



*Photograph of King's Bridge, Launceston,  
officially opened in 1864.*

QUEEN VICTORIA MUSEUM AND ART GALLERY,  
LAUNCESTON

## CHAPTER 35

# ENGINEERING

D. CUMMING AND L. J. JONES

ON 3 JUNE 1828, when the Institution of Civil Engineers was incorporated in England, the founders wrote into its charter a statement aimed at clarifying what civil engineering was all about. The civil engineer, they declared, was someone concerned with 'the art of directing the Great Sources of Power in Nature for the use and convenience of man'.

Of course the adjective 'civil' had a somewhat different meaning then. Basically 'civil' meant 'not military', and so in 1828 civil engineering was understood to include areas which are now regarded as quite separate. As the charter document went on to explain, civil engineers dealt with the design and construction of roads, bridges, canals, harbours and the like, but also 'the construction and adaptation of machinery'—work which nowadays is the acknowledged concern of mechanical rather than civil engineers.

With the passing of time the 'art' mentioned in the original charter has become more formalised; scientific principles now guide much (though still by no means all) engineering activity. Nevertheless, we should understand that while engineering and science are now closely associated, there are important differences between them. The former's concern is with 'doing things', while the business of the latter is observing and trying to understand the phenomena of the world around us. In short, science seeks knowledge of the world, while engineering's concern is with providing goods and services.

Modern engineering encompasses a vast range of activities, and so for convenience the profession is now divided into a number of separate and more-or-less specialised 'branches'. Apart from the military, civil, and mechanical groups already mentioned, we now acknowledge electrical (and electronic) engineers, chemical engineers, mining and metallurgical engineers and industrial (or production) engineers, as well as some perhaps less populous groups such as agricultural, textile, marine and so on. Obviously then, in a relatively short essay such as this, an exhaustive coverage of engineering historical sources cannot be provided. Nor is it possible to include historical material associated with every kind of engineering.

Books and documents are not the only valid record of engineering activity. What are termed 'hard relics'—that is, surviving artefacts and structures or their remains—are also of prime interest. Technical museums have been set up to preserve some of these, and also perhaps to bring the general public a little closer to technology. Familiar examples abroad are the so-called Science Museum in London (founded 1857), the Smithsonian in Washington, DC (1846) and the great Deutsche Museum in Munich (1903). In Australia there are technological collections of interest

at Sydney (1880) and Melbourne (1870), but over the years both have suffered from a chronic lack of staff and endowments. Probably a contributing factor to this unhappy state of affairs has been the long-held (though incorrect) assumption in Australia that we can always import the technology we need, and thus do not need to develop our own.

In recent times various 'heritage' groups in Australia (both private and government-sponsored) have begun to take some interest in technical sites and relics, though once again Australia has been much slower than many other countries to move in this direction. The various state-based National Trust organisations, and the federal government's official agency, the Heritage Commission, still tend to concentrate on conserving places of natural beauty and buildings of architectural merit, while giving scant attention to historically significant industrial sites and remains. True, in the comprehensive *Heritage of Australia* (1981), the commission's record of what it sees as the National Estate, a number of industrial buildings such as flour-mills are listed. So too are several bridges and mine sites, the Humphrey pumps at Cobdogla on the River Murray, the zigzag line at Lithgow, and the remains of the Lal Lal blast furnace in central Victoria.

Some useful preservation work has been accomplished by various societies of enthusiasts around the country, notably those interested in areas such as railways and tramways. A few smaller specialist enterprises (for example, maritime and riverboat museums) have contributed as well. In general, however, specifically engineering remains—and especially 'hardware' such as machinery—have been ignored.

The study of the history of engineering has been a recognised scholarly discipline in the northern hemisphere for quite some time. In Britain, for example, Samuel Smiles wrote his *Lives of the engineers* in the years following the Great Exhibition of 1851, while the Newcomen Society (for the study of the history of engineering and technology) has published scholarly articles on engineering history in its *Transactions* continuously since 1920. Australia lags considerably by comparison. There are still no Australian societies devoted specifically to studying engineering history, and indeed there has been little interest shown even by individuals until quite recently. The little that has been written about Australia's engineering achievements has tended to come from economic and general historians, whose perspective and expertise, naturally, are not those of the engineer. It is for this reason that most of the otherwise excellent works of G.N. Blainey and like authors are not listed here, but included in other chapters. Similarly no mention is made here of the records of public inquiries into bridge failures and such; Australia's 'disasters' are dealt with elsewhere in this volume.

