

8.01 Iron

- a local iron
- b imported components
- c local foundries
- d structural developments

a. local iron

The local extraction of iron was on too small a scale to be of much significance to the building industry until well into the twentieth century. The first smelting of iron in Australia was undertaken in 1848 at Ironstone Bridge, near Mittagong, New South Wales. The ore was from the New Sheffield mine, which became the Fitz Roy Iron Mine, following a visit by the eponymous governor in 1850.¹ The Fitzroy iron smelting works were opened in 1852, and operated only intermittently and approached viability only in the 1860s, when the hot blast system was introduced and rolling mills installed, before the works were again closed. During this brief efflorescence, however, large beams were cast for the Gundagai Bridge, and iron girders for Vickery's Chambers in Pitt Street, Sydney.² New Zealand was not far behind, for in 1849 feruginous sand on the island of Taranaki, near Wellington, was smelted to produce what was said to be superior quality iron (or, according to one account, steel), from which a knife blade was made.³ Nothing seems to have come of this in the long run.

There were a number of subsequent iron mines opened in Australia, all more or less abortive, but for a substantial operation established at Lithgow, by James Rutherford, who began smelting operations in October 1875. He was unsuccessful, and deliberately blew up the blast furnace in 1885,⁴ but this was not the end of the site: it was to rise to new importance under the control of William Sandford, who produced Australia's first steel there, of which more below. Until then the total contribution of locally produced iron to the Australian building industry had been those few components cast at the Fitz Roy works in the 1860s.

¹ Helen Hughes, *The Australian Iron and Steel Industry 1848-1962* (Melbourne 1960), pp 3-4; Ian Jack. 'The Iron and Steel Industry', in Judy Birmingham, Ian Jack & Dennis Jeans [eds], *Australian Pioneer Technology* (Richmond [Victoria] 1979), p 88; Jack Southern & Jeremy Platt, *The History of Ironmaking in Australia 1848-1914* (Port Kembla [New South Wales] 1986), p 17.

² *Sydney Morning Herald*, 6 June 1865, quoted in Southern & Platt, *Ironmaking in Australia*, p 20. The report refers to the preparation of the mould for casting one of the bridge beams, which indicates that Jack, 'Iron and Steel Industry', p 88, is incorrect in describing them as being of wrought iron.

³ *Hobart Town Courier*, 3 November 1849, quoting the *Wellington Spectator*.

⁴ Hughes, *Australian Iron and Steel Industry*, pp 18-25; Jack. 'The Iron and Steel Industry', p 93 ff; Southern & Platt, *Ironmaking in Australia*, pp 28-9.

b. imported components

Iron reached Australia in only very small quantities before the middle of the nineteenth century, and apart from nails, which will be dealt with below, the most prominent items were cast iron window sashes. These resembled those illustrated by Loudon in 1833,⁵ and appear at Highfield, Tasmania, in the 1830s and 1840s,⁶ and 'Woodlands', Tullamarine, Victoria, in 1842-3; Dunn's Cottage, Mount Torrens, South Australia, in 1844-5;⁷ and in Gothic versions at 'The Hermitage', The Oaks, New South Wales, of the early 1840s, and in three West Australian examples, Upton House, Australind, of 1844; William Forrest's house at Bunbury, of 1849;⁸ and, re-used from elsewhere, at 'Leschenault House', Bunbury.⁹ A rather more elaborate form appeared in the largely Singapore-made house, 'St Ninian's', in the Melbourne suburb of Brighton, built from 1841 onwards but now demolished. Each sash was divided into three horizontally and four vertically, but the top panes terminated in arches, which were not so much Gothic as Moresque, as they waisted inwards at the springing.¹⁰

Some of these sashes were bought off the hook from ironmongers or dealers, while others arrived as part of a prefabricated house package. For example, sashes are included in a list of the various tools and implements for emigrants available in 1840 from the London ironfounders Cottam and Hallen.¹¹ At the Australind settlement in Western Australia, the house brought for the commissioner, Marshall Clifton, was supplied with sashes which had been bought from Manning of London, who was a prefabricator, and must have made the house itself. However, they measured 2 ft 8 in by 1 ft 5 in [800 x 425 mm], which Clifton thought completely inadequate for the local climate, and he preferred the casement sashes supplied with the other buildings, measuring 4 ft 4 in by 3 ft 10 in [1.321 x 1168 mm]. These were from Thompson,¹² presumably meaning Peter Thompson, the other leading London prefabricator. These are the sashes that survive at Upton House, Forrest's house at Bunbury, and the outbuildings of 'Leschenault House'. They are divided into twelve panes, three across by four high, with Gothic arches in the top ones. A distinctive characteristic is that

⁵ J C Loudon, *Encyclopædia of Cottage, Farm and Villa Architecture* (London 1846 [1833]), § 307, p 154. The tradition was much older. According to Hugh Morrison, *Early American Architecture from the First Colonial Settlements to the National Period* (New York 1952), p 85, the medieval style casement windows of the original college at Harvard, USA, of 1638-42 were of metal. It seems probable that they were imported from Britain.

⁶ Miles Lewis, 'Highfield and the VDL Company', *This Australia*, V, 3 [1986], pp 17-23.

⁷ Information from Gordon Young, 1991.

⁸ My information on Upton House and Forrest's house is from Ian Molyneux, who says the pattern is the same as at Leschenault House, and similar to The Hermitage. At Upton house each sash is of four panes by three, 1145 x 500 mm, and terminates in three Gothic arches.

⁹ R McK Campbell, 'Leschenault House - Conservation: Preliminary Report' (typescript report, Fremantle [1985]), p 4.

¹⁰ Clare Lewis & Mary Lloyd, 'Portable Buildings' (BArch, University of Melbourne, 1959), plate 3.

¹¹ A manuscript document in the papers of Eliza and Thomas Brown, immigrants of 1840, 'A list of Agricultural Implements, Tools etc Suitable for Emigrants by Cotton [*sic*] and Hallen', quoted in Ian Molyneux and Associates, *'Leschenault Homestead' Conservation Plan* (2 vols, Fremantle [Western Australia] 1996), p 133.

