

10.08 *The Flat Roof*

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The use of the flat roof in Australia can be seen as an aspect of climatic design. Notwithstanding the fact that it is not really a form particularly suited to the Australian climate, the South Australian architect Edmund Wright argued that:

the roof of a house, being exposed to the heat of the day and consequently being the medium through which the heat is transmitted should be as small in extent as possible, hence my advocacy of this style and my objection to Gothic architecture, whose steep roofs originated in the colder climate of Europe.¹

The argument is of course fallacious. All other things being equal, the insulation space created in even a moderately pitched roof is a major thermal asset, especially if it is ventilated so that the hottest air escapes. And the cost is and was usually less. Apart from this spurious argument its climatic relevance is indirect, in that it is one aspect of the bungalow syndrome, for the bungalow taken as a whole was undoubtedly seen as a way of responding to a hot climate. It is also true that the flat roof was associated with some otherwise uncommon forms of insulation. It had a functional rationale only very occasionally, such as those few cases where it was used for sleeping out in hot weather. Culturally, its sources were not only Indian, but also South African and British.

In Britain the flat roof was used on some major and well-publicised buildings which would have been known in Australia, and possibly a few private ones, as in the case of Espie's system, referred to above. In India the flat roof made of *chunam* plaster had been used in Mogul architecture and was taken up by European colonists and entrepreneurs, appearing in the buildings of the European factories by the seventeenth century. It was in the nineteenth century that it became common in the houses of East India Company officials, and that the 'classical' bungalow evolved as a separate type.² It is to the influence of these sources, as well as that of Cape Colony, that most of the earlier flat roofing in Australia can be ascribed.

Flat roofs were also well-known in California, a region which was to become very relevant to Australia at the time of the gold rushes. They were of wooden boards covered in pitch or tar, and very susceptible to fire. In one case it was reported that water barrels were kept standing around the perimeter against this eventuality. Others were covered in a layer of sand and then of metal screenings, which made them not

¹ *South Australian Register*, 7 May 1859, quoted in E & R Jensen, *Colonial Architecture in South Australia* (Adelaide 1980), p 185.

² A D King, *The Bungalow* (London 1984), pp 15-16, 38, pls 1, 9.

only trafficable but less combustible.³ In New Zealand a flat roof was used in 1857 on the house 'Blythecliffe' at Akaroa, but no technical detail is available as it was replaced by a hipped roof in the 1870s.⁴

a. the Underwood house

There is some indication that the flat roof may have appeared in Sydney in the first decade of the nineteenth century. An early view by C A Lesuer appears to show a small flat-roofed structure adjoining the parade ground and powder magazine. A more substantial structure was the house of the emancipist trader James Underwood, which C H Bertie first identified as having a flat roof,⁵ and to which Robert Irving has since attributed considerable importance as being the first flat roof in Australia.⁶ This seems somewhat questionable. The house shows in views from about 1808 onwards⁷ as being a foursquare Georgian building with its roof concealed by a parapet, and in one specific view of about 1812, by Absolom West,⁸ the parapet appears to be a balustrade, suggesting that the roof space was trafficable: however, the detail is very obscure.

One must ask whether Underwood's parapet really was a balustrade; whether, the artist, from his vantage point at St Phillip's churchyard, could actually see the nature of the roof; and, most importantly, whether the engraver who executed the plate in England - and who neither had seen the building nor attached any importance to this aspect of it - may not have used his imagination to fill in a few of the details. The other views, which do not particularly suggest a balustrade, are paintings done on the spot. Even West's view does not show the roof itself as being flat, but it does show a small glazed structure standing at its centre, which Irving interprets as being like the deck house of a ship, but which one might more reasonably interpret as an ordinary monitor light. Certainly a flat roof would not have been impossible, and Broadbent suggests that, as Underwood was the proprietor of a ship-building yard, it might well have been planking, caulked and covered in canvas.⁹ More probably, however, it was either of the traditional plaster type, of tarred felt, or of tarred or painted canvas. Such flat roofs were already common at Cape Town,¹⁰ and would therefore have been known to the majority of colonists, who stopped there en route for Australia.

³ P R Wilson, 'The Architecture of Samuel Charles Farr 1827-1916' (MA, University of Canterbury, 1982), p 15.

⁴ Malcolm Edwards, "'Substantial, Fire-Proof Edifices ...' Made so by the Marvelous Invention of Iron Door and Window Shutters', *California Historical Quarterly*, 50 (1971) p 432.

⁵ C H Bertie, *The Story of Old George Street* [Sydney 1920], p 17. It is doubtful whether Bertie was making any specific assertion about the form of the roof beyond the fact of its generally flat appearance in West's view: it is only Robert Irving who has invested it with significance

⁶ Robert Irving, 'A Narrative of Early Sydney and Parramatta', in Tim McCormick et al, *First Views of Australia 1788-1825* (Chippendale [New South Wales] 1987), p 18, pp 375-6.

