The Development of N.S.W. Railway Signals

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SUMMARY
Signals, whilst not essential to run a railway, are necessary to achieve the levels of safety required by all stakeholders in the community.

NSW has nearly always followed the best practice prevailing overseas and in some cases taken the lead in some aspects of technology. Changes are not usually undertaken for technology’s sake, but rather as part of a larger infrastructure or enhancement project where the opportunity was taken to install the most suitable modern technology. The end result is that the railways of NSW have equipment and practices spanning a broad technology timeline.

This paper traces the major stages in the development of railways signalling in NSW, the major signal personalities involved, and issues that have led to the present position.

1. INTRODUCTION
A Signalling system is a means to convey information to a train driver about the condition of the line ahead. Essentially he is told that he can proceed because the line is clear, proceed at reduced speed as there is some obstruction ahead or he is going to pass from one line to another, or must not proceed further because the line ahead is occupied.

To this is added the question of single and double lines. On double lines, traffic moving in one direction uses one track of a pair and trains going in the opposite direction use the other track. The main issue is to ensure that a train does not run into the preceding one, a question of train separation. On single lines trains running in both directions use the same single line and an additional hazard has now developed, which is to prevent head on collisions.

2. THE BEGINNINGS IN NEW SOUTH WALES
In the beginning rail traffic was light, speeds were low and no trains ran at night. As a cost saving, the line from Sydney to Granville was duplicated only as far as Newtown with single line beyond. To control traffic on the single line, only one train was allowed on the single line at any one time. After a train had left Newtown for Granville, another train could not be dispatched from Newtown until the previous one had returned. However, it would seem that special arrangements applied when circumstances required.

Points were controlled by hand levers mounted on or near the signal post. The only signals used were double arm semaphores mounted on the station platform to indicate the time since the previous train had departed, that is:
- arm horizontal - previous train departed within last 10 minutes. Do not depart.
- arm lowered 45 degrees - previous train departed between 10 and 15 minutes previously. You may depart but proceed slowly.
- arm vertically in a slot in the post - previous train departed more than 15 minutes ago, off you go.

This signal did not provide an indication of how far the previous train had travelled; it only indicated how long since it had left. This could then lead to a false sense of security.

When the first railway extension, from Granville to Liverpool, was opened in 1856 there is evidence to indicate that the new single line was regulated by a token system. In this system, the driver is issued a physical token that applies to that section of single line only. Having that token in his possession a driver can take his train into the applicable section and have confidence knowing that he should not meet another train until he has left the section.

The arrival of John Whitton saw the withdrawal of the staff system. It was replaced by timetable working, with variations to that being authorised by telegraphic messages.

As traffic increased so did accidents and near misses.
From the early 1870s there were questions being asked and moves made to re-install the staff system as well as installation of interlocking (This first happened in Victoria in 1873 and possibly even earlier in South Australia). By the middle of the decade, Traffic Manager Donald Vernon was getting quite concerned about the safety of operations; he issued a series of Working Orders to strengthen and clarify the existing Rules. Bad blood developed between him and Whitton. Vernon was transferred and his Working Orders were abolished.

Work progressed on extending double lines in the 1880s, particularly as traffic built up around Sydney and Newcastle.

Interlocking in some form was also rapidly being installed at a considerable number of locations. Traffic density and speed appeared to be the determining factor for selecting locations to install interlocking equipment. The Main Southern Line was given priority for the installation of interlocking equipment.

On the Southern line, construction moved ahead of the installation of telegraph wires. In 1877 the staff system was used on some of these new extensions as a temporary measure.

At this time, the telegraph and other communications systems were the responsibility of the Telegraph Department run by EC Cracknell.

A change of administration took place 22 January 1878. Whitton’s role changed to that of looking after new Construction only and, in 1881, George Cowdery was appointed to take charge of Existing Lines. Vernon reverted to his role as Traffic Manager and drafted new Rules, which included use of the staff system for all single lines. The new rules were with the printer and awaiting Executive Council approval when the Emu Plains accident occurred.

