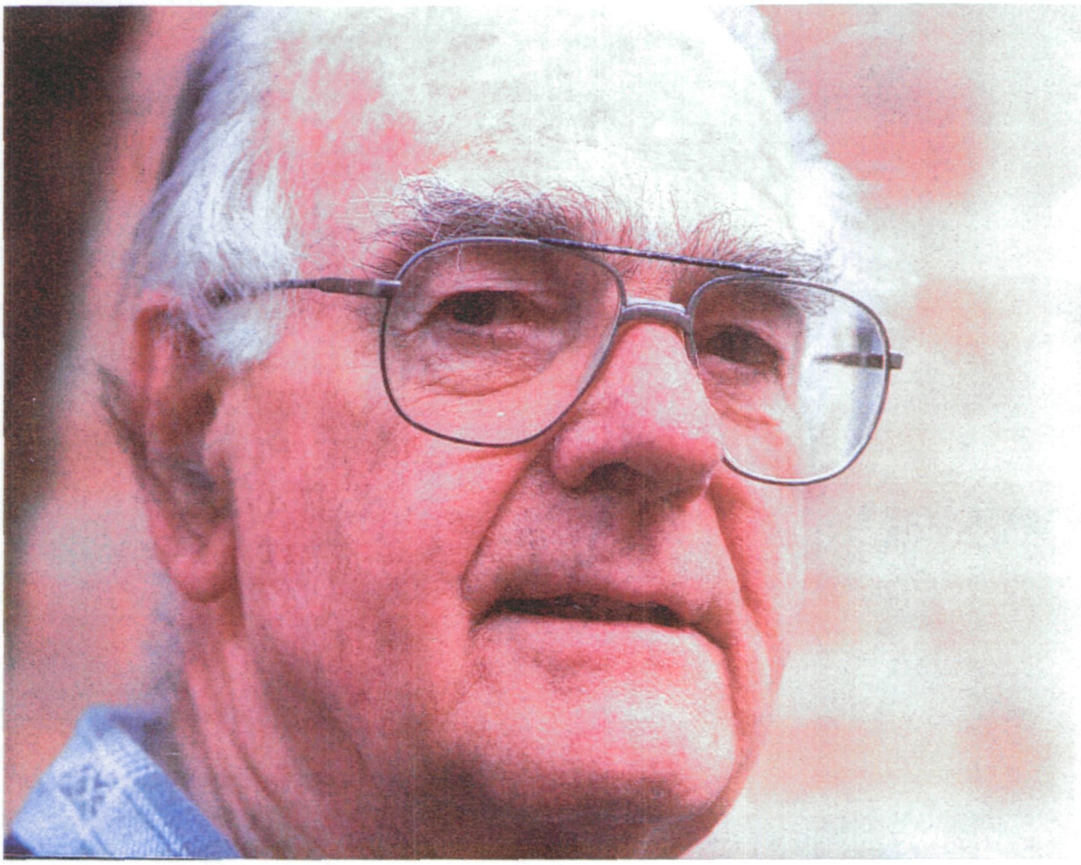
Rae French, as Chief Engineer of the Department of Motor Transport's Traffic Signals Group, presided over all of the advances made in traffic lights, controllers and detectors from the early 1950s to the late 1960s. He developed a keen interest in the application of equipment to traffic control. He has devoted his life to improving traffic signal technology and is credited with introducing cutting-edge technology to bring about traffic signal coordination.

Jim Giffin



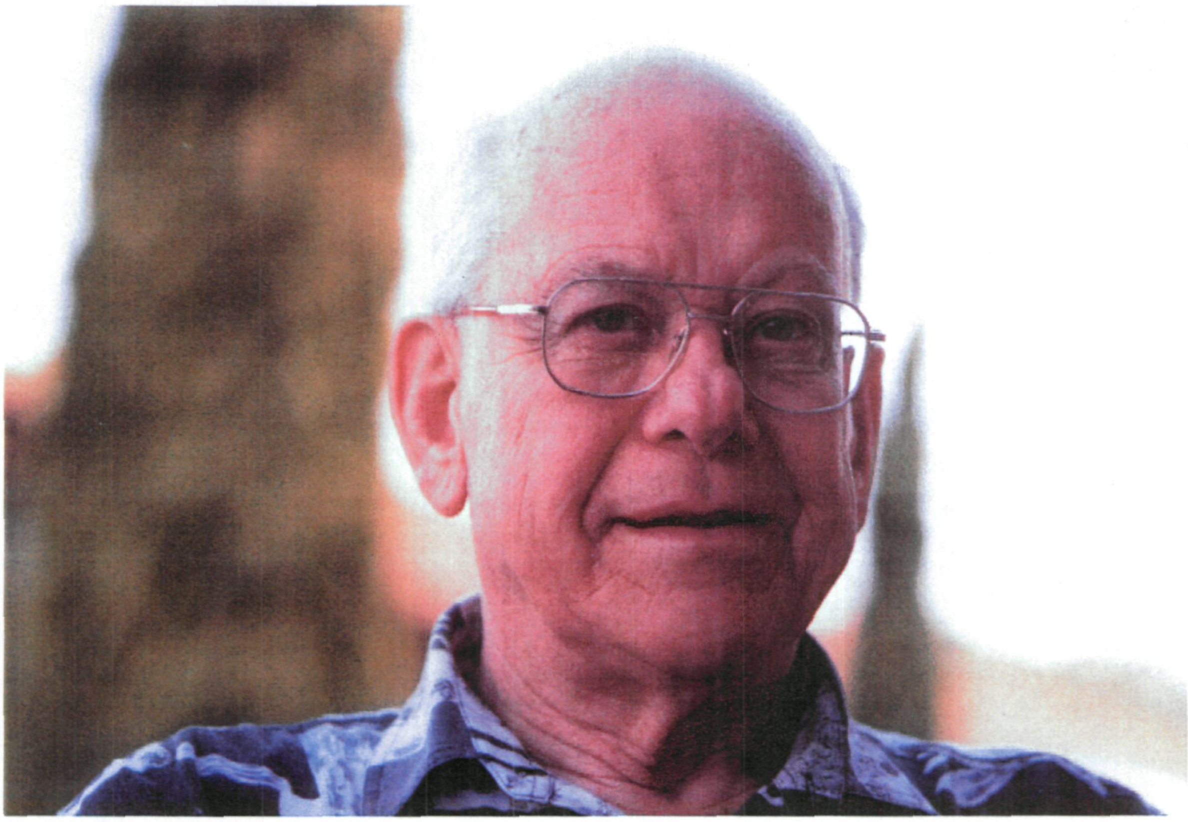
Jim Giffin started his apprenticeship with the NSW Railways as a signal electrician. He moved to the DMT's Burwood Traffic Signals Group, repairing and maintaining traffic signal equipment. During his time with the DMR and RTA he trained specialist technicians in the Traffic Technology Branch. He is presently Manager, Client Liaison and is involved in coordinating activities of the Traffic Systems Branch and in marketing SCATS to traffic authorities worldwide.