Colonists (mostly British) began coming to this continent in 1788, bringing with them a knowledge of the advanced British technologies and practical skills of that time. It was in Britain, after all, that the Industrial Revolution had begun not so many years before. As a result Australian engineering at first was strongly derivative, reflecting the backgrounds and training of some of those early migrants. Let us not forget, however, that the original (Aboriginal) Australians had skills and technologies of their own—albeit of a much different kind. These skills helped them to survive in extremely inhospitable parts of the continent, and from them some of the European newcomers undoubtedly learned. In time the Europeans, too, devised new approaches to cope with an environment that was very different, and so in technology as well as in agriculture the 'make do' colonial tradition was born. Indeed 'bush engineering'—in which whatever happens to be to hand, together with native ingenuity, is employed to meet a need in the absence of proper facilities—is an element of Australian rural life still.

From the beginning of European settlement in Australia a number of primary needs of the migrant population had to be met. Obviously a reliable supply of water for drinking and washing was an early priority, and the establishment of local agriculture to make the new colonies self-sufficient in food was also important. Scholarly historical work in these areas is at last underway, but so far most of the results have only appeared in higher degree thesis form.

In agriculture generally Australia has had a quite fascinating history, not only because of the vastness of the country, but also because the climatic and soil conditions are unique. A number of new and important agricultural machines were invented and introduced in Australia over the

past century and a half. John Ridley's 'stripper' for harvesting grain (1843), R.B. Smith's 'stump-jumping plough' (1876) and, in this century, C. Howard's 'rotary hoe' are three which come readily to mind.

The pastoral industry likewise has had its share of local inventions and innovations directed to specifically Australian needs. A rare (also brief) treatment of the development of the shearing handpiece is to be found, for instance, in A.D. Fraser (1938). More recently an excellent biography by W.R. Lang (1982) deals with the invention and development by James Harrison of the refrigeration machinery which made possible frozen meat exports from Australia to Britain and Europe in the latter half of the last century.

Manufacturing industry of course came later, as the population grew and colonial markets developed. The history of Australian manufacturing, however, is still largely unresearched and unwritten—though there are a few exceptions. We are indebted to Helen Hughes (1964) for her fine treatment of developments in iron and steel making. As well as being one of the first published works in the field, it is also one of the most instructive and most readable. Also of some interest in this area are the biographies by G.N. Blainey (1971) and P. Mawson (1958).

A few accounts of particular manufacturing activities have appeared in recent years, but once again most remain in postgraduate thesis form. Publications in this area to date represent only a scratching of the surface; much more work is required before any clear picture of local manufacturing (and in particular of what is genuinely Australian) will emerge.

An interesting aspect of all the Australian colonies is that most of the development of their basic services was, from the beginning, government sponsored. Little was left to private initiative. This pattern of establishing such things has become characteristic of Australia and Australians, and continues to this day. As a result significant government engineering organisations were established quite early. The stories of these official enterprises are by no means easy to unravel. It is not that there is any scarcity of historical material; indeed detailed information (often including original engineering calculations and drawings) on the construction of railways, roads, bridges, dams, sewerage systems, irrigation schemes, electricity generating stations and networks, and so on, abounds. The difficulty is that much of it resides in reports and other disparate records held by a multitude of government departments and municipal and semigovernment authorities distributed across the nation.

Most technical documents from government departments eventually find their way into the official government archives, where they are relatively safe. Regrettably local and semi-government authorities are not obliged to deposit their non-current materials in the same way, and there have been some important losses of historical evidence from time to time. Even so there is a vast amount remaining for researchers to examine.

The situation is different, and even less satisfactory, in the non-government area. Very few documents of any kind from early engineering firms have survived; those that have are mostly lacking in technical detail, relating mainly to ordinary commercial aspects of profit and loss. However, some papers have been gathered by university archivists. The University of Melbourne Archives, for example, has prepared a guide to its holdings of this type of material.