3. EMU PLAINS
Prior to the Emu Plains accident trains followed the timetable. Therefore, if a train was required to wait at a place to pass a train travelling on the single line in opposite direction, then there it was to wait at the appointed place until the other train had arrived. If one train was running late and the stations at both ends of the section were attended, then a telegraphic line clear report could be issued, one train advanced and a new passing place appointed.

On the night of 30 January 1878, an up goods train was required to wait at Wascoe’s (old Glenbrook) to pass a down goods. The guard of the up goods train thought he could make it to Penrith before the down goods departed Penrith (assuming it was running late as it regularly did, even though it would be after the scheduled departure time of the down goods. On this night, the down goods left on time and five employees were killed in the collision near the Emu Plains cemetery.

After this, the new rules were promptly approved and issued. The staff system was quickly introduced on all single lines. The new rules also provided for a telegraph block system on double lines. This ensured that a train did not leave a station until a message on a special telegraph instrument had been received to say that the preceding train had arrived complete at the other end of the section.

4. RENAISSANCE
In 1879 the Garden Palace Exhibition was held in Sydney. One of the exhibitors was McKenzie and Holland. McKenzie and Holland exhibited their signalling equipment, including their patented interlocking machine. It was a case of being in the right place at the right time.

After the Exhibition, NSW Railways purchased the exhibited machine and also employed John Parry, the McKenzie and Holland employee from the exhibition. Orders were placed for more machines to interlock Sydney and Newcastle.
Block telegraph had been installed on all sections of double lines (Sydney to Granville and Newcastle to Wallsend Junction), staff and ticket working on single lines. The staff system was installed as new lines were opened. With John Parry on the payroll, a program commenced to interlock major junctions and stations. It should be borne in mind that even a small interlocking machine was a very expensive item of equipment. The levers themselves cost five pounds each.

Although the staff and ticket system provided safe operation, it had one major problem in general train working arrangements. If a train arrived at one end of the section and the train staff was waiting at the opposite end of that section, this train could not be dispatched until the train staff was returned to this station. There were only two methods of returning the train staff:

1. Train Staff returned by the next train travelling from the opposite end of the section to the station where the waiting train is standing.
2. If no train was available to return the staff, an employee could transfer the staff by horse or on foot.

In each case a lengthy delay would be incurred and disrupt the timetable.

To overcome this problem, the new Electric Train Tablet system was investigated. Some instruments were purchased, and the initial installation took place at Balmoral (near Mittagong) in 1888.

In the tablet system, an instrument was placed at end each of the single line section, i.e. two instruments for the section of single line. Each instrument had a magazine containing a number of tablets, and the instruments were electrically interconnected so that only one tablet could be out of the pair of instruments at any time. A tablet was withdrawn from the instrument at the departing station, and handed to the train crew. When the train reached the far end of the section, the tablet was placed in the arrival end instrument, and both instruments were freed to allow another tablet to be withdrawn from either instrument. This system of working was rapidly extended to all sections of the main Southern Line and portions of the Main Northern Line and the Illawarra.

At the same time an alternative token system known as the Webb Thompson electric staff was patented, using a cylindrical token similar to the familiar train staff. This system brought together the security of the tablet system, a greater flexibility of operation and the familiarity of the staff system. There is a suggestion that NSW may first have used the electric staff system in 1889 (the year of its patenting) but it was certainly in use by 1891. The electric staff system was initially used on the Western Line and portions of the Northern Line.

At the same time, the administration of the NSW Railways was re-arranged, once again. EMG Eddy was brought from the U.K. to take up the appointment as Chief Commissioner. John Whitton’s career was coming to an end; his power had been in decline for some time, partly due to a difficult attitude to signalling and running arguments with other senior officers.

One of Eddy’s early actions was the creation of a Signalling Branch (very soon to be
renamed the Interlocking Branch), but still reporting to the Engineer for Existing Lines. Parry was appointed the Interlocking Engineer and this took effect from 1 July 1889. At about the same time, telegraphs were transferred from the Commissioner for Internal Communications to the Telegraph Department, and later to the Railway Electrical Engineer. Block telegraph, electric tablet and electric staff were also under the control of the Telegraph Department and soon after was again transferred to the Electrical Engineer’s Branch.