Frank Hawes



Starting at the DMT as Electrical Engineer in Traffic Signals, Frank Hawes became Traffic Engineer at the DMR after the merger with the DMT. His area of expertise is in traffic and pedestrian signals installation and maintenance. He became District Engineer in the late 1960s and Supervising District Engineer in the 1970s. His duties involved planning, training and dealing with political representations.

Don Hughes



Starting as an apprentice electrical fitter with the Department of Road Transport & Tramways, Don Hughes became a Traffic Signals Draftsman at the DMT in the early 1950s. There were only 71 signals in operation when Hughes joined. He drew plans, measured sites, became involved in designing traffic signals for school crossings and became Rae French's trusted assistant. Don has spent 36 years as Draftsman and Senior Draftsman.

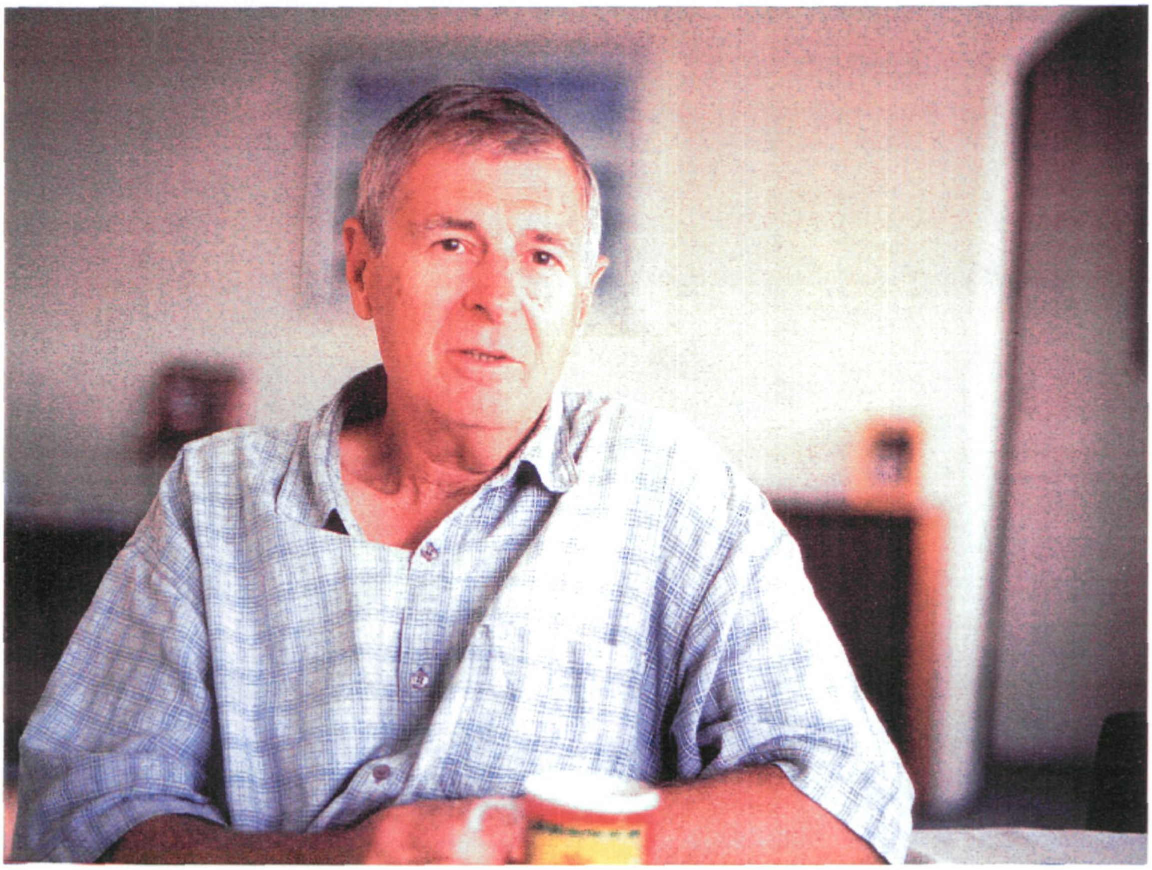
Frank Hulscher

Born in the Netherlands East Indies, Frank Hulscher spent his early years in a concentration camp under the Japanese occupation of Java. He survived a bout of diphtheria, returned to Holland in 1947 to complete his High School and migrated to Australia in the late 1940s. He became an expert in all aspects of traffic signal equipment design and maintenance at the DMT and significantly improved the performance of lenses, lamps, posts, controllers for vehicular traffic and pedestrian crossings and detectors. He wrote a book, *A Signal Career* about his experiences in traffic signals and was awarded the Public Service Medal in 1990. He retired in 1996.

Peter Lardner-Smith

After completing his Bachelor of Electrical Engineering degree in 1967, Peter Lardner-Smith began his career with the DMR in 1974. He developed many electronic solutions to traffic management problems, particularly in the area of electronically-controlled line marking equipment, radio links for SCATS helicopter applications and development of electronic tolling systems software. He was also responsible within the RTA for preparing standards and was Chairman of the Australian Standards Committee from 1995 to 2002.