In a few cases dedicated public servants have themselves taken a hand in recording and publishing the significant accomplishments of their particular departments—though, curiously, rarely to our knowledge in the railway systems. Published works dealing with the development of roads, however, are more common. Two useful recent works of this type are by M.J.L. Uren and F. Parrick (1976) (from Western Australia), and a volume by members of the New South Wales Department of Main Roads (1976). A somewhat different aspect of transport is dealt with by J.D. Keating (1980), who traces the interesting history of cable trams in the city of Melbourne.

Published accounts of early Australian engineering works by contemporary writers have been few and mostly lightweight. However, W.B. Hays (1856) treated civil engineering projects in South Australia in the early nineteenth century. Similar in content, though shorter and less detailed technically, is W.H. Warren's article (1888). Much of the engineering historical record—preserved as mentioned earlier in the fading collections of scattered government

departments and authorities—still awaits examination. We must wait a little longer for researchers to assess, collate and interpret this record for the benefit of all.

Before presenting a formal bibliography comprising a selection of available works, a few words might be said concerning certain topics which would appear to be relevant and interesting, but which are not represented in this selection. Telegraphy and radio, for example, have a considerable history on this continent, and publications of quality are available. Both, however, are covered in other parts of this volume. Mining in Australia is also treated in another chapter. This notwithstanding, we have chosen to include a few works on mining subjects, where there are specifically engineering connotations.

It is well known that the development of railways by the Australian colonies occurred separately, and the resulting variety of track widths is one of the technical embarrassments of the nation. Their history is an interesting one, beginning with a few small horse-operated lines around 1854 and progressing eventually to steam and finally electrified systems in each of the states. In the early days of steam railways the locomotives and rolling stock were purchased overseas, but as early as 1854 a complete locomotive was successfully built in Victoria. By 1856 New South Wales, Victoria and South Australia all had steam railways operating, and all were government owned. By 1864 the Victorians had a line to Echuca on the River Murray, linking up with the thriving steamboat trade there.

Historical writing on Australian railways and tramways has tended to have the same piecemeal approach. There are reasonably satisfactory accounts available for most of the state systems, but suitable books dealing with railways or tramways nationally are conspicuously absent.

Australian aeronautical engineering is another area where suitable publications are lacking—perhaps that branch of engineering is yet too young to be much concerned with such things.

Finally we would draw attention, very briefly, to a small group of contemporary Australian engineers (as distinct from economists, general historians and others) who are pursuing historical research into specific areas of technical endeavour. They include the authors of this literature survey (South Australian engineering and Australian agricultural machinery, respectively), P. Milner in Victoria (metal mining and its technology), D.J. Fraser (lattice-girder bridges in New South Wales), C. O'Connor (Australian bridges generally), and R.L. Whitmore (coalmining in Queensland). Already O'Connor has published a small book (1983) and Whitmore two substantial ones (1981, 1985). In addition the latter has for some time been active in promoting the serious study of engineering history in that state.

The following bibliography is divided for convenience into five sections. The items included should indicate something of the great diversity of engineering work carried on within Australia over the years, and perhaps also something of its uniqueness.

For assistance with the compilation of this essay and bibliography, the authors are grateful to Drs P. Milner and B.W. Field of Melbourne, and to Mr I. Macfarlane of Canberra.



English Electric Company of Australia Ltd Tender, 1924. One of the unsuccessful tenderers for the Sydney Harbour Bridge was the English Electric Company of Australia Ltd which produced this design for a stiffened suspension bridge in 1924. The successful tenderer, Dorman Long and Co, built an arch bridge between 1925 and 1932.

BOOROWA PRODUCTIONS

## INVENTIONS, AGRICULTURAL AND PASTORAL MACHINERY

AUSTRALIAN ACADEMY OF SCIENCE. Science and Industry Forum, Canberra, 1977. *From stump-jump plough to interscan: a review of invention and innovation in Australia; papers delivered at a meeting ...* Canberra, The Academy, 1977. 112 p, illus. (Forum report, 10, 1977.)