⁷ John Eyre's view of c 1808, and the anonymous view of c 1809, in McCormick, op cit, p 128 pl 94 and p 126 pl 92.

⁸ McCormick, op cit, p 159, pl 123.

⁹ James Broadbent, 'Aspects of Domestic Architecture in New South Wales 1788-1843' (3 vols, PhD, Australian National University 1985), I, pp 45-7.

¹⁰ Ronald Lewcock, *Early Nineteenth Century Colonial Architecture in South Africa* (Cape Town 1965) pp 8, 385. At Port Frances, on the Kowie River, the Harbourmaster's and Customs Officer's houses had flat roofs at the back, built of wood waterproofed with tarred canvas, and with two inch [50 mm] battens covering the laps in the canvas: Lewcock, p 236.

b. Dalwood

The first unequivocally identified flat roof on the local scene was that built by George Wyndham at 'Dalwood' in the Hunter Valley in 1829-30. The source of the idea, and the source of the structural system, are probably not identical. The technology (as we shall see) may have been inspired by John Nash's contemporary work in England. The concept was probably derived from India, and the probable connection is through Wyndham's friends and neighbours, Helenus and Robert Scott of 'Glendon'. The brothers were Indian born and had architectural interests, and Helenus exchanged visits with Wyndham during the construction.¹¹ It has been claimed that Wyndham favoured the idea of his children sleeping on the roof in the Moorish manner.¹²

The roof at Dalwood consisted of a layer of timber slabs covered in a 150 mm layer of earth, and then a 25-50 mm finishing layer of lime, blood and tar.¹³ On 4 January 1830 Wyndham recorded in his diary that he had begun laying the plaster on his roof, and on 26 January he was washing blood, lime and tar into the cracks. On 18 February he was running the cracks over with tar and sand. In the middle of the following year he was splitting slabs for the roof of the kitchen, and on 3 January 1831 he was putting on the first coat of his composition.¹⁴ Ultimately the whole thing failed and was covered with a shingle roof. The use of *chunam*, or plaster, for flat roofs was reportedly common in India, and the use of lime and blood was common in various forms of traditional earth floor in Britain,¹⁵ but the use of tar suggests a link with Lord Stanhope's composition.

Charles, later Lord Stanhope, invented a fireproof 'composition for flat roofs' which was first used in about 1797 for stables at Broomfield Lodge, Surrey.¹⁶ It consisted of a layer of tar mixed with chalk, which remained flexible, then a layer of tar and sand, which hardened and cracked, but which provided a firm base for slate flagstones, which were placed while the tar / sand layer was still boiling hot. It was then smoothed with large flat irons. Nash used this material in a number of buildings from 1807 onwards, and, at the time 'Dalwood' was built, was roofing Buckingham Palace with it.¹⁷ Any connection of Nash's, such as Francis Greenway, might have known of it.

¹¹ 'Diary of George Wyndham of Dalwood, 1830 - Feb. 1840', Mitchell Library ms B1313; also James Broadbent, 'Aspects of Domestic Architecture in New South Wales 1788-1843' [3 vols, PhD, Australian National University 1985], II, p 413.

¹² G N Griffiths, *Some Northern Homes of N.S.W.* (Sydney 1954), p 126.

¹³ National Trust data sheet, citing, *inter alia*, the Diary of George Wyndham of Dalwood, Mitchell Library, and letters from Dinton to Dalwood.

¹⁴ Diary of George Wyndham of Dalwood, 1830 - Feb. 1840, Mitchell Library ms B 1313, CY Reel 859.

¹⁵ For example, Loudon describes a floor using quicklime and smithy ashes mixed with bullock's blood, stale milk or some other greasy substance. J C Loudon, *Encyclopaedia of Cottage, Farm and Villa Architecture &c* (London 1846 [1833]), § 585, p 280.

¹⁶ Wyatt Papworth [ed], *The Dictionary of Architecture* (London 1853-92), sv Stanhope.