John Longfoot

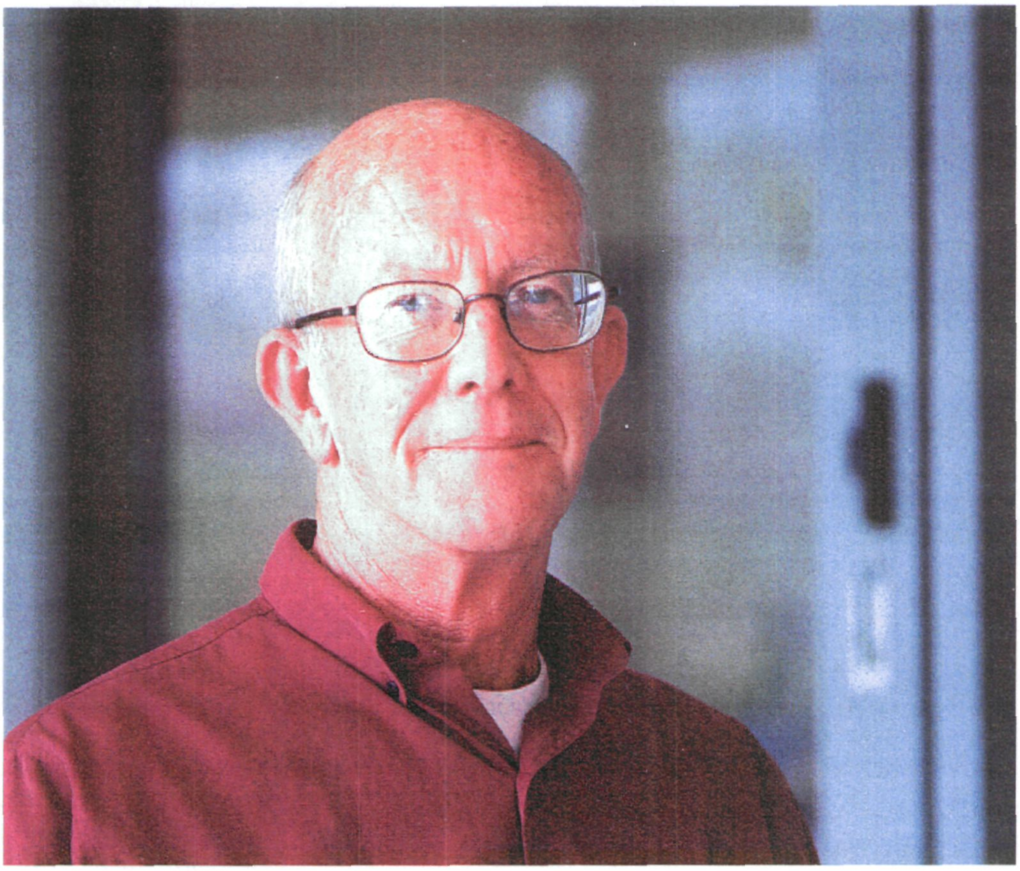


With Bachelor and Masters degrees in Electrical Engineering, John Longfoot first worked with the PMG's Department, installing microwave radio links for telephony and regional television. He then joined Miniwatt, a Division of Philips Industries. When it closed he moved to AWA, where he became a Design Engineer in 1967. At AWA he designed and developed traffic controllers and loop detectors. He moved to the DMR as Design Engineer, subsequently becoming Manager of the Sydney Traffic Control Centre in Oxford Street. In the 1980s, he trained technicians in China and the US during the first installations of SCATS systems in Shanghai and Detroit. He developed the ANTTS system of transponders in vehicles, which can determine travel time and location information and was used in Airport buses. John has added a high degree of professionalism to traffic management.

David Lowe

David Lowe has a Master's degree in Traffic Engineering from the UK and a keen interest in Traffic. He started his career in Traffic management in Manchester on fixed-time systems. He had heard of SCATS and was keen to migrate to Australia. He was offered a position by John Longfoot to start at the Sydney Traffic Control Centre in 1990 and moved to Head Office as Leader, Network Technology. David took an active role in the building of the new TMC and is presently Manager, Transport Operations in the RTA's Transport Management Centre in Redfern.

Peter Lowrie



As a boy, Peter Lowrie always loved electronics. He joined the DMT in 1961 and worked with Frank Hulscher and Grahame Davis in a tightly-knit group dedicated to extending the functionality of traffic signal equipment. He became District Engineer, Eastern District (Sydney), was involved in the planning and construction of the Sydney Traffic Control Centre and worked with the first solid-state master control equipment. He was also a key person on the team that developed and implemented SCATS. He carried out training and technical assistance to set up SCATS in Shanghai, Hong Kong, USA, Indonesia and the Philippines. He has written a history paper on SCATS and is presently engaged on the development of SCATS-7, the next generation.

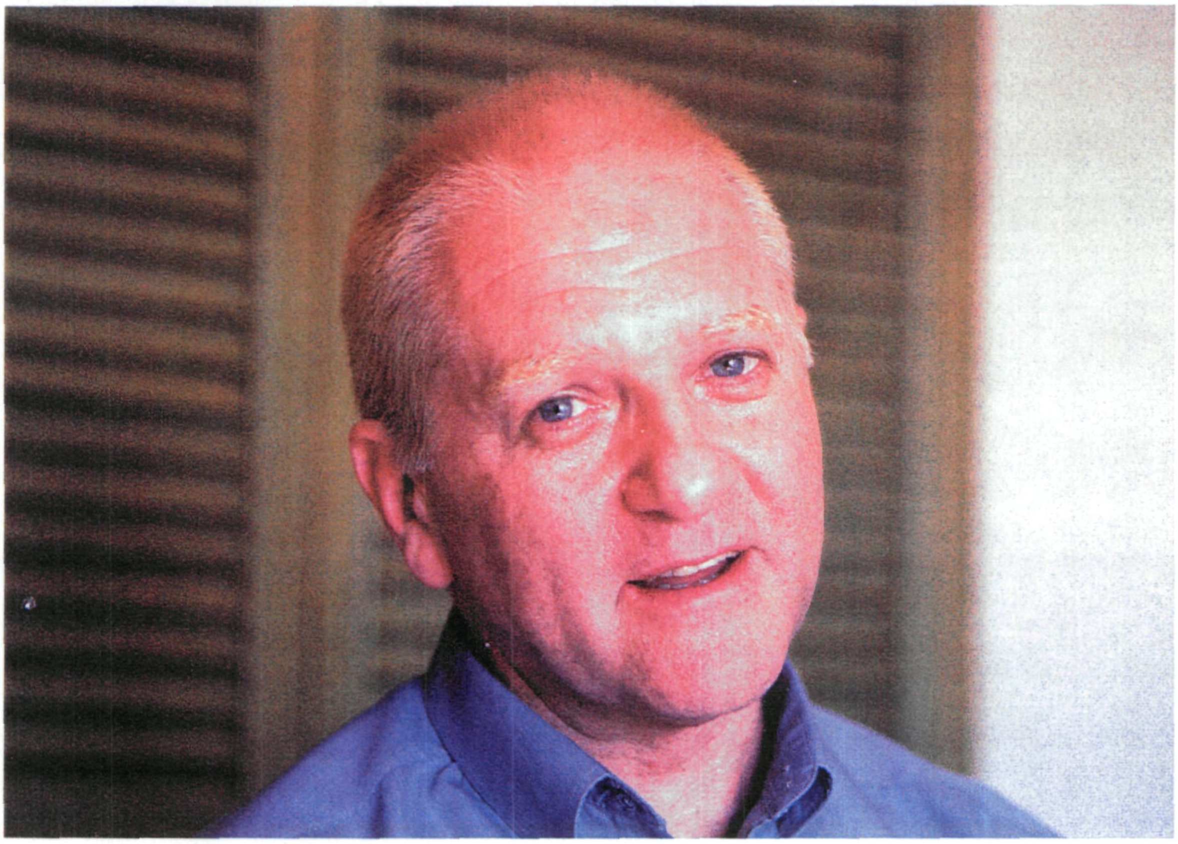
John Lymbery

John Lymbery was one of the great improvisers at the DMR. At first working in the DMR's Urban Planning Section, he would simply make up his own equipment if none were available. He improved the design of automatic counters and introduced them on main roads, replacing manual counting. Joining the Traffic Section in the early 1960s he became the Senior Draftsman, working on projects such as the Advisory Speed Sign Determination and heading the team designing new signs. Together with John McKerral, he introduced the SIGNS computerised traffic sign design program - the first in Australia. He presided over the introduction of metrification in 1974 when all signs in the State were changed and took thousands of photographs from the DMR's first Bell helicopter. John's other passion is his love of Lancia cars.