Papers reviewing some Australian inventions—though nothing on the stump-jump plough. Those on Sirotherm and Interscan are the most interesting.

CONIGRAVE, J.F. *Agriculture in South Australia: a description of the South Australian seed-sower, stripper, and winnower*. Adelaide, Government Printer, 1883. 11 p, illus.

A rare document for this period in that it includes some technical detail. It was prepared, at the behest of the South Australian government, for the Calcutta Exhibition of 1883–84.

DUTTON, F.S. *South Australia and its mines*. London, T. & N Boone, 1846. 361 p, illus, maps.

Primarily concerned with mines and mining, but it contains also a detailed description (with diagrams) of the Ridley stripper. Facsimile edition, Adelaide, Austaprint, 1978.

FRASER, A.D. *This century of ours, being an account of the origin and history during one hundred years of the House of Dangar, Gedye & Malloch Ltd*. Sydney, Halstead, 1938. 214 p, illus. Chapters 16 ff and the appendix provide probably the best available account of the development of the shearing handpiece.

KENDALL, J. 'H.V. McKay: a pioneer industrialist' in *Victorian historical magazine* 43, 3, 1972, 885–95.

One of the few soundly written pieces dealing with McKay's contributions.

LANG, W.R. *James Harrison pioneering genius*. Newtown, Vic, Neptune, 1982. 141 p, illus, maps.

Well-researched first book on the achievements of this important Australian inventor whose work made possible frozen meat exports.

PORT, L.W. AND MURRAY, B. *Australian inventors*. Sydney, Cassell, 1978. 205 p, illus, map.

Rather lacking in factual accuracy more often than is comfortable. However, there is little else available of this type.

SELFE, N. *Machinery for refrigeration ...* Chicago, H.S. Rich and Co, 1900. 416 p, illus.

An early work by an Australian pioneer in this field which should be read following W.R. Lang (1982).

WHEELHOUSE, F.L. *Digging stick to rotary hoe: men and machines in rural Australia*. Sydney, Transpareon, 1977. 222 p, illus.

A pioneer work clearly written and well illustrated but contains, like Port and Murray (1978), a disturbing number of incorrect assertions. First published in 1966.

## MANUFACTURING INDUSTRY, MINING AND METALLURGY

BLAINEY, G.N. *The steel master: a life of Essington Lewis*. Melbourne, Macmillan, 1971. 217 p, illus.

Biography of an important industrialist, whose dynamism and vision saw the Broken Hill Proprietary Company through the years of the depression become one of the world's steelmaking giants.

CHARLETON, A.G. *Gold mining and milling in Western Australia, with notes upon telluride treatment, costs and mining practice in other fields*. London, E. & F.N. Spon, 1903. 648 p, illus.

Provides a good and detailed treatment of early mining and mineral processing in the West Australian goldfields.

CLARKE, D. *Australian mining and metallurgy*. Melbourne, Critchley Parker, 1904. 534 p, illus, maps.

An account of mining and mineral processing in WA, Qld, Vic, NSW and Tas.

GREEN, F.A. *The Port Pirie smelters*. Melbourne, Broken Hill Associated Smelters, 1977. 170 p, illus.

Written by one who was associated with the development and operations of the smelters, their people, plant, processes and products.

HUGHES, H. *The Australian iron and steel industry 1848–1962*. MUP, 1964. 213 p, illus, map.

An excellent work with emphasis on economic history, but the coverage of technical matters is adequate and accurate.

KING-ROACH, J. *Not without courage: the story of the fortunes which one hundred years of trading have witnessed for Hawke and Co ...* Adelaide, Griffin, 1957. ix, 28 p, illus.

History of a significant South Australian manufacturer of mining and agricultural equipment between 1860 and 1920. The firm continued until 1983.

LEWIS, E. *Importance of the iron and steel industry to Australia*. Adelaide, Hassell, 1948. 33 p, map.

A published lecture by the then chairman and guiding spirit of BHP.

MAWSON, P. *A vision of steel: the life of G.D. Delprat, C.B.E., general manager of B.H.P., 1898–1921*. Melbourne, Cheshire, 1958. 269 p, illus, maps.