¹⁷ *Mechanic's Magazine* (London), XVIII, 498 (23 February 1833), pp 339-40; XXIX, 775 (16 June 1838), p 79; XXXVIII, 1036 (17 June 1843), pp 497-9. Loudon, *Encyclopaedia*, §1789, p 865-6, cites the 1833 reference. See Papworth for further technical detail

As George Wyndham of Dalwood wrote regularly to his English relatives and described his house, it is not impossible that they in turn told him of Buckingham Palace and of Stanhope's composition, if he was not already conversant with these matters. Moreover the Buckingham Palace roof was extensively reported in the *Mechanic's Magazine* in 1833-8, and if there were any such reports in earlier issues they probably came to Wyndham's attention, for Helenus Scott lent him three volumes in 1830.¹⁸ It is interesting that Wyndham continued building flat roofing even after the first part had begun to crack, for this is consistent with Stanhope's system, in which the cracking of the top layer was expected and was provided for.

c. the South African connection

At Cape Town the flat roof began to be favoured in the buildings of the Dutch East India Company as being less susceptible to fire, and by 1732 began to be used by private settlers as well. By the 1770s the flat roof was becoming the dominant type,¹⁹ and in 1853 Peter Manifold remarked that

The whole of the buildings have flat roofs, being formed of strong plank, with cement over it. This is very heavy, so that the walls require to be very thick, which also greatly assists in making them cool. The whole of the buildings are of brick, and few of the houses are sealed [*sic*, for ceiled] having the strong beams, and planking of both stories exposed to view.²⁰

In the early nineteenth century the flat roof was used extensively by British settlers in the Western Cape, and at Port Elizabeth.²¹ At Grahamstown, too, Peter Retief's house was reported to have a flat roof of brick and plaster like those in Cape Town; Captain Page had a flat-roofed house built in 1818, and Hugh Huntley another before 1822.²² In 1827 Captain Henry Somerset, son of the governor, built his large 'Graham House' at Grahamstown with flat roof of lime plaster and brick. In 1835 Jeremiah Goldswain's house near Bathurst had a 'flat rufe maid with Stone and Lime and ... wood' only on the kitchen and associated rooms, and it was there that the family retreated when they feared that the Kaffirs would fire the house.²³ The Dutch church at Pietermaritzburg, Natal, of about 1839-40, had a flat roof for about a decade, after which it was replaced by a thatched one.²⁴ In 1862 J S Dobie commented that the town of Cradock, in the Natal, was 'peculiar in its flat-roofed houses'.²⁵

By the 1820s, just before they began to be accepted in Australia, flat roofs were already being denigrated in South Africa as less thermally effective than conventional thatched roofs, inevitably liable to leakage, and lacking the storage space afforded by

¹⁸ 'Diary of George Wyndham', 1 April 1830. Broadbent, *op cit*, p 413, identifies these volumes as those sent to the Scotts by their mother in 1827, though it is unclear why she might not have sent subsequent volumes as well.

¹⁹ Lewcock, *Architecture in South Africa*, p 8.

²⁰ W G Manifold, *The Wished-For-Land* (Camperdown [Victoria] 1986), p 93.

²¹ Lewcock, *Architecture in South Africa*, p 192.

²² Lewcock, *Architecture in South Africa*, pp 195-8.

²³ Jeremiah Goldswain, quoted in John Hale [ed], *Settlers* (London 1950), p 252.

²⁴ Brian Kearney, *Architecture in Natal* (Cape Town 1973), pp 5-6.

²⁵ J S Dobie, quoted in Hale [ed], *Settlers*, p 297.

a pitched roof.²⁶ However, they retained the advantage of being fireproof, and in 1834, during the Kaffir War, the inhabitants of Grahamstown were glad to be able to take shelter in the surviving flat-roofed buildings.²⁷

One of the first flat roofs in Western Australia was on the first floor rooms of the Round House at Fremantle of about 1830, the construction is not readily apparent, though it seems to be a limestone concrete on a timber substructure.²⁸ It is likely to have been inspired by the flat roofs at Cape Town, the previous posting of the Colonial Engineer, H W Reveley. Flat roofs were used for prisons during Reveley's time at the Cape, as at Grahamstown, where there were 'good watertight flat roofs, plastered and finished with shell lime.'²⁹ The last recorded use of lime-based roofing for government work was on the prison at Rondebosch in 1832, for by then it had been conclusively established that tarred canvas was cheaper and more readily repaired.³⁰ It could therefore be argued that Western Australia inherited an already obsolescent technology from the Cape.

The South African roofs were built with heavy beams, then a layer of 1 to 1½ inch [25 to 38 mm] 'yellowwood' or deal boarding, a crushed brick aggregate, and three coats of shell lime and seashells,³¹ which seems strongly suggestive of chunam. When such a roof leaked, it was repaired with tar or paint, and if it was to be walked upon it was paved with red 'Italian' tiles, or with local Robben Island slate.³² At Port Elizabeth, about 1815, such roofs were made of brick, lime mortar, and large flat tiles or Robben Island slate.³³

d. the Indian connection

T W Maslen, in his book *The Friend of Australia*, of 1830, advocated flat roofs for use in Australia, both because they were less subject to fire than pitched roofs, and because they could be used for sitting in hot weather. He described the Indian way of building them:³⁴

the teak joists being nicely planed, and moulded at the lower edges, are laid across the house or room, on the top of the walls, with an interval of six or eight inches between each joist and then a process like vaulting is begun; namely, small bricks are laid vertically (on their edges) side by side, upon the joists, firmly fixed together with strong mortar, the same as in turning the arch of a vault, but of course without forming an arch, and every crevice between the bricks must be carefully filled with mortar. When this first layer (of bricks) is perfectly dry, a coat of strong mortar, mixed with large sand or pebbles, about

²⁶ Lewcock, *Architecture in South Africa*, pp 193, 384-5.