Phil Mallon

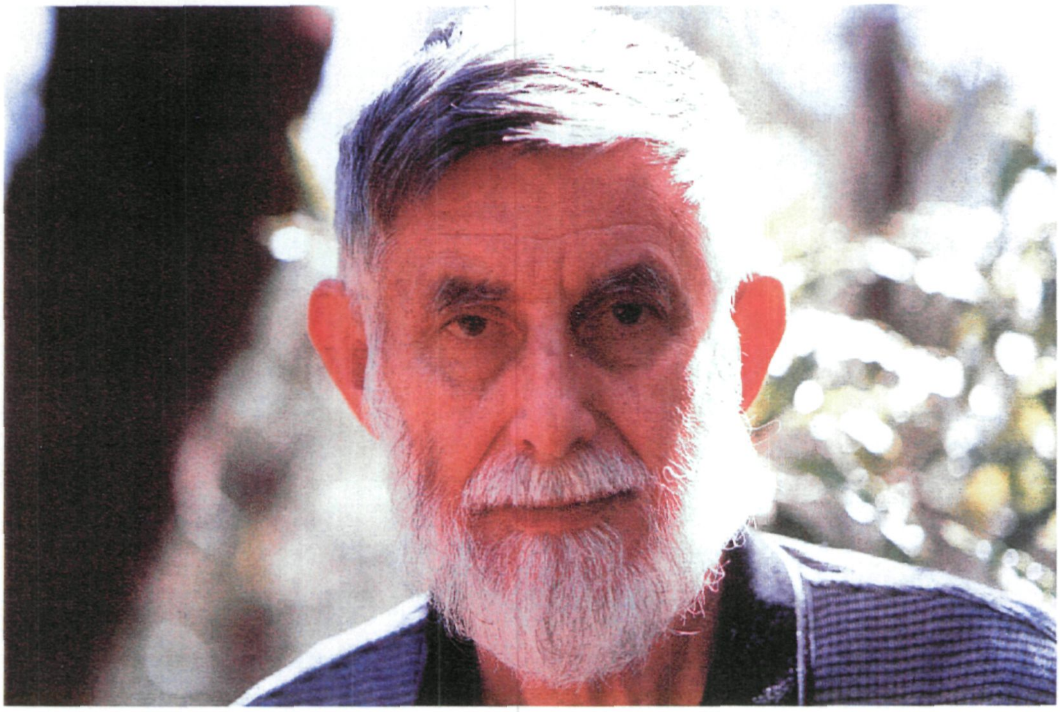
A staff member at the RTA's Intelligent Transport Systems Projects Section, Phil Mallon joined the DMR in 1981. He designed roadside equipment, management and accounting software and automatic toll machines, thereby improving the toll collection system on the Sydney Harbour Bridge. He also designed the Accelerated Loading Facility, a machine that tests the effectiveness of constructing motorways with various materials. He project-managed the video camera contract for the new Transport Management Centre and the Driver Aid Scheme for the F3, a system of variable message signs. He is currently involved in the Transitways Rapid Bus System for Western Sydney and is refining the Incident Management Program for the TMC.

Ken McCallum



Ken McCallum started with the DMR as a Traffic Engineering Assistant on traffic counting, number plate surveys, signposting, advisory speed sign determination and aerial photography. He soon developed a fascination for computer technology. He helped to develop the early versions of SCATS and produced the first manuals for SCATS. He was also involved in SCATS installations in Shanghai and developed, with Grahame Davis the ability for SCATS to run on a PC, in the process producing SCATS-6, now in common use around the world. He is currently involved in ongoing development of software in the RTA's Traffic Systems Branch.

John McKerral



Starting at the DMR's Traffic Service Section in 1957, John McKerral was involved in many research projects, including the Average Car Study, placement studies, traffic counting and line marking. He sat on Standards Committees, produced guidelines for the design of roundabouts, designed street lighting, wrote the design outline for the SIGNS computer program and as Assistant Divisional Engineer, supervised the implementation and construction of S-Lanes. He originated Traffic Committees and became Chief Engineer, Traffic and Design within the DMR. With the formation of the RTA in 1989, he became Director, Technical Services. He has authored a number of authoritative texts on traffic management issues and was awarded the Public Service Medal.

Glen Morgan

Glen Morgan joined the DMR's Goulburn Regional Office in 1965 as a Road Design Officer. After a stint in the Urban Investigation Section he transferred to the Traffic Section in 1972 where he worked for 12 years on the design of interchanges, intersections, traffic networks modelling and examined the designs sent in from regional offices. He also worked on the *Road Design Guide*, a book setting national standards for AUSTROADS. Since 1989 he has designed and delivered training courses for Traffic Engineering officers in the art and science of Transport Management. He has had a high-level operational role in ORTA leading up to and during the Olympics.

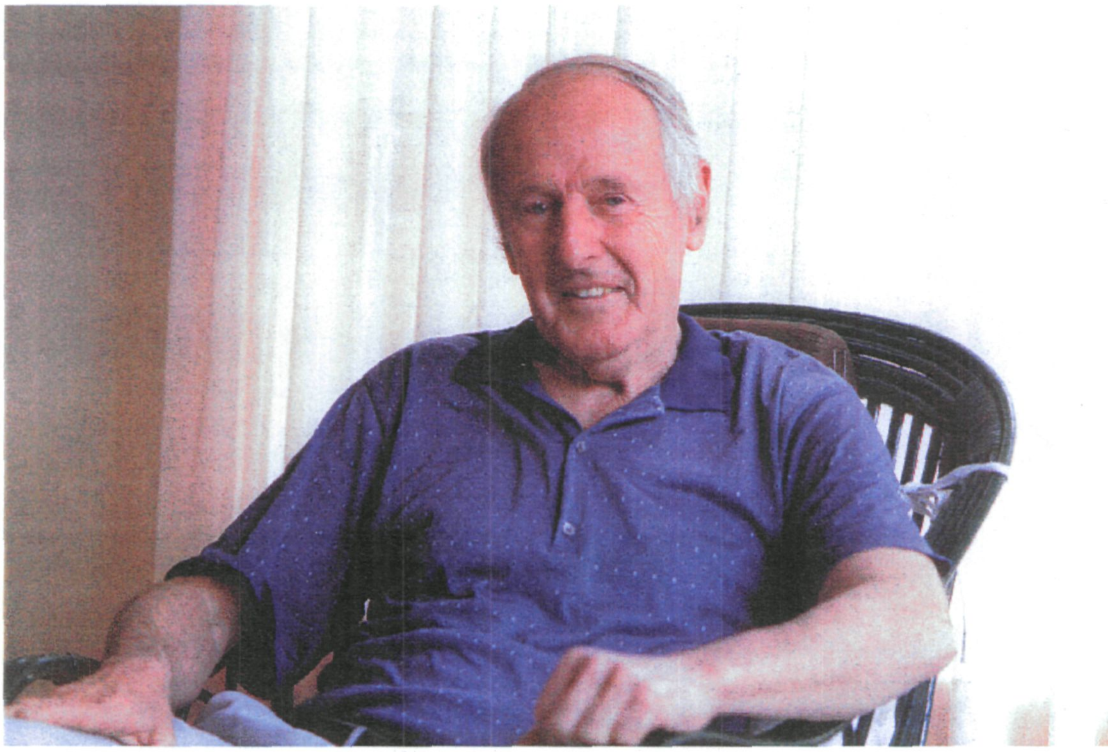
Bob Morris

Bob Morris graduated with a degree in Civil Engineering and joined the DMR in 1968. He helped design the fog warning system for the F6 Freeway, out of which emerged the concept of automating the Sydney Harbour Bridge tidal flow management. Morris took over the DMR's Milsons Point Office in 1974 and the North Metropolitan Office in 1976. He left the DMR in 1978 to take up a senior position at the Public Transport Commission, running Sydney's buses and put in the Airport Bus and City Explorer. In 1985, he returned to the DMR as Strategic Planner and helped to initiate the 'Roads 2000' plan for Sydney's road network. When the DMR merged into the RTA, he wrote the strategic plan that articulated the core philosophy of the RTA: *Road Building, Traffic and Safety.* He cut the regions to five and took over the Sydney region. In 1994, he left RTA to join the private sector. He regards it as a privilege to have worked at the DMR and RTA.