An account of Delprat and his career in the Australian steel industry, with little in the way of hard technical information.

PENN, D.W. *How firm the foundation: a historical survey of an independent venture that founded the Portland Cement industry in Australia*. Sydney, Concrete Publishing, 1977. 182 p, illus.

A good history of the cement industry in Adelaide, with special emphasis on the Brighton Cement Company and those who worked for it.

WHITMORE, R.L. *Coal in Queensland: the first fifty years: a history of early coal mining in Queensland*. UQP, 1981. 185 p, illus, maps.

A substantial work and most important contribution. A further volume, published in 1985, brings the story up to 1900.

## WATER SUPPLY AND HYDRO-POWER

AIRD, W.V. *The water supply, sewerage and drainage of Sydney: an account of the development and history ... from their beginnings with the first settlement to 1960 ...* Sydney, Metropolitan Water, Sewerage and Drainage Board, 1961. 347 p, illus, maps.

Comprehensive treatment, engagingly written and accompanied by detailed statistics.

EATON, J.H.O. *A short history of the River Murray works*. Adelaide, Government Printer, 1945. 69 p, illus, maps.

A useful account of the engineering works carried out on the River Murray between 1890 and 1940, written by a member of the River Murray Commission. Also deals with the political rivalries which complicated the execution of projects.

GARVIE, R.M.H. *A million horses: Tasmania's power in the mountains*. Hobart, Hydro-Electric Commission, 1962. 111 p, illus, maps.

The development of hydro-power in Tas from Duck River power station in 1895 to Poatina in the Great Lakes. Good bibliography.

HILL, E. *Water into gold*. Melbourne, Robertson & Mullens, 1937. 328 p, illus, maps.

A good history of the work of the Chaffey brothers in establishing irrigation in the Mildura–Renmark region. Reissued in many editions.

MEEKING, C. *Snowy Mountain conquest: harnessing the waters of Australia's highest mountains*. London, Hutchinson, 1968. 192 p, illus, maps.

The work involved in the Snowy scheme, the people who carried it out, and the problems they faced.

ROSEBY, T.J. *Sydney's water supply and sewerage, 1788–1918*. Sydney, Government Printer, 1918. 112 p, illus, maps.

An early account of the establishment and development of Sydney's water supply, and those involved in the work.

TAUMAN, M. *The chief: C.Y. O'Connor*. UWAP, 1978. 290 p, illus, maps.

Biography of the government's chief engineer for WA responsible, among other things, for the design and construction of the harbour at Fremantle and the water supply to Coolgardie and Kalgoorlie. For a time he was also chief engineer of the state's railways.

THOMAS, H.H. *The engineering of large dams*. London, Wiley, 1976. 2 vols, illus, maps.

A comprehensive Australian textbook on the design and building of large dams, with reference to actual and past Australian projects.

WIGMORE, L.G. *Struggle for the Snowy: the background of the Snowy Mountains Scheme*. OUP, 1968. 215 p, illus, maps.

An account of the Snowy Mountains hydro and irrigation scheme, with details of the economic and political factors and the personalities involved, but little on the engineering aspects of the scheme.

## TRANSPORT AND PUBLIC UTILITIES

ARMSTRONG, J. ed, *Shaping the Hunter: a story of engineers, and the engineering contribution to the development of the present shape of the Hunter Region ...* Newcastle, NSW Newcastle Division, Institution of Engineers, Australia, 1983. 192 p, illus, maps.

Engineers and their contribution to the development of the Hunter River waterway, and also the cities, industries and transport of the region.

BEADELL, L. *Outback highways*. Adelaide, Rigby, 1979. 237 p, illus, maps.

An account of the development of roads in connection with the Woomera rocket range; the people and events associated with their construction.