²⁷ Lewcock, *Architecture in South Africa*, p 201.

²⁸ R McK Campbell, *The Round House, Report No. 2* (Fremantle [WA] 1973), no page.

²⁹ Lewcock, *Architecture in South Africa*, p 247.

³⁰ Lewcock, *Architecture in South Africa*, p 322.

³¹ Lewcock, *Architecture in South Africa*, p 384.

³² Lewcock, *Architecture in South Africa*, p 384.

³³ J Campbell, *Travels in South Africa* (London 1815), cited in Lewcock, *Architecture in South Africa*, p 192.

³⁴ T J Maslen, *The Friend of Australia* (London 1830), p 270.

the size of No. 1 shot, should be plastered all over the bricked roof two inches thick, and gradually, as it dries, it should be gently trodden firm, and all the cracks closed. When dry, a second, but thinner coat of mortar (about half an inch thick) should be plastered over the first, and trodden carefully as it dries. A third and last coat, of very fine mortar, chunam, or stone cement, is to be laid over the roof, and polished as it dries.

By 1833, however, chunam had not reached Sydney, though James Thompson thought it 'would make the houses in the town much more healthy and agreeable'.³⁵ A recipe for Madras chunam was given in 1837 by Captain J T Smith, in his well-known translation of Vicat's *Mortars and Cements*. It was essentially a stucco in three layers, of which the first was a mixture of shell lime and sand with *jaghery* water (water with coarse sugar dissolved in it). The second coat was of sifted shell lime and fine white sand, sieved to remove pebbles. The third used the purest and whitest shells, and a small proportion only of the finest white sand, all ground with a roller into a smooth paste, with egg white, *ghee* (clarified butter), *tyre* (sour curds) and soapstone. The finished surface was then polished with soapstone or agate.³⁶

A number of flat or very shallow pitched roofs at Rottnest Island, Western Australia, seem to represent a break from the earlier South African influence in the colony. They were carried on the split beam trusses which have been discussed above. In 1843 Governor Hutt personally prescribed the method to be used in roofing the lighthouse and prison, and, as this was almost certainly inspired by his own Indian experience, though it is nothing like traditional chunam. Nonetheless, it perhaps marks a local shift from the Cape Town to the Indian model:³⁷

To mix two parts of slaked lime with one part of unslaked powdered lime using a small portion of this mass only at a time, as it so quickly hardens into a perfect stone after the requisite quantity of water is added, which slakes the before unslaked lime in this mixture.

It is supposed that the slaked lime should not be slaked with water but slaked by exposure to the atmosphere and that the water mentioned is only to be added when the two descriptions of lime have been mixed together.

Vegetable oils were applied regularly to these roofs to keep them waterproof. Another of these roofs at Rottnest was that of the pilot's house, was built by Henry Vincent in about 1844 of a thin layer of lime concrete laid on planks, which are in turn supported on rough timber arches.³⁸

³⁵ J[ames] Thompson, letter of 10 August 1833, in *Architectural Magazine*, I (December 1834), p 337.

³⁶ L J Vicat [translated J T Smith], *A Practical and Scientific Treatise on Calcareous Mortars and Cements* (London 1837), p 176.

³⁷ Colonial Secretary to Vincent, 13 November 1843 Colonial Secretary's Office Records, outwards correspondence p 189, quoted in R J Ferguson, *Rottnest Island: History and Architecture* (Nedlands [Western Australia] 1986), p 21.

³⁸ Ian Molyneux, *Looking Around Perth* (East Fremantle (Western Australia) 1981), p 2. See also Barbara Chapman, *The Colonial Eye* (Perth 1979), p 82.