Bob Mudford

Bob Mudford has wide experience in traffic management, particularly in intersection and roundabout design. He joined the DMR as a Junior Draftsman in 1960 and the Traffic Section in 1986. He helped to design the widening of the Hume Highway from Liverpool to Crossroads from a 2-lane to a 6-lane divided road. He then secured a senior position in Head Office with the Urban Investigation Section. In 1985, he returned to the Traffic Section as Senior Draftsman and later wrote *Roundabouts - Geometric Design Method,* a manual for designing and constructing roundabouts. He has also played a major role on Standards Australia and AUSTROADS committees.

Barry Pennell



Barry Pennell has spent his whole working life - 42 years - with the DMR and RTA. He joined the DMR aged 16 in 1948 as Junior Engineering Draftsman in the Petersham Office, then known as the Outer Metropolitan Office. There he learnt how to design roads and intersections. From 1951 to 1959 he was at the Milsons Point Office where he became an expert on urban road and complex intersection design. He joined the Traffic Service Section in 1959 and ended his career by examining road designs and carrying out State-wide design audits, ensuring that design standards were being applied.

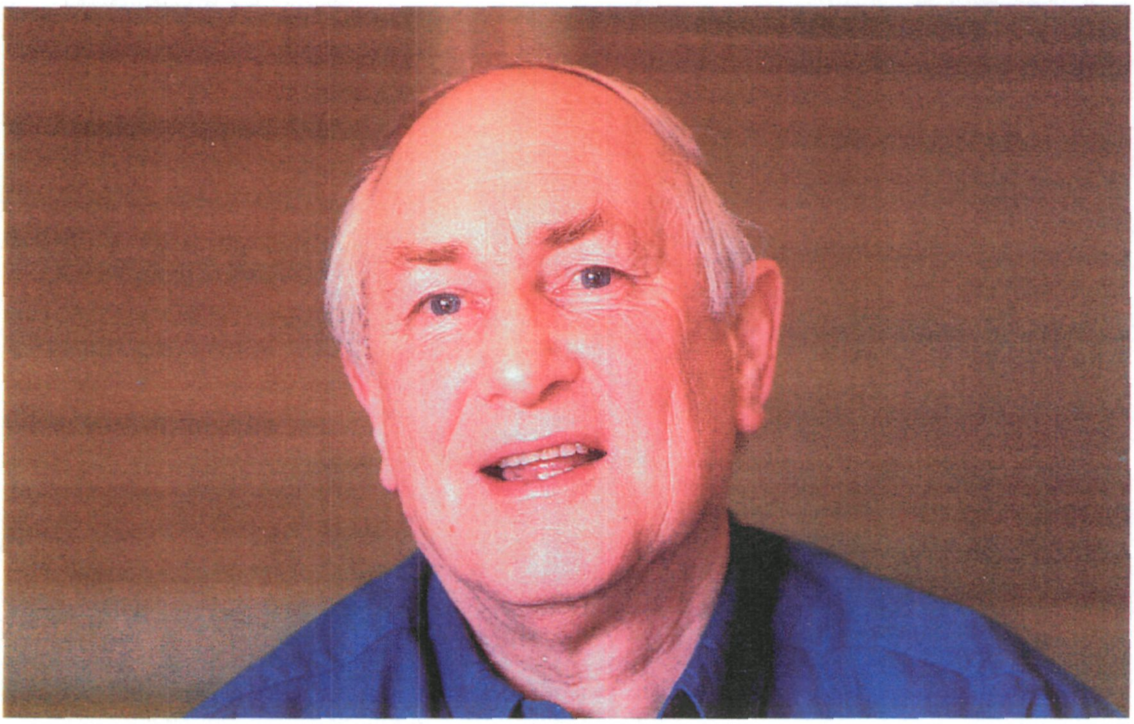
Doug Quail

After completing his HSC Doug Quail was offered a traineeship by the DMT to study Electrical Engineering at Sydney University. He worked closely with Frank Hulscher and wrote a report on lamps which Hulscher used to set his criteria for lamp specifications. He then perfected an illuminated sign warning system for the Glebe Island and Pyrmont bridges where telephone lines, rather than cables were used for the first time and an automated sign changing system for Tom Uglys and Ryde bridges. In 1974, he helped Philips to develop software for the PSF, the first microprocessor controller for traffic signals. He was also involved in designing the SCATS software for use from a helicopter, wrote software for the D-Counter used in traffic surveys and developed he TRAFFICORDER in which a laptop computer automated the traffic counting process. He became Network Efficiency Strategy Manager at RTA and is currently Manager, Traffic Systems Integration. His responsibilities include ensuring that SCATS-7, when delivered, will meet the RTA's specifications.