By 1891, 234 locations (47% of locations) were interlocked, 10% of lines were equipped with electric token systems and all double lines were controlled by block telegraph instruments.

The period of John Parry’s control was one of introducing interlocking and modern signalling, largely in accordance with British practice and a little modified to meet colonial economies. It should be remembered that interlocking was a very large investment and the decision could have been made to use American practice in NSW in lieu of the British which might have been more realistic.

Control of the telegraph as well as the safeworking instruments rested with the Telegraph (Post Office) Department, with the railways retaining some sort of control.

What is interesting in this period was that Whitton had lost control of all but the construction of new lines, and it was the Existing Lines Branch who were introducing and maintaining this new equipment. Existing Lines Branch were even involved with the enhancement of corridors such as the construction of the quadruplication between Redfern and Homebush.

In January 1891 John Parry received a promotion to Outdoor Traffic Superintendent, and Charles Wilkin, formerly of South Australian Railways, was appointed to replace him.

5. PIONEER STANDARDS

It would appear that the Depression of the early 1890s hit Australia particularly hard, with Victoria seemingly the worst.

In signalling terms, it probably took some time before there was much in the way of obvious signs, possibly due to works already committed.

Other than the slackening off of work, the first effect of the Depression was the introduction of a cheaper method of operating points and signals at intermediate sidings. This new system of working, called Duplex and Bracket Lock, was mentioned to the world at the International Railway Congress in 1894. Any saving would have been in the initial cost of materials, but it was more labour intensive to operate.

Soon after, there was another indication of the severity of the economic conditions, as salaried officers earning more than 200 pounds had that portion of their salary over that amount reduced by 10% for six months. Chief Commissioner Eddy’s death in 1893 may have also influenced the decline in railway work. If he had lived, then his influence and energy may have helped push things along despite economic conditions.

The only advance in this period was the change from white lights to green for the all clear indication on signals from 1893. This change was in line with a Board of Trade edict.

After about 1900, the effects of the Depression diminished and traffic levels started to climb. In about 1901 the Duplex and Bracket lock was no longer being installed and for most new installations the Lever and Bracket Lock was used. Although slightly cheaper than a ground frame, it still did not offer the same level of security.

A new chief commissioner was appointed from the GNR (UK) in 1907, one Tom Johnson, a no-nonsense commissioner who realised he
had a job to do. It is said that he even ordered a Minister of the Crown from his office. He pushed the amplification of tracks, particularly in the country. Most of the country duplication was carried out or initiated under his direction. He recognised talent and promoted those in the service and only imported senior officers from overseas where there was a particular need. One of those imported was Cyril Beuzeville Byles, at that time a leading signal engineer in the UK.

Johnson and his senior officers had been considering introducing automatic signalling close to Sydney to relieve congestion, but nothing happened until Byles’s arrival. They had already installed electro mechanical interlockings at Sydney Station in conjunction with the project to build a new station. It is understood that the Interlocking Branch only undertook part of these works, with the rest done by Electrical Branch. It is said that this was because Wilkin did not believe in electrical equipment.

In summary, it could be said that Wilkin added little to the development or advancement of the signalling system of the NSW Railways. It seems that he did not view new technology favourably and merely tinkered around the edges, and in some instances took the interlocking backwards. It was the Electrical Branch who pushed new technology and ideas to the forefront and in most cases before any other Railway in Australia, and in the case of the electric staff system NSW was one of the first railways in the world to adopt the system.

It should be mentioned here that the Electrical Branch was formed under Paul Elwell in June 1891. The initial role of the electrical Branch was to look after the infant electric power system for the workshops, electric token and block telegraph systems and the telegraph network. Later his Department also expanded to cover power generation and the electrification of the tramways. Elwell died early in 1899 and was replaced by his assistant, O. W. Brain. It was under Brain, that his assistant, Walter Barton, commissioned the power signalling installation in Sydney Yard rather than the more obvious Wilkin.