In Melbourne the house 'Rajpootana', St Kilda, was built about 1866-7 with a flat roof of 300 square metres in area, and the inspiration was certainly Indian, for the owner was the Anglo-Indian William Walker (sporting writer for the *Australasian* under the pseudonym of 'Tom Cringle'),³⁹ the house was described as a bungalow, and the roof construction was reportedly based on a description published in the *Bombay Builder* some years earlier. There was a substantial ventilation space above the ceiling, and then the roof constructed of strong timber joists, tongued and grooved boarding, a layer of tar, 75 mm of fine rammed sand, a layer of bricks on edge, grouted with cement, then a layer of 'artificial stone' or concrete, apparently divided up with joints of Keene's cement. Another architect reportedly copied this method, but laid the artificial stone as a continuous sheet, and it failed disastrously, while the roof at Rajpootana remained perfectly sound.⁴⁰

The use of *chunam*, or what purported to be chunam, persisted for purposes other than flat roofing. From the 1880s to 1908 Mayes recommended it as a cheap and effective substitute for white lead in T & G flooring for verandahs and elsewhere. It was to be made of one bushel [0.036 m³] of fine sifted lime and two gallons [9.1 litres] of 'best thin black oil', well mixed together.⁴¹ According to the engineer H D Walsh in 1911 chunam consisted of lime and tar, and it had been used in wharf works between the timber decking and the overlying sheathing, to prevent decay.⁴² The original Indian chunam formula had been debased from a graded application in three layers to a single layer; the complex recipe of shells, shell lime, fine white sand, soapstone and jaghery water had been replaced by common lime; the original ghee, egg white and curds replaced first by vegetable oils at Rottnest Island, then by 'thin black oil' and finally by tar.

e. English sources

In South Australia the earliest identified flat roofing was on 'Prospect House', Prospect, designed by Alfred Price and built in about 1846-7 for J B Graham, a director of the Burra Mine. S T Gill did paintings from on top of the second storey, which he described as 'on the leads', though this is a traditional British expression, and whether it was literally a lead roof is questionable. Others of Gill's paintings, as Andrew Klenke points out, show figures on the roof, and this suggests that its primary purpose was to take advantage of the eponymous prospect. There was another flat area on top of the ground floor, onto which the first floor rooms opened, but as the house has been long demolished we have no clue whatever as to how this was finished. The original portion of 'Beaumont House', Beaumont, which dates from 1849, has a surviving flat roof which measures 8.5 by 11 metres, falling to a spoon drain at the centre. The construction is of timber joists at about 200-250 mm centres, across which are laid 55 x 15 mm battens with 6 mm gaps between. On these is a bed

³⁹ The identification with walker is somewhat doubtful, as his name does not appear to be in the directories. The owner of the house appears to have been the ironmonger W H Freer, and Freer's name was given when the house was put up for sale a few years later.

⁴⁰ *Argus*, 15 March 1867, p 6.

⁴¹ Charles Mayes, *The Australian Builders' Price-Book* (4th ed, Melbourne 1883), p 93; also (5th ed, Melbourne 1886), p 105; C E Mayes, *Australian Builders & Contractors' Price Book* (7th ed, Sydney 1908), p 226.

⁴² *Building*, 12 December 1911, p 23: however, the word is printed as 'chinam'.

of cement material, 10 to 20 mm thick, and on this in turn are laid 245 x 245 x 50 mm tiles in a stretcher bond pattern, with about 10 mm joints between them. The surface is finished with a 15-25 mm layer of light brown cement.⁴³

The source of the idea does not seem to be English. Loudon describes the use of 'Grecian' or 'Italian' tiles which could be laid flat enough to 'be walked on and used as a terrace; while at the same time, it is perfectly water-tight'.⁴⁴ These claims should be viewed with some scepticism. Both patterns are essentially the tegula and imbrex type, which is a flat tile with raised edges, or tegula, and a curved cover tile, or imbrex, to be placed over the joint. The raised edge is at the sides of the tegula, not the ends, and the roof could not possibly be watertight if laid flat. It seems unlikely that the tiles would sustain traffic, and if they did, the raised imbrices would be extremely inconvenient. Loudon also discusses Tugwell's mode of slating, allegedly usable at slopes of less than 12^o, though this also seems questionable, as it differs from conventional slating only in the use of rebated laths.⁴⁵

Loudon also discusses 'terrace roofs' which are carried on tile arches spanning between cast iron joists,⁴⁶ which have no particular relationship to colonial practice, and, more relevant to Australia, the use of 'tiles covered with Roman cement in three coats and courses' which could be laid perfectly flat and form 'one of the most efficient and durable of roofs'.⁴⁷ Gwilt similarly describes Indian roofs made of layers of twelve inch [300 mm] square tiles, carefully jointed, with 150 mm of concrete over.⁴⁸ Papworth refers to various types of flat roofing, including Charles Fowler's, which was used at the Hungerford Markets and at his own house, and was made of courses of tiles embedded in pure cement and carried on iron beams.⁴⁹ The system is commonly thought to have been Fowler's invention of about 1835, but Pasley credited it to 'the late ingenious Mr Smart'. But much the closest analogy is between the South Australian roofs and Reveley's roofs in Western Australia or, more precisely, the South African roofs which inspired Reveley. These, as we have seen, have a similar sequence of timber beams, boarding, a chunam-like material, and tile paving.