Chris Ruwoldt

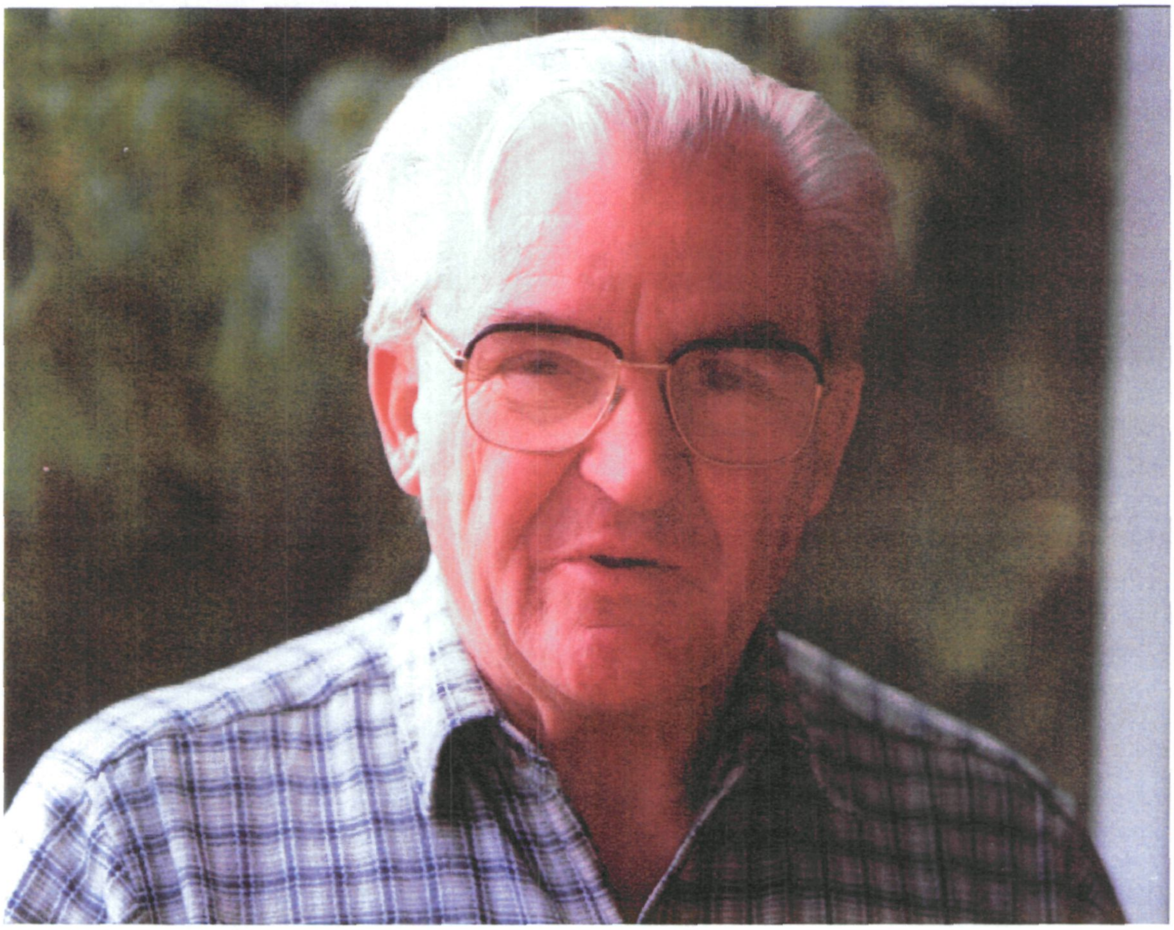
Chris Ruwoldt won a cadetship in Mechanical Engineering with the DMR in 1972 and worked at the DMR's Central Workshop at Granville while completing his studies. After ten years with the DMR he joined TNT Equipment as Fleet Manager, rejoined the DMR in 1986 and in 1990, became the RTA's Fleet Operations Manager. He started at the Traffic Technology Section in 1995, put in a Quality Management System and in 1996 was appointed as Project Manager for the proposed new Transport Management Centre at Redfern. This involved constructing a totally new building, staffing it and developing all the systems in it. The new TMC, claimed to be the best in the world, has integrated all of RTA's traffic management functions under the one roof and has changed the RTA's vision for Traffic Management. Chris now works in the Transport Operations Planning Section at the TMC and is responsible for the development of systems for special event planning and incident response.

John Shattock



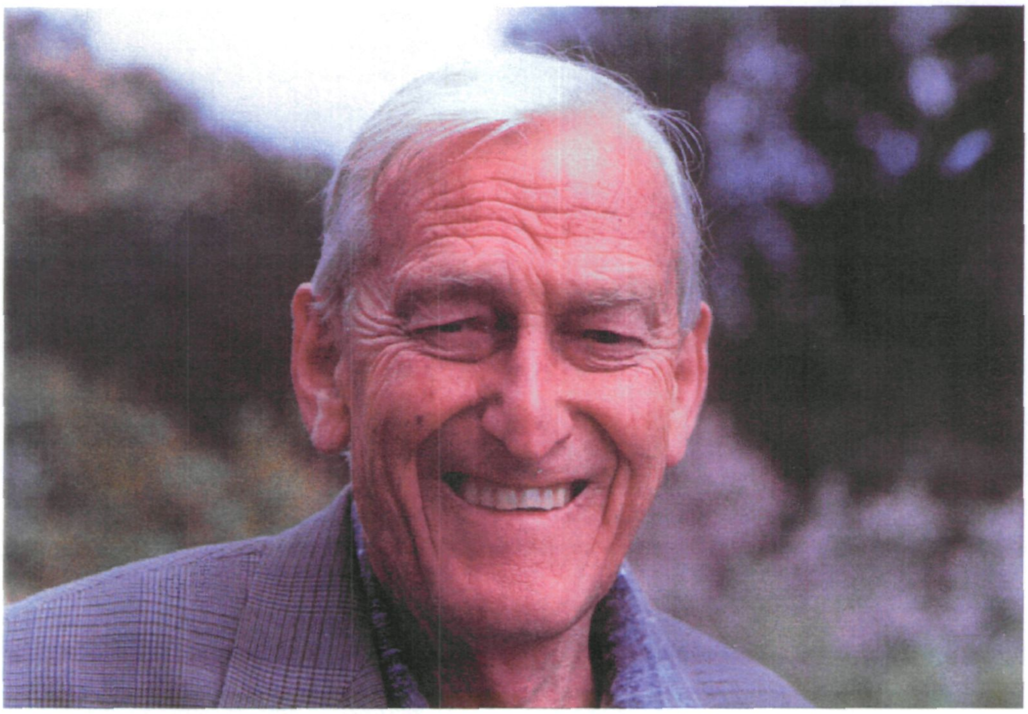
After finishing his BE in Civil Engineering at the University of Sydney in 1958, John Shattock was employed by the Bridge Section of the DMR and worked on the Sydney Harbour Bridge tram tracks conversion to match the Cahill Expressway. He then completed his Master of Engineering Science at UNSW in Highway Engineering and became Resident Engineer at the DMR's Rosebery office and later, Supervising Engineer at Traffic Head Office. In 1981 he became the DMR's Senior Traffic Engineer and in 1983, Chief Assistant Traffic Engineer. John started the MITERS (Minor Improvement Traffic Engineering & Road Safety) Scheme and has presided over many of the changes and decisions that were made in Traffic Management during the 1980s and 1990s. He retired from the RTA in 1994.

Alan Short



Alan Short started his career as Trainee Engineer at AWA in 1946. There he learnt how to manufacture components for radios, television, traffic signals and telephone systems. By the time he joined the DMT as District Engineer (South-East Metropolitan) in 1969, his knowledge of all facets of electronics in traffic signals was already extensive. He was responsible for traffic signals maintenance and reconstruction, traffic surveys for signal design and liaised with the police, the DMR, Councils, MPs and the public on traffic operational matters. In 1976, he transferred to the DMR as District Engineer (Traffic) North and was responsible for the design of new signals. Alan became Traffic Signals Engineer, Yennora Works Centre at the RTA and was a Fellow and Member of the National Executive of the Australian Institute of Traffic Planning and Management.