The Interlocking Branch was responsible for the signals and interlocking. This was expanded to include the management of the Permanent Way workshops. Due to Wilkin’s obvious lack of expertise in modern signalling practice, Chief Commissioner Johnson brought in to Australia a leading U.K. Signal Engineer, C.B. Byles.

6. RESURGENCE

C.B. Byles was recruited by Tom Johnston as his Signal Expert. In fact Byles’s title on arrival in 1911 was Signal Expert. He had an excellent background having started in the Signalling Department of the Great Western Railway when it was one of the leading railways in the UK. There followed a period with the Lancashire and Yorkshire Railways (L&Y) as the assistant Signal Engineer under Herbert Raynar Wilson one of the leading UK advocates of power railway signalling systems and author of leading signalling texts. When Raynar Wilson left to be an agent for one of the power signalling suppliers, Byles took his place as Signal Engineer. The L&Y Railway was considered to have the highest density of signals on any railway in the UK and probably the highest traffic density of goods and passenger traffic. Byles was also part of the L&Y when the new power interlocking schemes were being commissioned. In addition, Byles was the first secretary of the
Institution of Railway Signal Engineers, as well as a special lecturer in Railway Economics at the Universities of Manchester and Liverpool. His book “First Principles of Railway Signalling” ran to two editions.

Byles’s title on appointment was Signal Expert, while Wilkin remained in his position as Interlocking Engineer. In the following year, when Byles was appointed to the position of Signal Engineer, Wilkin was effectively demoted to General Foreman of the Interlocking Works. Byles was also given the task of sorting that workshop out. Wilkin did not last long after his demotion and retired. It is said that he haunted various inquiries for construction of new lines, advocated mechanical signalling practices and not the new schemes that Byles was introducing.

It could be said that with the arrival of Byles, signalling in NSW was turned on its head and all the latest technology was utilised, where appropriate, to turn the signalling system into a modern and efficient network. What never changed were the underlying signalling principles that governed space between trains and signalling and interlocking rules. Byles had strong beliefs in these areas and expected everything to be done correctly. Safety was No.1.

One major factor in his influence, other than Byles’s strong beliefs of safety was that as head of the Signal Branch he reported direct to the top like the Chief Mechanical Engineer, unlike the other states – i.e. his voice held an equal weight with the other disciplines.

Byles was in the right place at the right time to answer the needs of the NSW Railways. The rapidly increasing level of freight traffic to Darling Harbour and suburban passenger numbers were producing increased congestion in the inner areas of Sydney. Something needed to be done to relieve this pressure.

The major activities that took place on the NSW Railways during Byles tenure from 1911 until 1928 were:

- extensive country duplication – Waterfall to Port Kembla North, Picton to Cootamundra, Lithgow to Orange (mixture of double and single line), Gosford to Adamstown, Maitland to Branxton
- six tracks from Illawarra Junction to Homebush and sections of quadruplication in the Metropolitan area
- construction of the Metropolitan Goods lines
- electrification of the Sydney Metropolitan Network
- construction of the first stage of the first underground railway in Australia
- significant expansion of the country branch line network and the North Coast and Broken Hill Lines.

In all of these, Byles ensured that the most modern signalling was installed on the main lines consistent with levels of traffic. Most of the equipment was supplied by the Railways’ own workshops.

At a signalling discipline level the following significant achievements occurred:

- first automatic signals in Australia – Erskineville to Sydenham in 1913 using air operated lower quadrants
- first upper quadrant signals in Australia – 1914
- first country automatic signalling in Australia – 1914. This became the pattern for most new work
- first colour light signal in Australia – 1914 – series production from 1924
- standardised shunting signals
- standardised distant signal indications – consistency
- first New South Wales standard interlocking machines – made in own Workshops – 1914 (and continued until about 1976)
- introduction of standardised components for all work, made in and dispatched from workshop
- introduction of a concrete prefabricated building system
- train stops to improve the level of train protection with faster electric stock
- introduction of a speed controlled signalling system on the City underground for close headway working
- introduction of automatic turn backs
- rebuilding of most of the metropolitan area signalling to coincide with the electrification. Wherever possible this included power signalling with full track circuiting and electro mechanical interlocking machines
- construction of electro mechanical interlocking machines in Branch workshops, something few railways tried
• miniature electric staff including in house manufacture
• trials of train control and cab signalling.