¹² Clifton to the Board of the Australind Company, 9 November [?1840], quoted in Molyneux, *Leschenault Homestead*, p 133.

the central cross bar joins the stile at either side by way of a small semicircle, a detail found in some windows at 'Woodlands', Tullamarine. The latter are not Gothic, but they are part of a house prefabricated by Peter Thompson, and this connection confirms that he was the supplier of those at Australind. It must be conceded, however, that such a detail is not unique to Thompson, for one of the sash designs illustrated by Loudon has such a junction, though on one side only.

The 'Highfield' windows contained small sections within them which opened in casement fashion. In the stable building, of 1836-7, this consisted of 3 x 3 panes in an overall window of 7 x 7 panes, and there was a smaller version in the chapel, of 1842. One of the larger windows illustrated by Loudon in 1833 had a section of six lights which opened by pivoting on a vertical axis, and by 1846 Loudon's widow could illustrate more elaborate types. One had been developed by McCulloch & Co of Glasgow, and had a fixed bottom sash and a smaller top sash which pivoted horizontally, and was held in place by a notched stay. Another, the 'Belper cottage window', had an opening casement section in the middle which, in the example illustrated, consisted of 2 x 2 lights within a 4 x 4 light window. The distinctive improvement was that instead of a stay bar which was designed for a specific degree of opening, and which hung down when not in use, there was a bar of which one end slid in a horizontal track in the sash, and which permitted the opening to be adjusted. It had been invented by Anthony Strutt, and was widely used at Milford and Belper, near Derby.¹³ This type has not been identified in Australia.

In the 1850s cast iron sashes were incorporated in a number of prefabricated iron buildings imported from Britain, especially those made by E T Bellhouse of Manchester, which incorporated openable panels, typically of four lights and pivoting horizontally. This was already a common detail in Manchester cotton mills, which were the sphere of Bellhouse's engineering activity. Locally made sashes also incorporated openings. A particularly large cast iron sash at the 'Stone Hut' near Leura, South Australia, dates from about 1858 and may therefore have been cast locally. It is divided into forty-nine lights, seven across by seven deep, with a panel of 3 x 3 opening as a casement.¹⁴ In Z Block of the Parkside Lunatic Asylum, Adelaide, completed in 1885, the windows are segmentally headed, and were probably required for reasons of security. Two single lights open casement fashion within the overall arrangement of six across and eight high.¹⁵

There are some indications of metal clad buildings in existence as early as the 1830s,¹⁶ but whether they were prefabricated and what they were clad in is unknown. During the early 1850s large numbers of prefabricated buildings were imported, especially to Victoria - some framed in iron, some in timber, and with a cladding of

¹³ Loudon, *Encyclopædia*, §§2462-3, pp 1254-6.

¹⁴ D W Berry & S H Gilbert, *Pioneer Building Techniques in South Australia* (Adelaide 1981), pp 6-7. On p 9 is illustrated (lying on the ground) a window almost exactly the same, but for a segmental head, which the panes are shaped to fit.

¹⁵ A photograph has kindly been supplied by Caroline Wigg.

¹⁶ Lady Jane Franklin recorded staying in a 'tin hut' at Green's station, north of Melbourne, in 1839: Mabel Brookes, *Riders of Time* (South Melbourne 1967), p 69.

sheet wrought iron or corrugated iron, and in a few cases a facade of cast iron.¹⁷ These are somewhat distinct from the normal operations of the building industry, and need not be considered here, but there were other items imported as well, such as iron and glass shop fronts, the first of which, from Glasgow, was used for Carson's shoe shop in Melbourne.¹⁸ Cast iron columns, probably also imported, were on sale in 1856 as standard items in lengths from eight to thirteen feet [2.2 to 3.9 m].¹⁹ These are found in buildings of the period mainly in basements, or supporting internal balconies in public buildings and churches, but also occasionally in domestic verandahs.²⁰ It was not until 1868 that iron columns became the norm for shop verandahs in Melbourne. A most prolific source of components of all sorts, including elaborate fountains,²¹ garden buildings,²² gates,²³ and the cast iron balustrading which is discussed separately below, was Walter Macfarlane & Co of Glasgow. The same was true in South Africa.²⁴ At dates Macfarlane's patterns were imitated with some

¹⁷ The writer has dealt with these elsewhere in various publications, of which the most accessible is Miles Lewis, 'The Portable House', in Robert Irving [ed], *The History and Design of the Australian House* (Melbourne 1985), pp 274-289.

¹⁸ Alexander Sutherland et al, *Victoria and its Metropolis* (2 vols, Melbourne 1888), II, p 709.

¹⁹ *Argus*, 23 June 1856.

²⁰ 'Black Rock House' in the Melbourne suburb of Sandringham, of 1856, has cast iron columns in the basement and in the verandahs.

²¹ His catalogues show many items which are familiar in Australia, most of all the ornamental drinking fountains to be found in Green Park, Darlinghurst; Kensington, South Australia; Williamstown; Launceston; Hay, &c: Walter Macfarlane & Co., *Illustrated Catalogue of Macfarlane's Castings* (6th ed, 2 vols, Glasgow, no date [c 1880s]), II, pp 412-13. E G Robertson & Joan Robertson, *Decorative Cast Iron in Australia* (South Yarra [Victoria] 1984), illustrate the Green Park fountain, p 46. The *Town and Country Journal*, 9 July 1870, reports that eight such fountains have been imported by A Chisholm of Sydney at a total cost of £269.3s.8d, and it has been suggested that one be erected in each ward of the municipality. Robertson illustrates the Launceston fountain, p 85, and in Robertson, *Ornamental Cast Iron: a World Heritage* [GET DETAILS], pl 462. The fountain at Kensington, of 1887, is illustrated in Australian Heritage Commission, *The Heritage of Australia* (Melbourne 1981), p 5/31, and E G Robertson, *Adelaide Lace* (Adelaide 1973), p 126. Most of these are of Macfarlane's smaller type, p 412 no 8 (with variations, such as the bust of Queen Victoria on some models), but Launceston is of the larger, p 413 no 20. The fountain at Hay was presented by the mayor, John Whitcombe, in 1883, and bears the Macfarlane diamond brand.