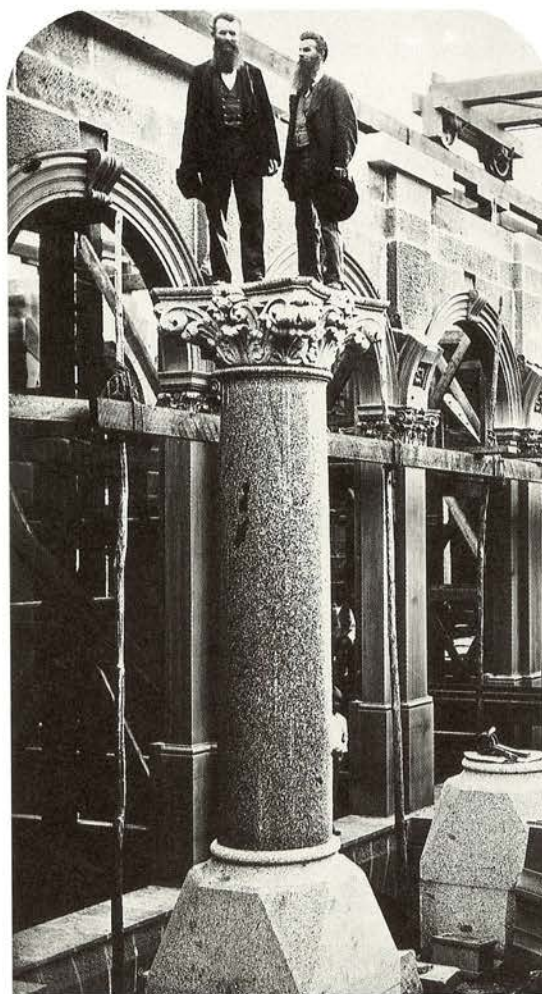
CARROLL, B. *Getting around town: a history of urban transport in Australia*. Sydney, Cassell, 1980. 176 p, illus.

A history of city transport from the horse-buses of 1849, through the eras of horse-drawn, steam, cable and electric trams, to the taxis, buses and suburban trains and ferries of the present day.

COANE, J.M. et al, *Australasian roads: a treatise, practical and scientific, on the location, design, construction and maintenance of roads and pavements*. Melbourne, Robertson, 1908. 334 p, illus.

A description of all aspects of municipal and general road engineering, including descriptions of hand and horse-operated machines, as well as those powered by steam, petrol and oil. Fifth edition, published 1937, contains 811 pages.

FITZGERALD, A. ed, *Canberra's engineering heritage ...* Canberra, Canberra Division, Institution of Engineers, Australia, 1983. 211 p, illus, maps.



Granite columns at the GPO in Martin Place, Sydney. Photograph, c1879–80. Government departments regularly captured on film the progress of capital works during various stages of construction and demolition primarily for their own records though some were used as promotional material in government publications. Their photographic collections provide a rich source of historical data.

NSW GOVERNMENT PRINTING OFFICE

The work of engineers in creating roads, railways, urban public transport, lakes and dams, water supply and sewerage systems, electricity supply, and other amenities in Canberra.

HARRIGAN, L.J. *Victorian railways to '62*. Melbourne, Victorian Railways Public Relations Board, 1962. 299 p, illus, maps.

A detailed but readable history, liberally supported by photographs, maps and statistics.

HARTNETT, L.J. *Big wheels and little wheels*. Melbourne, Gold Star Publications, 1973. 278 p, illus.

An authoritative account of the beginnings of the Australian automobile manufacturing industry, by one of its most important pioneers. First published in 1964.

HAYS, W.B. *Engineering in South Australia*. London, printed by John Knott, 1856. 45 p, illus, map.

A description of colonial engineering works and of bridges over the River Torrens in Adelaide, and the development of Port Elliot and its tramway. Facsimile edition, Adelaide, LBSA, 1965.

KEATING, J.D. *Mind the curve! A history of the cable trams*. MUP, 1980. 173 p, illus, map.

A history of the cable tram system in Melbourne, the company and people that operated it, and the establishment of the Melbourne and Metropolitan Tramways Board.

KINGSBOROUGH, L.S. *The horse tramways of Adelaide and its suburbs, 1875-1907*. Adelaide, LBSA, 1967. 101 p, illus.

Deals briefly with the systems, the types of equipment used and the various tramways companies of the period.

NEW SOUTH WALES. Dept of Main Roads. *The roadmakers: a history of main roads in New South Wales*. Sydney, The Department, 1976. 335 p, illus, maps.