What characterised NSW signalling was the almost total “in house” manufacture of all equipment. This probably allowed better control of costs and tailoring of needs with what was supplied to the field. It also made them relatively independent of the commercial manufacturers, mostly located overseas.

Byles’s aim was to make the system of signalling as safe as possible and wherever possible remove the chance of human error. Byles was well aware of signalling developments around the world, not just the UK. The expansion of the country duplication and construction of new lines gave the opportunity to introduce interlocking on country lines and automatic signalling on main lines. This reduced some labour costs as was found in Britain.

This was unlike the situation in Britain, which had not long ago spent vast sums completing the interlocking of their lines and installation of absolute block in compliance with the requirements of the Board of Trade; railway company Boards were unlikely to look favourably on requests for further funding to modernise such equipment.

The USA was well behind Britain with widespread application of interlocking and therefore, when new inventions arrived it was a little easier to build a business case for their installation, particularly as in many cases there was nothing else there.

To some extent NSWR was like the USA and Byles was able to take advantage of the latest developments as the system was being rebuilt. It could be said that if he had been
conservative in his attitudes, then the traditional systems would have been installed on these new works. However, being who he was, and as other Branch heads had similar progressive attitudes, the choice was usually made in favour of the latest safe working equipment where it was cost effective.

7. ELECTRIFICATION
Whereas much of the initial work that took place when Byles arrived dealt with the country enhancements, the electrification of the suburban area under Dr Bradfield’s plan moved the focus to the Sydney Metropolitan Area, along with most of the resources.

Byles, again, used the latest practices with this rebuild of the metropolitan area with most of the equipment being supplied by the Signal Branch’s own workshops and in many cases was designed in-house. The massive project provided the opportunity to view signalling on a much larger scale and to make decisions at a strategic level. It provided the chance to install many power interlockings, certainly in the inner Sydney area and at busy junctions. This action allowed the removal of much mechanical equipment, and consolidation of existing signal boxes to the limit of the available technology. Restricted sighting of semaphore signals following the erection of the new overhead wiring and structures led to the near complete replacement of semaphore signals with colour light signals. Electrification also led to the need for an additional indication (medium) and train stops to deal with the greater acceleration of the new trains. The construction of the underground railway led to the use of the upper yellow as a distinctive turnout indication because of the lack of room for the traditional bracket signal arrangement and the adoption of a speed control system to increase track capacity.

Also at this early stage, automatic points were used at some turn back locations. Once the train had arrived complete in the siding, the points reversed automatically behind it and a relay driver waiting in what had been the rear end and was now the leading end, was able to immediately drive the train into the other platform.

When the bulk of the electrification was completed in late 1928, attention returned to the country areas.

Byles retired early (aged about 55 years) in somewhat unclear circumstances. He did return briefly a little later as an advisor.

It could be said that this period with Byles at the helm saw an almost complete rebuild of the network, the adoption of the most modern technologies where these were appropriate and a focus on safety systems to remove wherever possible the impact of human error. His period of control established many principles and practices which are still relevant and in use today. If Whitton is the father of the NSW Railways, then Byles must surely be the Father of NSW Railway Signalling.

8. DEPRESSION
Walter Barton, Byles’s principal assistant for nearly twenty years, took the Chief’s position when Byles retired.

As the Depression bit, Barton had little opportunity to undertake anything innovative. Expenditure was severely curtailed, and staff were laid off or put on work rationing. Like farmers in a drought, it was a case of trying to hold everything together until times improved. Besides, Byles had already overseen the renewal of nearly everything.