²² The bandstand in Elder Park, Adelaide is illustrated II, p 674, no 225: see also E G Robertson & Joan Robertson, *Decorative Cast Iron in Australia* (South Yarra [Victoria] 1984), pp 204-5. The bandstand at Maryborough, Queensland, is known to have been imported from Macfarlane: Australian Heritage Commission, *The Heritage of Australia*, p 4/33. It appears to be a hybrid of his patterns, most resembling II, p 672, no 223, but with a turret which is a truncated version of II, p 679, no 230.

²³ Notably a magnificent gate at 997 Burke Road, Hawthorn, presumably dating from the construction of the house in the 1890s. It is highly distinctive in form, the top spanned by two concentric arches, and it appears as pattern no 845 in Walter Macfarlane & Co, *Illustrated Catalogue of Macfarlane's Castings* (6th ed, 2 vols, Glasgow, no date [1880s]), I, p 332. All the components - the inner and outer arches, colonettes, side panels, and the gate leaf itself, appear also as separate catalogue items: no 47, II, p 486; no 46, II, p 485; no 15, II, p 571; no 115, II, p 571; no 990, I, p 228 (this shows the upper and lower side panels together, but they also appear separately as no 882, I, pp 191 & 194, and no 189, I, p 297). We know that this gate was produced by Macfarlane because it bears his brand, but the design also appears, with others from his catalogue, in the catalogue of A C Harley & Co, Adelaide, as late as 1914: A C Harley & Co, *"Sun" Foundry Illustrated Catalogue* (2nd ed, Adelaide 1914), no 894, p 50.

²⁴ Desirée Picton-Seymour, *Victorian Buildings in South Africa* (Cape Town 1977), p 22, illustrates Macfarlane's larger octagonal fountain, saying that it differs only slightly from the Vasco da Gama fountain in Durban. Indeed she reproduces many of Macfarlane's catalogue illustrations and implies that these products were widely used in South Africa, but she rarely troubles us with any specific detail.

precision by local founders, so that a close inspection of makers' marks is required to determine their origin.²⁵

Iron fencing for both garden and farm purposes was imported in fairly large quantities, though it is difficult to document. One of the most comprehensive ranges available was that of C D Young & Co of Scotland, who were geared to the export trade and in 1850 published two catalogues, one in Edinburgh and one in Glasgow. These probably reflect the different products of the two works, though they were ostensibly issued on behalf of the whole firm (which had branches also in Liverpool and London).²⁶ The illustrations include all the types of iron fencing found in Australia and more: posts for strained wire fences, various patterns of wrought iron hairpin fencing, hexagonal wire mesh, moveable wrought iron hurdles with spikes into the ground, cast iron gates, and so on.

Numerous other British firms made iron fenceposts, gates and other components. Edward Hill & Co of the Brierley Hill Works, Dudley, Staffordshire, showed a number of items at the Great Exhibition of 1851, including a wrought iron field gate and posts, another field or entrance gate, continuous iron fencing, and wrought iron hurdles.²⁷ At 'Abercombie House', outside Bathurst, of 1870-8,²⁸ the gates are branded by what must be the successor firm:

HILL & SMITH
BRIERLEY HILL

The same brand has been found at 'Baroona' near Singleton, New South Wales, probably dating from the 1880s.²⁹ The firm showed its fencing at the Sydney Exhibition of 1879³⁰ and the Melbourne Exhibition of 1880-1,³¹ and they were still advertising in Britain in 1901.³²

²⁵ Examples are those in Errol Street, North Melbourne, and Machattie Park, Bathurst. The North Melbourne fountain is in Robertson, *Adelaide Lace*, p 125, where it is pointed out that it bears the brand of the local firm of Danks, and cannot be by Macfarlane. The F Grago fountain in Machattie Park, of 1891, bears no brand at all.

²⁶ C D Young, *A Short Treatise on the System of Wire Fencing, Gates, etc., as manufactured by Charles D. Young & Company* (Glasgow 1850); *Illustrated and Descriptive Catalogue of Ornamental Cast and Wrought Iron and Wire Work manufactured by Charles D. Young & Company* (Edinburgh 1850).

²⁷ Great Exhibition of the Works of Industry of all Nations, 1851, *Official Descriptive and Illustrated Catalogue* (3 vols, London 1851), I, pp 383-5. For Hill's bedsteads see II, p 600..
²⁸ Inspected 2002.

²⁹ Information, 1997, from Barney Collins of EJE Architecture, Newcastle. The house itself dates from 1886.

³⁰ Sydney International Exhibition 1879, *Official Catalogue of the British Section* (London 1879), p 306

³¹ Melbourne International Exhibition, 1880, *Official Catalogue of the Exhibits* (2 vols, Melbourne 1880), II, p 340.

³² J E Sears [ed], *The Contractors,' Merchants,' and Estate Managers' Compendium and Catalogue* (London 1901), pp 140-141.

Many such elements were made by Francis Morton & Co, of Liverpool and Manchester.³³ Morton had supplied five school buildings to the National Schools Board of Victoria in the eighteen-fifties, but it is not his work as a prefabricator that most concerns us here. At the 1862 Exhibition in London Mortons showed their patented improvements in permanent railway fences, iron telegraph poles, and galvanized corrugated iron roofs and buildings.³⁴ Francis Morton himself died at the age of forty-eight, and to provide funds the business was formed into a limited liability company, the first in Liverpool following new legislation in 1861. Francis's eldest son, another Francis, became managing director, and William Llewellyn Davies, civil engineer, became managing director.

The business prospered. Patents were taken out for railway and park fencing, the company was put on the list of government contractors, offices were opened in London and Glasgow, and more modern works were established in Naylor Street, only to be themselves superseded in 1880.³⁵ In 1879 the Australian *Town and Country Journal* illustrated a number of the buildings then available from Morton, and reported that the company was represented by G H Royce and Co of George Street, Sydney. Royce undertook that the buildings could be put up at a fixed cost to the purchaser at any location in Australia within one hundred miles [160 km] of a railway station.³⁶ This may have been a considerable selling point, especially in Queensland, which was served by a number of separate lines running inland from the coast, but not linked in the north-south direction.