Arthur Sims

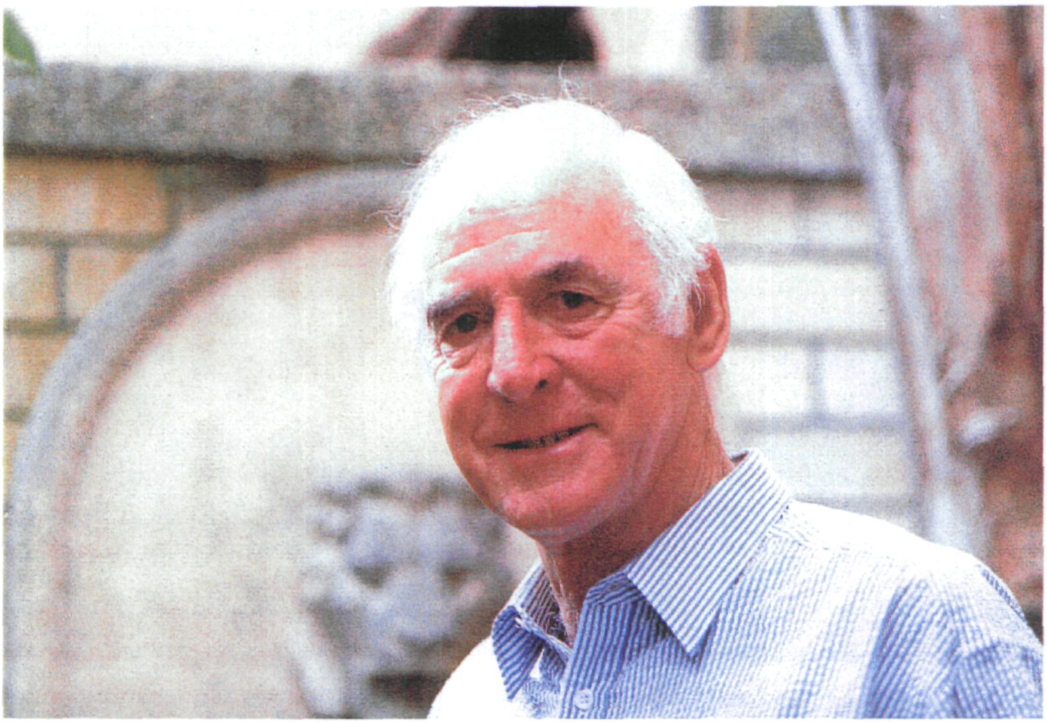


Generally acknowledged as the 'Father' of SCATS, Arthur Sims always had a flair for invention. He joined IBM as Customer Engineer and made the world's first digital LED clock that displayed the time and temperature. He produced the first master control system for traffic management in 1962 in the days before commercially-available computers, adapting cumbersome IBM accounting machines for the task. He then built prototypes that controlled sets of traffic lights for the Sydney CBD and turned fixed-time systems into adaptive systems that responded to traffic density. When IBM folded its traffic signals division in 1965, Sims joined the DMT where he first worked with Grahame Davis. Together, they developed SCATS into a world-class traffic management system. In the 1980s, Sims helped to create overseas markets for SCATS which is now operating in 70 cities around the world.

Rod Tudge

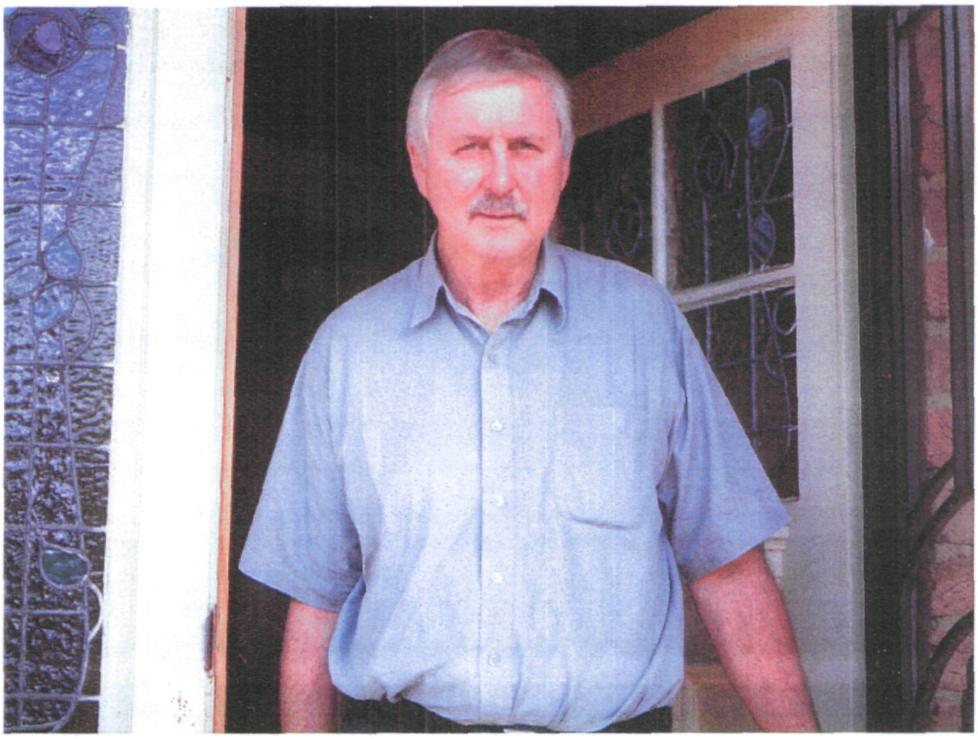
With a Diploma in Civil Engineering and a Masters degree in Transport Economics, Rod Tudge has vast experience in all areas of traffic management, particularly in traffic modelling and data analysis. He quotes that the differences in outlook between an engineer and an economist are that an engineer is someone who asks 'Can it be done?' and an economist asks 'Should it be done?' Rod was involved in the development of the first roundabout design guidelines in NSW; he produced an Economic Evaluation Study of the new TMC and also oversaw the INSECT model for simulating traffic flows through intersections. He wrote a design for several models for the Olympics and has designed many traffic models using PARAMICS, a vehicle-by-vehicle simulation model that replicates the decisions that drivers make. He is also a councillor and former Mayor of Lane Cove Council.