⁴³ Information from Andrew Klenke of the National Trust, South Australia, 1992 & 1994.

⁴⁴ J C Loudon, *Encyclopaedia of Cottage, Farm and Villa Architecture &c* (London 1846 (1833]), §50, p 25.

⁴⁵ Loudon, *Cottage, Farm and Villa Architecture* [1846], §1222, p 564.

⁴⁶ Loudon, *Cottage, Farm and Villa Architecture* [1846], §2446, p 1249. Although these have not been identified in Australia, it is interesting to note that Loudon's description is very suggestive of the Roussillon vault, a traditional Spanish form which was perfected and transported to the United States by Raphael Guastavino in 1881, as discussed above. Guastavino vaults were a minimum of three tiles thick, and Loudon similarly recommended three layers. However Loudon's vaults were built between cast iron beams, whereas Guastavino's vaults tended to be two-way, and he avoided steel so far as possible. The similarity is nevertheless striking, and Loudon refers to his roofs as being 'very general about London', and cites examples by prominent architects such as Charles Fowler.

⁴⁷ Loudon, *Cottage, Farm and Villa Architecture* [1846], §1221, p 563.

⁴⁸ Joseph Gwilt [ed Wyatt Papworth], *Encyclopaedia of Architecture* (London 1899), p 566, § 1903g.

⁴⁹ Papworth, *Dictionary of Architecture*, sv Terrace Roof, ref 'Flat Tiled Roofs Explained', *Builder*, III, p 371 (1845), &c, &c. Fowler's roofing is also discussed in C W Pasley, *Observations on Limes, Calcareous Cements, &c.* (London 1838), pp 163-4, ref *Transactions of the Royal Institute of British Architects*, vol I.

Leaded roofs are a part of traditional British practice, which never attracted any special attention, and were likewise usually applied only to minor components of a buildings. A substantial example, however, was the roof of the Royal Hotel in George Street, Sydney, of about 1841.⁵⁰ Here the roof was surrounded by a battlemented parapet, which may have provided the inspiration for Edward Ogilvie's bizarre mansion 'Yulgilbar' on the Clarence River, completed in 1866. There the battlements again surrounded a leaded flat roof which - inevitably - proved less than watertight.⁵¹

f. tar and compound surfaces

We have seen that in the 1830s tarred felt or canvas roofs superseded the solid type traditional at Cape Town, but this was not their first appearance. During the American War of Independence shingles of tarred paper were used in the West Indies, and similar material was used in England and at the Cape, as will appear below. In the United States canvas impregnated with tar was used at the Octagon in Washington DC, in 1799, though this roof had to be replaced within twenty years.⁵² At the Cape the roofs were of flush boarding or feather-edged weatherboarding, covered in canvas and coated in paint or tar (which was sometimes sanded).⁵³ Tarred felt, introduced in Sweden in the eighteenth century, was also used at Cape Town, and in the 1840s a number of felts for roofing and other purposes came onto the market in Britain.

In 1854 a flat gravel roof, supposed to be of an American type, was shown at the Melbourne Exhibition by Appleton & Kendall, a local firm of roofers.⁵⁴ It may have been similar to the roof of the Cooper Union Building, New York, built in 1853-9 to the design of the architect F A Peterson. This was described as being of 'tin, painted then slate bedded in asphaltum and gravel upon that.'⁵⁵ More probably it was the roof based on felt (presumably bitumenised or tarred) with gravel on top, which was developed in 1854 either by W H H Childs or by his corporate predecessor. Such materials, which are discussed in a later section, were to become well accepted in both Britain and the United States, and are likely to have been used in Australia for small areas of flat roofing such as porches, bay windows and belvederes.

In the later part of the century flat roofs on any scale were more or less confined to the hotter parts of the country. The Residency which J G Knight built at Darwin in 1871 was an extraordinary squarish structure in an exotic - perhaps Persian - manner, which was significantly described as a 'bungalow style'. It was built with a flat roof constructed like the deck of a ship.⁵⁶ Harriet Daly describes the warping of the

⁵⁰ Joseph Fowles, *Sydney in 1848* (Sydney 1848), p 52.

⁵¹ George Farwell, *Squatter's Castle* (Melbourne 1973), p 283.

⁵² Information from John Waite, New York, 1992.

⁵³ Lewcock, *Architecture in South Africa*, p 385.

⁵⁴ Melbourne Exhibition, 1854, *Official Catalogue* (Melbourne 1854), p 15.

⁵⁵ W H Rowe, 'The Cooper Union (1853-59)', in John Waite [ed], *Iron Architecture in New York City* (New York 1972), p 51.