While it has not so far been possible to identify any complete buildings by Mortons, some of their other products are found in Queensland, notably at Ravenswood, where the cemetery fence and gates bear his brand, as does a small fence standard which now supports a rubbish bin in the Main Street. This humble object is a minuscule version of the iron telegraph pole which Mortons exhibited in 1862: that is, a tapering pole of circular cross-section, made up in two halves with continuous flanges projecting outwards, and joined together through these flanges. A fence post of the same character, presumably by Morton, is found at Corwar Lodge, near Barhill, New Zealand.³⁷ Morton gates are also found at E H T Plant's house, 'Thornburgh', in Charters Towers, apparently contemporary with the house of 1890. These are the last datable products identified in Australia.

All rolled wrought iron sections, and later all steel sections until the early twentieth century, were imported, except for some very small wrought iron bars and rods which were rolled locally from scrap. However specifically fabricated iron structural components are rare. The commonest are cast iron columns, like those of the Eveleigh Railway Workshops, Sydney, discussed below. The Sydney Mint complex of about 1855 has in the overseer's office and bullion room parallel chorded Howe trusses carried on cast iron columns, greatly resembling the system of the Crystal

³³ Morton's business, known as the Patent Galvanized Iron and Corrugated Iron Works, had its head office at James Street, Liverpool ('late of the Coalbrookdale Company's premises') and a branch at 18 St Mary's Street, Manchester.

³⁴ *Illustrated Catalogue of the International Exhibition, 1862*, pp 27, 30-31.

³⁵ J M Swift, *The Story of Garston and its Church* (Garston [Lancashire] 1937), p 186.

³⁶ 'Iron Buildings Illustrated and Described', *Town and Country Journal*, XIX, 477 (1 March 1879), p 405.

³⁷ Visible in a photograph in Geoffrey Thornton, *Cast in Concrete* (Auckland 1996), p 59.

Palace, London. They were made in England by John Walker in 1853-4.³⁸ Various imported prefabricated buildings of the of the 1850s include specially designed or even patented components, especially those of E T Bellhouse of Manchester. The footbridge at Sofala, New South Wales, was first put up at a site on ther Fish River, probably in the 1860s or 1870s, and was moved to Sofala in about 1881-2. It bears the letters 'BDH', which have been identified as the mark of Joseph Hall (1789-1862), ironmaster at the Blomfield Ironworks, Tipton, Staffordshire.³⁹

c. local foundries

Local blacksmiths were probably responsible for many building components which might in Britain have been obtained more cheaply from a specialist maker or factory, but small items of ironmongery like nails, screws, hinges and locks, were mostly imported. In general, very little iron was used in building work during the first half century of settlement, and when Thomas Randall and Richard Harding opened their smithy in Sydney in 1805, their advertisement referred only to farming equipment, ironwork components for carts and carriages, and harness furniture.⁴⁰ Even when local foundries were established they concerned themselves at first mostly with machinery, and to some extent with structural components, but rarely with architectural ornament. As all the iron was imported in the first place, it was sensible to expend the labour on it Britain, where it was cheap, rather than in Australia, where, as the convict era declined, it was increasingly expensive. This might not be the critical factor where the work was required in a hurry, or had to be locally designed, so it was work in those categories which made up the bulk of foundry business. Suprisingly, however, it seems that wire was produced in Sydney by 1803, when an advertisement appears for missing steel plate used for wire drawing, six inches [150 mm] long, and pierced with thirty holes.⁴¹

James Blanch opened Australia's first recorded foundry in George Street, Sydney, in 1823, but this was principally an engineering works, apart from minor sidelines like making dish covers and repairing umbrellas.⁴² In 1831 A B Spark's house 'Tusculum' at Pott's Point, Sydney, was designed by John Verge with a surrounding verandah and balcony on cast iron columns,⁴³ but in the absence of information to the contrary they must be assumed to have been imported rather than produced by Blanche. Richard Dawson's Australian Iron and Brass foundry opened in Sydney in 1833, and at first it likewise had little impact upon the building industry. However, it cast the fourteen fluted columns to carry the gallery in John Bibb's Congregational Church, Sydney, of 1841-6, which were the first such components in the colony, and were finished in

³⁸ John Walker to Captain E Ward, 24 January & 2 February 1854, Archives Office of New South Wales, 2/764.

³⁹ Emails on the Engineering Heritage chat site from Stuart Read and Tony Brassil, 29 July 2005, and identification by Ian Bowie quoted in *Sydney Morning Herald*, 1 August 2005.

⁴⁰ *Sydney Gazette*, 10 February 1805, p 1.

⁴¹ *Sydney Gazette*, 1 May 1803, p 9.

⁴² Brian Turner, *Australia's Iron Lace* (Sydney 1985), p 30.

⁴³ Morton Herman, *The Early Australian Architects and their Work* (2nd ed, Sydney 1959 [1954]), p 169.

imitation bronze.⁴⁴ It is interesting that at this time cast iron columns, though well established in England, had not long been used in the United States, where one of the first examples was the Naval Asylum, Philadelphia, of 1827-35.⁴⁵ By 1851 the Australian Foundry had expanded into the building market, and advertised 'Cast and Wrought Iron Railing and Balconies'.⁴⁶

The ironfounder Robert Russell was an emigrant from Fife, who reached Hobart in 1832 to establish an engineering and foundry works with his sons, Robert, Peter and John. By 1835 they advertised an extraordinary range of products, including gates, railings, palisades and fences. However the fact that they were prepared to make these does not establish that they had received orders and were doing so. The transfer of the business to Sydney in about 1838 suggests that trade was not so good as the advertising would suggest.⁴⁷ The new business operated in Queens Square, Sydney until Peter Nicol Russell left to buy Blanch's original foundry in George Street, from which he filled such early orders as those for the Victoria Barracks and the Darlinghurst Gaol.⁴⁸

The lower wages in Sydney enabled founders to export structural ironwork even to Melbourne in the 1850s, as will appear below. It is likewise probable that they exported decorative ironwork, which was at first hardly made in Melbourne, though this has yet to be specifically demonstrated. Certainly it can be shown that Sydney iron reached Port Fairy, Victoria, in the 1850s (the Mills Cottage, as discussed in a later section), and it can readily be understood that for such a destination, where even Melbourne iron required to be sent by ship, the length of the sea voyage is not so significant a part of the cost as the production expenses.