However, appearances can be deceiving and although there were few outward signs of significant technical changes, there were some impressive improvements in the detail.

There were still some new works that continued. They included the Shore Lines section of the City Railway and the Harbour Bridge, where an enhanced speed control system of signalling was introduced to further increase track capacity. As part of this work, a new signal indication was introduced - the Low Speed.

Fig 10 Tunnel signal
The railways at this time underwent a number of re-organisations and changes to reporting paths. Barton lost control of the Workshops but eventually gained control of Telegraphs and all other communications.

The lingering effects of the Depression, with slow recovery, limited the opportunity to try anything new. The works around Newcastle with the widening of Scott Street allowed a pioneer installation of a relay interlocking at Civic in 1937. This followed the 1936 commissioning of the last power interlocking at Newcastle, which was built largely from recycled parts.

The line from Sutherland to Cronulla was opened in 1939, replacing a steam tramline. It allowed an extension of this relay interlocking technology to Sutherland and on the Cronulla branch line. In this system, there was no longer any mechanical interlocking between the various levers, as all functions were carried out by relays.

By this time, the Second World War had started and there seemed little opportunity to extend the relay interlocking system or to introduce anything new. However, restriction of the supply of components from overseas, wartime materials and labour meant that wartime rail works for moving troops and equipment where amongst the few projects allowed to take place. This was a double edged sword and as problems arose there was an opportunity to try innovative solutions. As a result, small relay interlockings were added to new or existing interlockings to control points and signals some distance away that ordinarily would have required a separate signal box with all of its equipment and staff.

In general, there is a reasonable physical limit on how far signalling ground equipment could be located from an interlocking due to voltage drop in the wires and the physical number of wires required. Therefore, in 1941 telephone relay technology was introduced at Villawood to remotely control the new sidings at Leightonfield. Further installations of relay-based remote control followed. These changes introduced by Barton were technical solutions, but generally not high profile. Barton was well aware of what was happening overseas, but restricted resources generally limited the options on what he could do.

After the end of the war, there were design schemes for hump yards, CTC and other innovations to bring the railway into the modern world and solve of the congestion problems. Requests were made for funds, but with little success, and it was a time of some frustration.

All projects suffered with the depression/recession at the end of the Second World War and little new construction took place.

Barton’s reign was one of holding the fort, but using the opportunity to try some technically innovative ideas and solutions and as before formed the basis for current day practices.

9. POST WAR

The period from about 1948 until the mid 1970s was a series of economic highs and lows, but in general it was a case of keep the ship steering in the correct direction.

The coal boom that came with the Korean War was the precipitator for the decision to electrify the line across the Blue Mountains to the coal mines at Wallerawang. In the end, the coal market collapsed and the decision was made to terminate the project at Bowenfels, just west of Lithgow. At least the problem of the long steep grades and slow sluging steam locomotives over the Blue Mountains had been dealt with.

As a considerable amount of equipment had been ordered, but could not all be used, it was decided to electrify the line to Gosford, thereby reducing the bottleneck problems arising from the steep grades of the Cowan Bank.

For signalling, these projects meant the extension of conventional colour light signalling. Part way through the project a decision was made to reduce costs by introducing a simpler set of signal aspects, using single-head signals. One factor on this
decision was a long term view that it would be a good thing to avoid a signalling ‘break of gauge’ by using country signal aspects in common with the other states. This was the start of a dual system of power signal indications, one for country lines and another for metropolitan lines.

Another innovation as a result of looking overseas for ideas was the adoption of the US system of level crossing protection equipment which eventually became known as Type F flashing lights (and half booms). This was to become the Australian Standard in level crossing protection.

There was no funding allocated to rail improvements in the 1950s, including expanding the suburban electric services in conjunction with the Western and Northern Lines electrifications, completion of the City Circular and new electric suburban trains. By the 1960s, this trend had continued with interstate standard gauge connections, the first double-decker electric suburban stock and further suburban electrification extensions.

For a while, NSW began to purchase Japanese signalling equipment, especially relays and point machines. The latter were of extremely good quality, but eventually were priced out of the market by unfavourable exchange rates.