A comprehensive discussion of roads and roadbuilding including bridges in NSW from 1788 to the mid-1970s. Includes an account of the difficulties in constructing roads through the Blue Mountains.

NEW SOUTH WALES. Dept of Railways. *The railways of New South Wales, 1855-1955*. Sydney, The Department, 1955. 304 p, illus.

A good coverage of the NSW railway system, with reasonable technical detail.

O'CONNOR, C. *How to look at bridges: a guide to the study of Australian historic bridges*. Canberra, Institution of Engineers, Australia, 1983. 50 p, illus.

This booklet instructs the reader how to 'interpret' some of Australia's bridges.

PHILLIPS, V. *Bridges and ferries of Australia*. Sydney, Bay Books, 1983. 160 p, illus, maps.

A lively book on these seldom treated subjects, but slight in technical content.

PHILLIPS, V. *Romance of Australian lighthouses*. Adelaide, Rigby, 1977. 221 p, illus.

An account of the lighthouses with particular reference to the people who built and manned them. Short on technical detail.

SERLE, G. *John Monash: a biography*. Melbourne, MUP in association with Monash University, 1982. 600 p, illus, maps.

The life and work of an engineer who pioneered reinforced concrete, became a leading general in World War I, and then chairman of the State Electricity Commission of Vic during its formative years.

SOUTH AUSTRALIA. Railways Dept. *South Australian railways: locomotives, steam and diesel electric, and rolling stock*. Adelaide, Government Printer, 1964. 56 p, illus.

This small work deals with its subject in reasonable technical detail.

UREN, M.J.L. AND PARRICK, F. *Servant of the state: the history of the Main Roads Department, 1926-1976*. Perth, The Department, 1976. 44 p, illus, maps.

As the preface states, 'the reader who looks in these pages for learned reports on engineering details of roads and bridges will be disappointed'. Nevertheless, a useful general account.

WARREN, W.H. 'History of civil engineering in New South Wales', *Report of the Meeting of the Australasian Association for the Advancement of Science* 1, 1888, 590-648.

An early review paper of NSW works relating to bridges, roads, railways, punts and ferries, tunnels and viaducts, water supply (for Sydney and several other towns), sewerage, harbours and docks.

## MISCELLANEOUS

BIRMINGHAM, J. *et al*, *Australian pioneer technology: sites and relics ... towards an industrial archaeology of Australia*. Melbourne, Heinemann Educational, 1979. 200 p, illus, maps.

BIRMINGHAM, J. *et al*, *Industrial archaeology in Australia: rural industry*. Melbourne, Heinemann, 1983. 191 p, illus, maps. These two efforts at interpreting Australian history through the evidence of industrial relics and environmental changes offer a new view of how European immigrants adapted to their country and point to some local innovations of national (and sometimes even international) significance.

CAMPBELL-ALLEN, D. AND DAVIS, E.H. eds, *The profession of a civil engineer: papers written for Jack William Roderick by former students*. SUP, 1979. 229 p, illus.

Biography of Professor Roderick and some general papers on engineering in Australia.

CORBETT, A.H. *The Institution of Engineers, Australia: a history of the first fifty years, 1919-1969*. Sydney, Institution of Engineers, Australia, in association with A & R, 1973. 288 p, illus.

An account of engineering activities in Australia, the people who were prominent and the various engineering organisations and societies.

LLOYD, B.E. *Engineering manpower in Australia*. Melbourne, Association of Professional Engineers, Australia, 1979. 420 p, illus.

Examines the nature of engineering works and the various skills required of professional engineers, technicians and tradesmen.

LLOYD, B.E. AND WILKIN, W.J. *The education of professional engineers in Australia*. Melbourne, Association of Professional Engineers, Australia, 1968. 490 p, illus.

Discusses the aims and ideals of engineers and the educational processes which form them. Includes a historical look at the features of the major institutions involved in educating engineers. First published in 1959.

McNICOLL, R.R. *The Royal Australian Engineers*. Canberra, Corps Committee, Royal Australian Engineers, 1977- . v, illus.

Australia's army engineers in both peace and war. Three volumes have so far been published covering the years 1835 to 1945. A planned fourth volume will cover the years to 1975.