In Melbourne the first foundry was opened in 1842 by Robert Langlands and Thomas Fulton, who were to be enormously influential in training those that followed. The partners split up in 1846, when Fulton set up in business with George Annand and Robert Smith,⁴⁹ while Langlands apparently remained at the original foundry, where he was joined by his brother Henry. Fulton, after a brief period elsewhere, moved into what had been Manton's Mills, next door to the Langlandses.⁵⁰ The old foundry was burnt out on 21 November 1850,⁵¹ but not put out of action, for H & R Langlands continued there until sometime before 1857: in that year J F Dow, their former chief

⁴⁴ Joseph Fowles, *Sydney in 1848* (Sydney 1848), pp 39-40, where the columns are erroneously described as ionic.

⁴⁵ Sara Wermiel, *The Fireproof Building: Technology and Public Safety in the Nineteenth-Century American City* (Baltimore 2000), pp 23-4.

⁴⁶ Advertisement in Ford's *Sydney Directory* of 1851, reproduced in Turner, *Australia's Iron Lace*, p 45.

⁴⁷ Turner, *Australia's Iron Lace*, pp 38-9 and p 37, reproducing a flier listing Russell's products, from the Allport Library, Hobart.

⁴⁸ Turner, *Australia's Iron Lace*, pp 44-6.

⁴⁹ 'Garryowen' [Edmund Finn], *The Chronicles of Early Melbourne 1835 to 1852* [2 vols, Melbourne 1888], II, p 959.

⁵⁰ *Argus*, 2 June 1846; 25 September 1846. See also E A Mackay, 'The First Flour Mills of Port Phillip', *Victorian Historical Magazine*, XVI, 4 (November 1937), p 119.

⁵¹ 'Garryowen' [Edmund Finn], *The Chronicles of Early Melbourne 1835 to 1852* [2 vols, Melbourne 1888], I, p 210.

manager and engineer, established his own Port Phillip Foundry in the premises.⁵² Apart from Dow, other Melbourne ironfounders who emerged from the employment of Langlands and/or Fulton included John Buncle, Clement Davidson, William Phillip, James Dangerfield, John Fraser and William Humble.⁵³

In 1851 Robert Fulton was producing cast iron window sashes,⁵⁴ some of which were used in Robert Rogers's Independent Church in Lonsdale Street,⁵⁵ and they were said to be cheaper than wooden ones but 'superior to lead, both in strength and in the keeping out of the dust and weather.'⁵⁶ Building components would still have been a very minor line of business, but in 1857 both the Langlands and Fulton foundries were making cast iron beams and pillars, principally for use in shops and stores.⁵⁷ The Cleve Brothers building in Lonsdale Street, Melbourne, by Leonard Terry in 1858, has cast iron columns at ground floor level, and timber columns with cast iron cross-heads in the basement. By 1860 columns were being cast in Melbourne on a large scale, for George Robertson's bookshop had, on each of its three floors, two rows of 'eleven airy-looking yet substantial iron columns, of colonial manufacture, ending in ornamental capitals'.⁵⁸

In 1854 there were four iron foundries in Melbourne, and by 1860 there were twenty foundries of all sorts (iron, brass and copper), and their prosperity over this period was a matter for remark:⁵⁹

Considering that the iron used in them has to be imported from England, and that the wages are at least four times higher than in that country, it is wonderful that such establishments could have been carried on at all. The superior quality of the work they turn out is no doubt the principal cause of success; for the competition with the imported article must operate against them.

The truth is that the foundries did not engage in much direct competition with imports because they concentrated on those products, such as quartz crushing machinery, for the purchasers of which the need for quick delivery and for local design and modifications outweighed the cost penalty. Moreover they paid high wages voluntarily. Both Henry Langlands and Thomas Fulton were radicals who supported the workers in issues like the Eight Hours Movement, and Robert Fulton, who succeeded Thomas, gave evidence to a government committee in 1860 that he could get men at half the rates he was paying if he wished.⁶⁰ Such a situation could not

⁵² P Just, *Australia* (London 1859), pp 228-9; see also their advertisement in C B Mayes, *The Victorian Contractors' and Builders' Price-Book* (Melbourne 1859), p B.

⁵³ Miles Lewis, 'Tradition and Innovation in Victorian Building 1801-1865' (3 vols, PhD, University of Melbourne 1972), II, p 341.

⁵⁴ *Argus*, 24 January 1851; 10 March 1851.

⁵⁵ Isaac Selby, *The Old Pioneers' Memorial History of Melbourne* (Melbourne 1924), p 239.

⁵⁶ *Australian Illustrated Magazine*, II, 9 (March 1851), p 138.

⁵⁷ Just, *Australia*, p 289.

⁵⁸ *Argus*, 16 July 1860, quoted in George Robertson [ed], *Notices of the Book and Stationery Warehouse, &c* (Melbourne 1860), p 3.

⁵⁹ Just, *Australia*, p 288.

⁶⁰ Victoria. *Votes & Proceedings of the Legislative Assembly 1859-60*, II, pp 237 ff, D26: Progress Report from the Select Committee upon the Tariff: evidence of Robert Fulton, 9 March 1860, pp 119-122.

normally last long, but in the 1860s Victoria instituted protectionist policies and became the manufacturing capital of Australia, thus creating even more work for the foundries.