At this time, Harold Bourne appeared to have groomed two bright young engineers, Eric Archer and Ken Hickson. They were sent overseas to study current British, US and European practice. In general many elements of the traditional sources of ideas was stagnating whereas the European practice was innovating. It was from their trips that such practices as HV impulse and jointless track circuits were introduced. Such study trips had been the practice for some decades past to review and refresh ideas and practices.

The same period saw the first NSW installation (between Antiene and Muswellbrook in the Hunter Valley) of Centralised Traffic Control (CTC) the control of multiple loops or interlockings on a length of line, by electronic transmission from a central control point with NSW.

A major innovation was the introduction of a route set type of interlocking practice where the signaller selects the desired route, and the interlocking sets the and moves the field functions to comply. This was in contrast to previous practise where the signaller had to set each individual points and signals. The route set practice chosen was based largely on that developed by Westinghouse, but modified in house to suit NSW needs.

The introduction of miniature BRB “plug in” relays in new installations made route-set interlockings practical. It also enabled an overall miniaturisation of signalling controls, in conjunction with new with small gauge PVC wiring, moulded disconnect terminals and crimped wire terminations. In the field, PVC insulation was adopted for all external cables between equipment housings and to ground equipment. The use of PVC insulation was another departure from British practice. In hindsight it was a very good decision as NSW has avoided the ongoing insulation degradation problems that continue to bedevil the British who continue to persevere with various forms of synthetic rubber insulation.

10. REBUILDING

Despite the apparent ‘good times’ with the capital works that were going on, a very significant part of the Sydney signalling infrastructure was still original equipment with material dating back to the 1950s and the 1920s. Some major mechanical interlockings still in intensive use were even older. Much of this was at or well past the end of its design life. Much wiring with VIR (cotton-covered natural rubber) insulation had degraded to the point where it could not be touched without endangering the safety of the signalling, let alone be maintained.

Gradually the crunch came, and it was apparent that the general lack of renewal funding for many decades past had led to the realisation that much equipment was becoming old and patching was at its limit. Moves commenced to re-signal a number of these lines and the opportunity was taken to consolidate interlockings so controlling many more places from a control centre and in many cases what had been proposed over forty years earlier was coming to fruition.

Technical innovation included axle counters for train detection, more modern equipment in general, introduction of computer and modern communication systems. In more recent times incandescent signals have been replaced with LED, believed to have been a world first. A result of this renewal has been that most of the mechanical systems in the current RailCorp area have been replaced, admittedly probably more for staff savings than for any innovation.
There is still a reasonable collection of interesting mechanical equipment in country areas, but it is suspected that it also is not long for this world.

It is hard to judge the last twenty five years as the events are too close to make a real judgement of the changes and their effects. What has changed is that NSWR lost most of its workshop capability, but unlike many railways retained its design and technical ability. This retention of design and technical expertise has allowed internal problem solving and the ability to make informed choices when looking at the wide range of competing products and claims to ensure that a safe and reliable system is always maintained as Byles himself had strived for. In this respect, they are system integrators who can make use of best products or manufacturers and combine them into a system that is optimised for performance.

11. SUMMARY
The greatest period in signalling was probably during the reign of Cyril Beuzeville Byles. He was the right person, at the right place, when the right needs existed and the necessary support and funding was available which allowed real technical development and growth. There always has to be a problem to be solved or other business driver for change.

What NSW did was to constantly review overseas practices both by visits and review of journals. By keeping an open mind, suitable solutions could be introduced, where appropriate, to solve a problem or enhance operations or maintenance. In these situations, NSW may not have always been the first, but it was certainly within the second wave that often improved what was available and then tended to make it in its own workshops.

Now the last real snapshot of many of the stages in the development of signalling in NSW and even Australia can be seen within NSW. Most of these older practices exist outside the Metropolitan Area and this may be your last chance to see this technology in Australia thus proving that what was designed and built many years ago is still working both appropriately, safety and reliably even though they may not look MODERN.

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