⁵⁶ It was reconstructed in 1874 according to Julie Martin, who has kindly provided illustrations, 2004. Although this is identified by Daly as the Residency, it is not the later Government House, according to Martin, but a building further down the cliff, the remains of which she has been investigating archaeologically.

planks, the incessant attempts at caulking them, and the blistering of the painted canvas which was then laid over the top. The final solution was a screed made with lime burnt from the local coral, and laid over the whole surface.⁵⁷ In Central Australia, flat roofs were to be used in about 1896-1910 at the Hermannsburg Mission, where the construction was based upon a close-set array of mulga wood poles, not unlike methods traditionally used in the Middle East. This form is presumably to be attributed to the builder, one Dave Hart, rather than to the missionary, the Rev Carl Strehlow, but its source is a mystery.

g. modern flat roofs

A new generation of flat roofs emerges in the 1880s. The annexes of the Centennial Hall, Sydney, were being roofed in 1888 in concrete and asphalt.⁵⁸ Soon afterwards the Victoria Palace in Smith Street had a flat roof covered in asphalt supplied by the Patent Asphaltum Company of New South Wales, and similar work was carried out on many Sydney buildings.⁵⁹ At 'Oxford Chambers' in Bourke Street, Melbourne, there was a flat roof finished with gravel and tar composition, which was reported as a novelty.⁶⁰

After these functional flat roofs come those which form a conspicuous element in the building design, as in an addition to an existing Sydney house in 1896.⁶¹ This would be in itself unremarkable, but for the fact that it was in turn the first in a series of grander and more deliberate flat roofs by the innovative Sydney architect George Sydney Jones. Jones was specifically interested in the Asiatic races, and in their buildings as being designed for climates comparable to that of Australia.⁶² He was also particularly influenced by the flat-roofed architecture of Egypt and India, and in 1906 he wrote:⁶³

In sub-tropical countries the flat roof is an architectural feature. It is used as a terrace on which one may, shaded by coloured awnings, defy the heat of the day or enjoy the cool of the tropical night.

He proposed that the flat roof could be used to provide outdoor living and eating areas.⁶⁴ In the same year his own ideal house design as published, complete with flat roofs,⁶⁵ while in 1909 he built the flat-roofed house 'Barncleuth' in Pennant Hills

⁵⁷ Harriet Daly, *Digging, Squatting, and Pioneering Life in the Northern Territory of South Australia* (London 1887), p 112.

⁵⁸ *Australasian Builder & Contractor's News*, 17 November 1888, p 439.

⁵⁹ *Australasian Builder & Contractor's News*, 24 January 1889, p 93.

⁶⁰ *Building, Engineering & Mining Journal*, 14 December 1889, p 486.

⁶¹ Hamann, 'op cit' [?thesis], quoted in Trevor Howells, 'The Morning After', in Trevor Howells [ed], *Towards the Dawn* (Sydney 1989), p 189.

⁶² Leonard Martin, 'George Sydney Jones Architect, 1864-1927' (BArch, University of NSW, 1978, 1979), p 12, quoting Conrad Hamann, 'Forgotten Reformer: the Architecture of George Sydney Jones, 1865-1927' (manuscript), p 2.

⁶³ *Art and Architecture*, March-April 1906, pp 69-73, quoted by Martin, 'G S Jones', p 45.

⁶⁴ *Art and Architecture*, VI, 6 (1907), p 223, quoted by Ian Kelly, 'The Development of Housing in Perth (1890-1915)' (MArch, University of Western Australia, 1991), p 201.

⁶⁵ *Art and Architecture*, March-April 1906, reproduced in Martin, 'G S Jones', pls 27, 28, 29.

Road.⁶⁶ Little if at all later than Jones was Henry Wilshire, whose own flat-roofed house at Double Bay was published in 1907.⁶⁷

It was at about this time that Malthoid roofing felt appeared in Australia, and the manufacturers shrewdly put considerable effort into promoting it indirectly, through the flat roof and the bungalow. A promotional article which appeared in the *West Australian Mining, Building and Engineering Journal* in 1909 saw 'no end to the style and grace and luxury of the modern mansion with a flat roof', and could imagine 'nothing more enchanting than the beautiful shores of the Swan River dotted with the wonderful roof gardens of Italy'.⁶⁸ This is one case where a stylistic innovation was being promoted for commercial and technical reasons. However, the flat roof was probably seen as too radical for popular consumption, and the company devoted more energy to promoting the Californian bungalow, in which the roof pitch was too low to be securely roofed in tiles. Nor was flat roofing a Malthoid monopoly, for it was still constructed with lead or asphalt, as at St Vincent's Hospital, Melbourne, before 1913,⁶⁹ or with other more recently introduced products. By 1914, for example, flat roofing was made of boarding overlaid with 'Vulcanite', when it had become a standard item in Mayes's price book.⁷⁰ The development of bitumenised felt finishes is discussed in the context of insulation, and the use of aluminium after World War II has been referred to in the context of that metal. In some cases it is not clear exactly what material were used, as with Icopal roofing, which was marketed largely on its appearance, with could be green or red fine mineral gravel, light grey fine mineral or 'aluminum metallised finish'.⁷¹