By 1885-6 Perth had at least three foundries, but this is still only the same number as Melbourne had thirty-five years earlier. Moreover they were somewhat diverse operations: Tomlinson & Sherman's Phoenix Foundry was also a boiler factory; the Perth Foundry also produced implements and carriages; and W H McGlew of the Vulcan Foundry in Murray Street, was also an engineer and wheelwright.⁶¹

The first iron rolling works was established in Melbourne, and proved notably successful. Cairns, Wilson & Amos, formerly of the Carron Timber Yard, Melbourne, opened their Carron Iron Rolling Mills in Dudley Street West in 1860, and began manufacturing bar and rod iron in sizes from $\frac{3}{4}$ to $2\frac{1}{2}$ inch [19 to 51 mm] square or round.⁶² They used scrap iron as the raw material, and their range gradually increased to include flats of up to $1 \times 3\frac{1}{2}$ inches [25 x 89 mm], angles, half rounds, feather-edges, rails and fluted fence bars. Robert Amos had become the sole proprietor by 1866, and by 1868 the mills employed forty people and had a capacity of forty tonnes a week.

It is not clear when the larger structural sizes began to be rolled locally, but in Melbourne the Lion Rolling Mills must have been a pioneering producer. An engineering works established by McCall & Black in the 1850s, which then passed to Anderson,⁶³ seems to have moved to the south bank of the Yarra by the 1870s, and in 1879 launched the Albion scrap iron rolling mill.⁶⁴ In 1883 the business passed to three young partners, Archibald Campbell, John Sloss and A N McCann, who extended its operations in maritime and railway work, but seemingly abandoned the rolling mill.⁶⁵ The old Albion plant was purchased in 1885 and moved to Grant Street, South Melbourne, to become the basis of the Lion Rolling Mills, under the management of Joseph Vaughan. It does not appear that I-sections were made, but large T-sections were rolled, and were used for structures such as the Falls Bridge over the Yarra.⁶⁶

d. structural developments

Structural iron, other than the occasional use of cast iron columns to support church galleries or verandahs as discussed above, hardly existed in Australia before 1850. And it is striking that the situation was not much different in the United States where, as Sara Wermeil has pointed out, 1850-51 was the watershed for introduction of structural iron such as had been used in Britain and France for half a century.⁶⁷ Cast

⁶¹ *Western Australian*, 1 May 1885, quoted in Ingrid van Bremen, 'The New Architecture of the Gold Boom' (PhD, University of Western Australia 1990), p 147.

⁶² C B Mayes, *The Australian Builders' Price-Book* (Melbourne 1862), p ix.

⁶³ Alexander Sutherland [ed], *Victoria and its Metropolis* (2 vols, Melbourne 1888), II, p 589

⁶⁴ Susan Priestley, *South Melbourne: a History* (Melbourne 1995), p 114.

⁶⁵ Sutherland, *Victoria and its Metropolis*, II, pp 114-5.

⁶⁶ Sutherland, *Victoria and its Metropolis*, II, p 748.

⁶⁷ S E Wermeil, 'An Unusual Application of Wire Cables from the 1850s: Benjamin Severson's Wire-tied Iron Girders', *Construction History*, XVII (2001), p 43.

iron beams such as those produced by the Melbourne foundries in the 1850s were already an obsolescent concept in Britain, though in wide use in New York and elsewhere in the United States. Cast iron was not good under bending stresses, and wrought iron was now coming into extensive use, largely due to the influence of William Fairbairn, but cast iron girders were used for the Houses of Parliament, Melbourne, in 1856. These were manufactured by T C Prebble's Richmond Foundry. The ironwork for Melbourne University was manufactured in Sydney for three farthings less per pound weight, but this discrepancy was said to be partly due to the simpler fabrication involved (which sounds like wrought iron). Sydney founders, however, tended to obtain the best Melbourne contracts due to the fact that wages there were more than 25% lower, and coal was cheaper.⁶⁸

In Sydney itself, wrought iron box girders carried on cast iron columns were used in Edmund Blackett's Bank of Australasia in George Street (later known as Jamieson House) in 1856.⁶⁹ However, imported cast iron beams from England were used for the Crown Street Reservoir of 1857-8. They were of the fish-belly type, curving up to a greater depth at the centre, which is structurally logical and often illustrated in overseas texts, but not normally found in Australia. The fact that they were individually load tested is also unusual. The system used at the reservoir, in which these beams carried arched brick vaulting, was emulated at the Paddington Reservoir, though that has been subsequently rebuilt.⁷⁰

The first patented I-beam, of a sort, appeared in Britain in 1824, and it was subsequently used by Richard Turner at the Palm House, Kew.⁷¹ Thuasné's flooring system, developed to avoid the use of timber during the Paris carpenters' strike of 1846, was based upon rolled wrought iron I-beams from which as suspended a plaster of Paris ceiling.⁷² C F Zorès developed more exotic sections, one of which - *fer tubulaire* - was in the form of an inverted trough with short flanges on either edge to support hollow tile arches,⁷³ whilst another - *fer à coulisse* - was like an I-beam, but with a double flange at the top.⁷⁴ Zorès claimed to have been working with other manufacturers from 1846 to develop rolled wrought iron beams for framing buildings, and by 1853 he was agent for several other makers, and issued a catalogue illustrating them in an enormous range of sizes. These beams were first used in a house in Paris in 1849.⁷⁵ Anglophone scholars have largely forgotten Thuasné and Zorès, and the true I-beam has been said to have been invented in England in 1853 and, so far as the United States is concerned, first rolled in wrought iron at Trenton, New Jersey, in

⁶⁸ *Australian Builder*, 18 (13 July 1856), p 143.

⁶⁹ Emery Balint & Robert Irving, 'Origins of Metal Structures', *Steel Profile*, 12 (April 1985), p 19.

⁷⁰ Information from Margaret Doring, 1991.

⁷¹ Julia Elton, *Catalogue Number 6* [of Elton Engineering Books] (London 1991), pp 167-8, notes to item 167: C F Zorès, *Receuil des Fers Spéciaux des Expériences faites sur leur Résistance et de leur Diverses Applications dans les Constructions* (Paris 1853).

⁷² *Builder* (UK), XI, 539 (4 June 1853), p 356; E S Eyland, Francis Lightbody, & R S Burn, *Working Drawings & Designs Architecture and Building* (Edinburgh, no date [c 1863]), p 23 & pl xxxvii, figs 28-33; R S Burn, *The New Guide to Carpentry, General Framing and Joinery* (London, no date [c 1870]), pp 331-3, figs 379-387.