George Vassallo



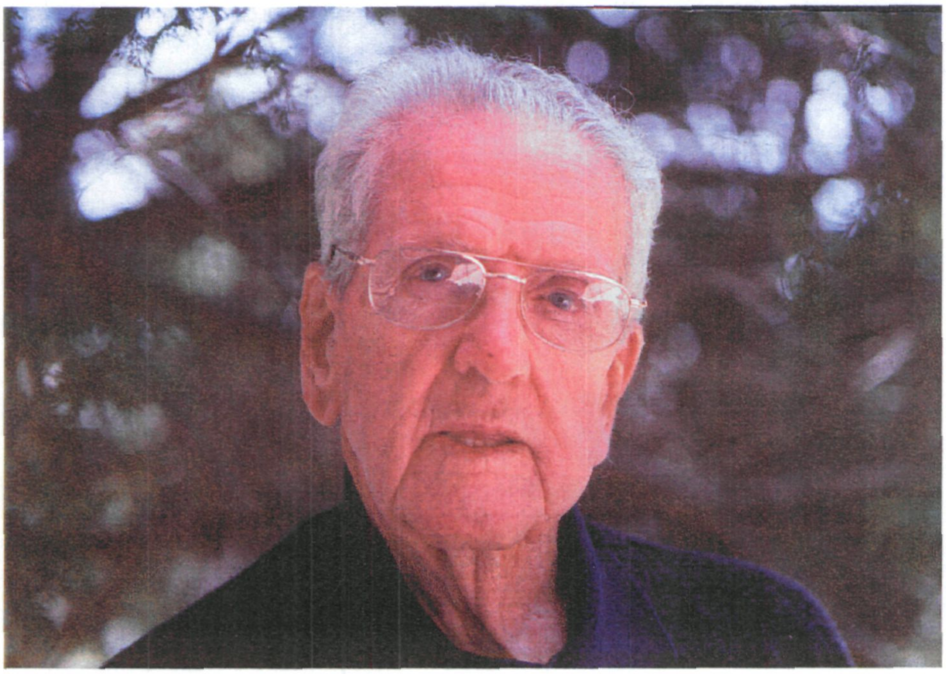
A former Senior Road Design Draftsman in the Traffic Section of the DMR, George Vassallo began his career with the DMR in 1952. He participated in the formation of channelisation design standards and practices for the DMR and other State Main Roads Departments. He evolved the form of traffic capacity calculations to determine future traffic needs and compiled templates that indicate the widened path occupied by cars and semi-trailers when negotiating a small radius turn. In addition, he produced typical layouts for the design of ramp terminals on expressways. He also instigated the design and placement of movable medians on the Sydney Harbour Bridge. Always innovative, George Vassallo has left his mark on Traffic Management.

Brendan White



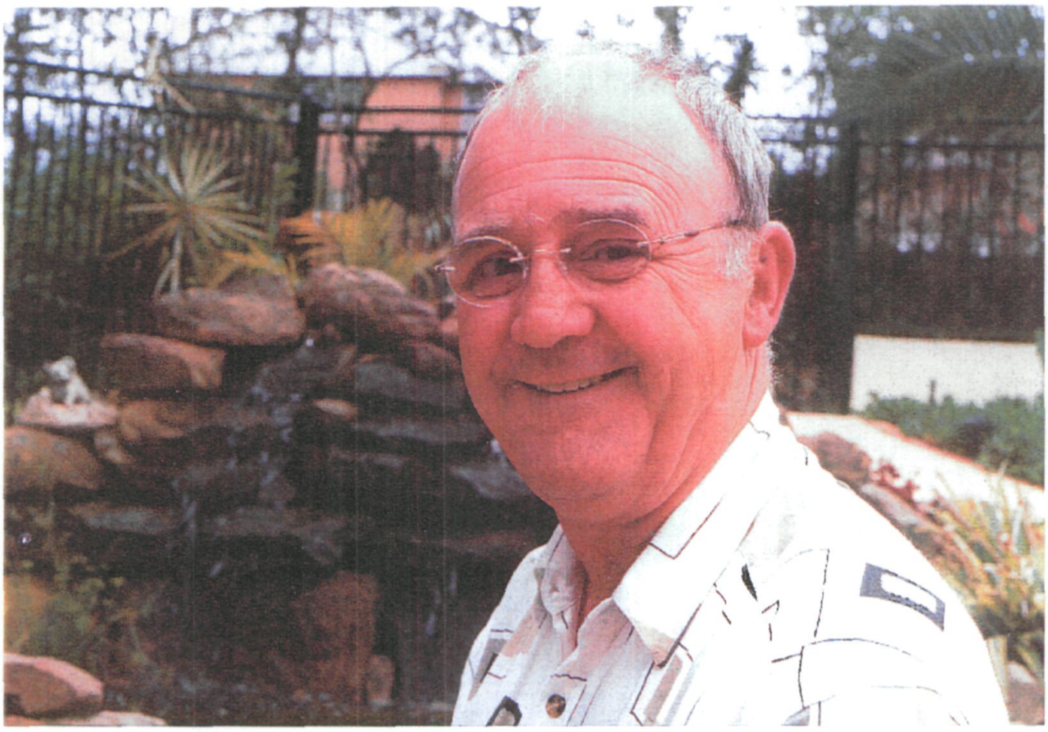
Brendan White started his career with BHP in Wollongong. In 1974, he joined the DMR. After a period of managing the ferries in the State, he was transferred to the Milsons Point Office where his responsibilities included maintenance of the structure of the Sydney Harbour Bridge. He was involved in the installation of movable medians on the bridge and also installed the steelwork gantries that support the overhead lane-changing lights. In 1989 he joined the Tunnel Projects Group, responsible for the construction of the Sydney Harbour Tunnel and monitored the installation of lighting, signs, safety escapes, detector loops and fire-fighting systems. He also prepared papers and briefings on future electronic tolling for Sydney's road network which were accepted in 1998 and now form the basis of the city's interoperable toll system. Brendan is presently Manager, Electronic Tolling at RTA.

Jack Winning



Jack Winning was born in Wooloomooloo in 1916. His family struggled through the Great Depression while Jack gained his Leaving Certificate from Fort St Boys High School. During that time, Jack's allowance was two pence a day - a penny for the swimming baths and a penny for his lunch. After unsuccessfully looking for a job for two years after leaving school, Jack finally got his break – a job with the Water Board and in 1946, he joined the DMR. Jack became the Senior Mechanical Draftsman at the DMR's Central Workshop at Granville and contributed many innovative ideas.. He loved his job and when asked if he could design a movable median for the Sydney Harbour Bridge, Jack just 'dreamt one up' - he tested timber models and then built the real thing. The DMR took out a patent on the invention and gave Jack a framed one dollar note, signed by the Commissioner, in appreciation. Jack and a colleague also constructed the moving tollbooths on the bridge. Jack still thinks back to the old days - he regarded his fellow employees as almost family and, at the age of 86, still misses the Central Workshop.

Terry Winning



After a stint with McDowells stores as a sock salesman straight out of school, Terry Winning found a job with the DMR in 1965 at the Milsons Point Office. A fast learner, he was transferred to Port Macquarie Works Office, where he performed road engineering and design tasks. He designed the River Flats Road at Port Macquarie and was then transferred to the Traffic Section at Head Office. He was involved in Traffic Capacity Analysis work and examined regional designs for capacity, safety and compliance to traffic engineering principles. He improved capacity by changing lane configurations on the Gladesville Bridge and introduced Clearway concepts to gain extra traffic capacity for special events. He also worked with Bob Morris on the Driver Aid Scheme for the Sydney Harbour Bridge, the automated scheme that replaced tow trucks, cones and flaps. Terry pioneered the use of Traffic Commanders, introduced a new management structure to the Sydney Traffic Control Centre, reviewed signposting methods and developed the Metroads signposting scheme. Since leaving the RTA, he now works as a traffic consultant in private industry.