It was only at a domestic level that the flat roof challenged social values. Sydney Ancher designed the house 'Poyntzfield', Gordon, New South Wales, in 1945 with a steel frame, flat roof, and walls of rendered expanded metal, but the Kuringai Council refused permission, and a brick house with a pitched slate roof was built instead.⁷² In 1947, however, flat roofs were built in houses in both Melbourne and Sydney. It may say something about the two cities that the former attracted little attention, while the latter became a *cause célèbre* - indeed nothing less than the public trial of the Modern Movement. The Melbourne house, in the suburb of Reservoir was designed by L Hume Sherrard, using E W Rose's patent system of concrete construction.⁷³ The Sydney house was 'Windy Dropdown' at Warringah, designed by Sydney Ancher for the engineer W M Farley. The Warringah Shire attempted to impose the condition that the roof be surrounded by a two foot [0.6 m] parapet wall. Farley's appeal to the Land and Valuation Court was upheld by Mr Justice Sugerman, who considered it to be a question purely of aesthetics. There followed a series of controversies over low

⁶⁶ Martin, 'G S Jones', p 48. For Jones's flat roofs see the *Salon*, I, 4 (1913), pp 279-280, quoted by Kelly, 'Housing in Perth', p 201.

⁶⁷ *Building*, I, 3 (21 November 1907), p 30.

⁶⁸ 'The Beauty of the Malthoid Flat Roof', *West Australian Mining, Building and Engineering Journal*, 15 May 1909, p 19, quoted by Kelly, 'Housing in Perth', p 269.

⁶⁹ *The Architectural Students Annual* (Melbourne 1913), p xxi.

⁷⁰ C E Mayes, *The Australian Builders & Contractors' Price Book* [8th ed, Sydney 1914], p 60.

⁷¹ *Journal of the Royal Victorian Institute of Architects*, xxxiv, 4 (September 1936), p lii.

⁷² Peter Cuffley, *Australian Houses of the Forties and Fifties* (Knoxfield [Victoria] 1993), p 94.

⁷³ SOURCE FOR THIS - AHB? Sherrard was doubtless influenced by the overseas trip which he took in about 1936 to study recent developments: *Journal of the Royal Victorian Institute of Architects*, XXXIV, 4 (September 1936), p 131., *The Australian Builders & Contractors' Price Book* [8th ed, Sydney 1914], p 60.

pitched, 'monopitched' (or single slope) and flat roofs, which have been summarised by Robin Boyd.⁷⁴

The issue is essentially one of style and need not further concern us here, but the flat roof was by no means so uncommon as these examples suggest. A book of house plans published in 1948 advocates the flat roof and repeatedly returns to the argument in the discussion of three already built examples which follow. The argument is to the effect that in the current shortage of building materials a flat concrete slab is more appropriate and will reduce delays in construction. It will also serve as a sun deck, a play area, and a place to sleep on hot nights: however this is nothing more than a convenient rationalisation, for none of the published designs provides any means of access to the roof.⁷⁵

At least one or two buildings in Australia took the logical step of covering the roof with a layer of water to insulate and cool it. The Whitehall Pharmaceutical Co factory at Parramatta, of 1954, was designed by Eric Nicholls with a six inch [150 mm] deep 'insulating lake'.⁷⁶ In 1956 a house with a 'roof lake' was completed at Hunters Hill to the design of Dr Henry Epstein. Here a roof of fifty by twenty-five feet [15 x 7.5 m] was clad in plywood with upturned edges and a skin of blue plastic, to hold 19 mm of water, to be replenished by a central spray operated from the kitchen.⁷⁷ In 1953 a water-covered roof was proposed for the Cadbury-Fry-Pascall warehouse and office complex, Nedlands, Western Australia.⁷⁸ Mercifully, history does not record the subsequent history of these enterprising experiments.

⁷⁴ Robin Boyd, *Australia's Home* (Melbourne 1952), pp 190-194; Robert Irving & John Kinstler, *Fine Houses of Sydney* (Sydney 1982), pp 154-9.

⁷⁵ Associated General Publications Pty Ltd, *Sixty Home Plans* (Sydney 1948 [1946]), p 20 and examples, pp 42, 83, 85.

⁷⁶ *Cross-Section*, no 21 (1 July 1954), p 3.

⁷⁷ *Cross-Section*, no 41 (1 March 1956), p 3.

⁷⁸ *Cross-Section*, no 57 (1 July 1957), p 1.