⁷³ Eyland, *Working Drawings & Designs*, pp 23-4 & pl xxxvii, figs 33-4; Burn, *New Guide to Carpentry*, pp 333-4, figs 388, 389.

⁷⁴ Burn, *New Guide to Carpentry*, p 334, figs 391-2.

⁷⁵ Elton, *Catalogue Number 6*, notes to item 167.

1854.⁷⁶ The Phoenix Iron Company of Philadelphia followed soon afterwards, and then in 1857 dramatically improved its technology and announced that it would produce much deeper beams, of eighteen to twenty-four inches [450-600 mm], and beams on the Zorès pattern.⁷⁷ Rolled iron joists were used in the Fox & Barrett flooring of Parliament House, Ottawa, begun in 1859.⁷⁸

By 1860 wrought iron beams were standard in Australia for heavily loaded floors in mills and stores, and for bressummers carrying walls across shopfronts. These were of course all imported, as there was no local rolling beyond the use of scrap iron for very small bars and sections. It is impossible to name the precise sources, but the presumption is that they were mainly if not wholly British. At the Parkside Lunatic Asylum in Adelaide, for example, the joists used in 1870 were from the Dowlais works in South Wales.⁷⁹

Plate girders were in use for floors, but box girders were preferred for supporting walls and heavy machinery. Charles Mayes, in his *Australian Builders' Price-Book*, tabulated their load-bearing capacity for spans of ten, fifteen and twenty feet (3, 4.5 and 6 m), assuming rivets of Lowmoor or other superior iron.⁸⁰ In 1887 a 'tubular' [or box] girder eleven metres long and 600 x 400 mm in section was used in the New Oddfellows Hall in Castlereagh Street, Sydney.⁸¹ A number of box girders weighing ten tonnes each were supplied by the Mort's Dock Engineering Company for the Australia Hotel in 1889.⁸² However, these were nothing compared with the giant girder made in the same year by Johnson & Sons of the Tyne Foundry, which was Victoria's (and almost certainly Australia's) largest iron girder to date. This was for the Solomon & Co building in Swanston Street, and measured 24.3 metres long, 2.6 deep and 0.9 wide, weighing 36 tonnes. It was to support five storeys of brickwork, but it was presumably divided into several spans.⁸³ More typical girders, at the National Mutual Life Association in 1890, were built up of 2 ft 6 in x 5/8 in [762 x 16 mm] plate, 4 x 4 x 1/2 in [102 x 102 x 3 mm] angle and 3.1/2 x 3.1/2 x 1/2 in [89 x 89 x 13 mm] stiffeners.⁸⁴

Metal trusses appear to have been unknown in Australia until the arrival of the prefabricated iron buildings of the 1850s. At the Sydney Mint (which was not wholly prefabricated), the trusses came from English prefabricators, the Horsley Iron

⁷⁶ J K Freitag, *Architectural Engineering* (2nd ed, New York 1909 [1895]), p 4.

⁷⁷ Wermeil, *The Fireproof Building*, pp 61-2.

⁷⁸ Eric Arthur & Thomas Ritchie, *Iron: Cast and Wrought Iron in Canada from the Seventeenth Century to the Present* (Toronto 1985), p 159: the claim that this was the first use of rolled iron joists in America is obviously wrong.

⁷⁹ South Australia, Government Architect, *Report from Government Architect* (Adelaide 1870), no page.

⁸⁰ C B Mayes, 'Essay on the Manufactures more immediately required for the Economical Development of the Resources of the Colony', in *Victorian Government Prize Essays, 1860* (Melbourne 1861), p 323; C B Mayes, *The Australian Builders' Price-Book* (Melbourne 1862), p 106.

⁸¹ *Australasian Builder & Contractor's News*, 18 June 1887, p 103.

⁸² *Australasian Builder & Contractor's News*, 26 October 1887, p 397.

⁸³ *Australasian Builder & Contractor's News*, 20 April 1889, p 390.

⁸⁴ Wright, Reed & Beaver, 'Specification for Erection of Premises for the National Mutual Life Association of Australasia. Corner of Collins & Queen Streets Melbourne' (Melbourne 1890), p 11.

Company and/or John Walker, and are of great interest. The Engine Room is roofed with tied wrought iron bow trusses, but carries a horizontal fireproof flooring system above, supported by pieces of plate rising from the top chord. This truss form had long been known in timber, though perhaps more in theory than in practice,⁸⁵ and in iron had recently been used on a massive scale in Robert Stephenson's High Level Bridge at Newcastle. However, as an ordinary iron roof truss it seems to have been exceptional. The coining and rolling room has triangular trusses (though extended at a later date to create a monitor light), which are essentially on the Howe truss principle in that the verticals are tension rods and the diagonals are angle sections designed to take compression. In form and in detail they resemble British trusses of much later dates.⁸⁶ The system used elsewhere in the complex, based upon that of the Crystal Palace, London, has been mentioned above.

By the 1880s cast iron columns were made in large sizes and quantities in Melbourne for industrial and commercial buildings such as the New Zealand Loan and Mercantile Agency store and offices in Collins Street, of 1886, the W B Jones Store in South Melbourne of 1888, and the NZLMA wool stores in Kensington of 1888-9, all designed by Lloyd Tayler. In Sydney, by contrast, John Young saved the then enormous sum of £1600 by obtaining overseas tenders for the ironwork of the Garden Palace exhibition building, and awarding the contract to a Scottish firm.⁸⁷ A large number of cast iron columns were imported from Ireland for the Eveleigh Railway Workshops, branded 'J. Coombe & Sons, Kilkenny'. The difference is probably attributable to the Victorian policy of tariff protection for local industries, and the Langlands Company, which supplied the columns at Kensington, had known thirty years of protection after its establishment as the pioneering foundry of Melbourne.

The Phoenix column, a tube built up out of four, six or eight flanged segments, rivetted together, was introduced in 1862 by the Phoenix Iron Company of Phoenixville, Pennsylvania.⁸⁸ By 1883 it was reported to be in general use in the United States,⁸⁹ but it has yet to be reported in Australia. However W H Lindsay's patent columns, which were very similar, were certainly made and marketed in Australia by 1890. The agents were Johnson & Sons of the Tyne Foundry, Yarra Bank, Melbourne. The columns were made up of trough sections with the arms turned up at 60° angle. When placed together with flanges pointing outwards they created a hexagon, and could be joined by riveting through the flanges. One hears little of wrought iron columns in the United States, where Chicago in particular seems to have moved straight from the cast iron columns which supported buildings up to sixteen storeys high, to those of steel which in 1890 appeared in a number of buildings.⁹⁰

⁸⁵ Peter Nicholson [ed Edward Lomax & Thomas Gunyon], *Encyclopedia of Architecture, being a new and improved edition of Nicholson's Dictionary, &c* (2 vols, London 1852), II, pl III facing p 378, fig 7.

⁸⁶ For example Swansea Station: see A T Walmsley, *Iron Roofs* (2nd ed, London 1888), pl 22; see also Ewing Matheson, *Works in Iron* (2nd ed, London 1877 [1873]), p 196 (truss no 5).

⁸⁷ Peter Proudfoot. "Management and Materials: the Genius of John Young", in Peter Proudfoot, Roslyn Maguire & Robert Freestone [eds], *Colonial City Global City: Sydney's International Exhibition 1879*, (Darlinghurst [New South Wales] 2000) p 63.

⁸⁸ Freitag, *Architectural Engineering*, p 5.

⁸⁹ C D Elliott, *Technics and Architecture* (Cambridge [Massachusetts] 1992), p 106.

⁹⁰ F A Randall, *History of the Development of Building Construction in Chicago* (Urbana [Illinois] 1949), p 15.

After the local appearance of structural wrought iron around 1860, it took almost three decades before the first fully wrought-iron framed building in Australia was built in 1887. It has been stated, almost unbelievably, that it was in the same year that wrought iron columns were being introduced in England by Lindsays of Paddington 'as an improvement on the old cast variety'.⁹¹ Wrought iron angles and tees had been used as vertical members in the walls of prefabricated buildings sent to Australia in the 1850s, and wrought iron columns must have been fairly extensively used in engineering structures. Horbury Hunt is said to have detailed both columns and box girders of wrought iron for Waterloo House, Sydney, whilst working for Blackett in the 1860s, but there is no indication that they constituted a complete frame.⁹² In fact wrought iron columns did not become standard in building until about 1887. They were substantially more expensive than cast iron, but where the loading was eccentric or variable, or included lateral forces like wind loads, as in the newer multi-storey buildings, wrought iron would be far the better material.

The first complete wrought iron frame in Australia (other than the smaller prefabricated examples of the 1850s) was that of the Melbourne Storage Company building, Lonsdale Street, of 1887. It was designed by the architect George Jobbins and the engineer P Behrendt, of Palmer, Scott & Co, who supplied the iron. The outside walls were of conventional masonry construction, but the columns were of built-up angle and flat iron, the girders were Westphalian rolled joists, and there were 9,600 square yards of fireproof flooring carried on arched Traegerwellblech plates.⁹³ Palmer, Scott & Co again supplied Westphalian iron for the structure of the Mutual Store in 1891.⁹⁴

Built-up sections were normally assembled with bolts, and even when mechanical rivetting became available it is doubtful whether it was much used for structural work in Australia (in contrast with Europe and the United States). William Fairbairn & Sons had shown a patent rivetting machine at the Great Exhibition of 1851, but the catalogue refers to its use in constructing wrought iron boilers and other vessels, rather than buildings.⁹⁵ A steam rivetting machine as shown by William James and John Gasforth of the Dukinfield Iron Works.⁹⁶ The first fully rivetted frame in America was the Tacoma Building, Chicago, of 1886-9,⁹⁷ and as early as 1890 the girders of the National Mutual Life Association building in Melbourne (mentioned above), used three quarter inch [19 mm] rivets at four inch [102 mm] pitch.⁹⁸ But there was little further opportunity for the development of rivetting technology in Australia before the depression of the 1890s. Even in the early twentieth century,

⁹¹ Murray Leslie, 'Fifty Years of Architecture and Building, 1887-1936', in J E Sears & J E Sears [eds], *The Architects' Compendium and Annual Catalogue* (London 1936), p v.

⁹² Peter Reynolds & Joy Hughes, 'The Blackett Years: Works 1863-1869', in Peter Reynolds, Lesley Muir & Joy Hughes [eds], *John Horbury Hunt: Radical Architect 1838-1904* (no place [Sydney] 2002), p 40.

⁹³ *Australasian Builder & Contractor's News*, 26 November 1887, p 464.

⁹⁴ *Building and Engineering Journal*, 5 September 1891, p 113.

⁹⁵ Great Exhibition of the Works of Industry of all Nations, 1851, *Official Descriptive and Illustrated Catalogue* (3 vols, London 1851), I, pp 286-7.

⁹⁶ Great Exhibition, 1851, I, p 292.

⁹⁷ C W Condit, *The Rise of the Skyscraper* (Chicago 1951), pp 169-171.

⁹⁸ Wright, Reed & Beaver, 'Specification for National Mutual Life', p 22.

rivetting appears to have been exceptional. Jeffries's *Australian Building Estimator*, of 1907, gives the cost of copper and galvanized rivets by the pound, and tinned rivets by the thousand,⁹⁹ but gives no estimates for the actual process of rivetting. In the following year Mayes's *Builders' Price-Book* gives costs not only for rivetted tanks¹⁰⁰ but for hand and machine rivetting, per hundred rivets.¹⁰¹ Even so this is principally in connection with bridge construction rather than conventional building.↑

⁹⁹ Walter Jeffries, *The Australian Building Estimator* (Sydney 1907), p 154.

¹⁰⁰ C E Mayes, *The Australian Builders & Contractors' Price Book* (7th ed, Sydney 1908), p 187.

¹⁰¹ Mayes, *Australian Builders Price Book* (1908), p 195.