

Towards the Development of Colonial Archaeology in New Zealand: Part 1

PETER J. F. COUTTS

In this, the first of two papers, Peter Coutts, Director of the Victoria Archaeological Survey, writes about part of his work in New Zealand some years ago. In New Zealand, as also in Australia, historical archaeologists are faced with the problem of constructing a usable data base, comprising both documentary and archaeological material, on which future research workers can draw. In the following paper this task is attempted for the New Zealand building industry in the 19th century. Other aspects of New Zealand historical archaeology will be examined in a subsequent paper. The author discusses building materials and their sources and examines the way that the availability of these materials influenced building, particularly house-building, in New Zealand during the 19th century. He shows also how fluctuations in the building industry correlated with economic booms and depressions.

During the late 1960s the author, at that time resident in Dunedin, New Zealand, developed an interest in colonial architecture and archaeology and carried out detailed surveys with some excavation on a sequence of 19th century mission houses on Ruapuke Island.¹ A number of early 19th century European-Maori contact sites were also excavated at Southport in Fiordland, yielding a wide variety of European artefacts which had probably been acquired by the Maori from European sealers and whalers working in the area.² Later, in 1972, as William Evans Fellow working out of the Hocken Library, Otago University, the author conducted historical archaeological projects at one of the South Island's earliest farms,³ at Taieri Island on a 19th century shore-based whaling station,⁴ at the Waipori goldfields on Chinese mud-brick houses, and in Dunedin and suburbs on 19th century buildings.⁵ As work progressed on these projects the lack of readily accessible comparative data and relevant historical information was continually thrown into focus. Eventually the author was persuaded that a major review of the evidence available from a variety of sources was essential before the archaeological and historical data could be meaningfully evaluated.

A literature survey was undertaken, followed by a search for reference collections of 19th century artefacts in New Zealand. These exercises indicated that few scholars had taken an interest in colonial architecture and none in historical archaeology, other than in a few instances where projects had focussed on Maori sites dating to the colonial period.⁶ Again no useful reference collections of archaeological material such as bottles, buttons, crockery, clothing, clay pipes and building materials were located. However, scattered amongst the wide variety of sources examined (diaries, newspapers, journals, photographs, drawings etc.) there proved to be an enormous body of information, which when properly ordered and assessed, will be of great utility to the historical archaeologists for erecting interpretative models. The information includes data on early building materials and how they were used, the tools and equipment used by colonists,

types of buildings erected, construction technology, the functions and life expectancies of buildings.

Over the past two decades, there has been a steady growth in interest in historical archaeology in New Zealand and several projects have been undertaken.⁷ However, the basic problem of drawing together information from a wide variety of sources to provide an accessible data pool for use by historical archaeologists remains.

Although the author's studies have been heavily biased towards the South Island, much of the information gathered is relevant for the whole of New Zealand and in some instances to the early colonial period of Australia. In this and in a later paper select aspects of colonial history of particular relevance to the historical archaeologist have been singled out for discussion. Attention is focussed on settlement patterns, the building industry and 19th century architecture. The intention is to begin the task of providing a usable data base for archaeologists working in this field.

During the 19th century both Australia and New Zealand grew towards nationhood in relative geographical isolation. Isolation sometimes meant delays in the transmission of new ideas and advances in technology and in the delivery of essential goods. It also increased the cost of some imported consumer items to the point where they became luxuries. It did not take long for local industries to be established and efforts were made to make maximum use of local materials. These industries also produced raw materials for local trade. The history of the building trades in Australia and New Zealand closely mirrors the economic histories of those two countries. It is dominated by a number of strongly interdependent factors, including technological innovations, inherited architectural traditions, construction techniques, labour availability and, of particular concern to the archaeologist, the availability and accessibility of building materials.⁸ In the following sections the history of the utilisation of local and imported building materials and the growth of local industries linked with the building trade for the Otago-Southland area of New Zealand have been summarised.

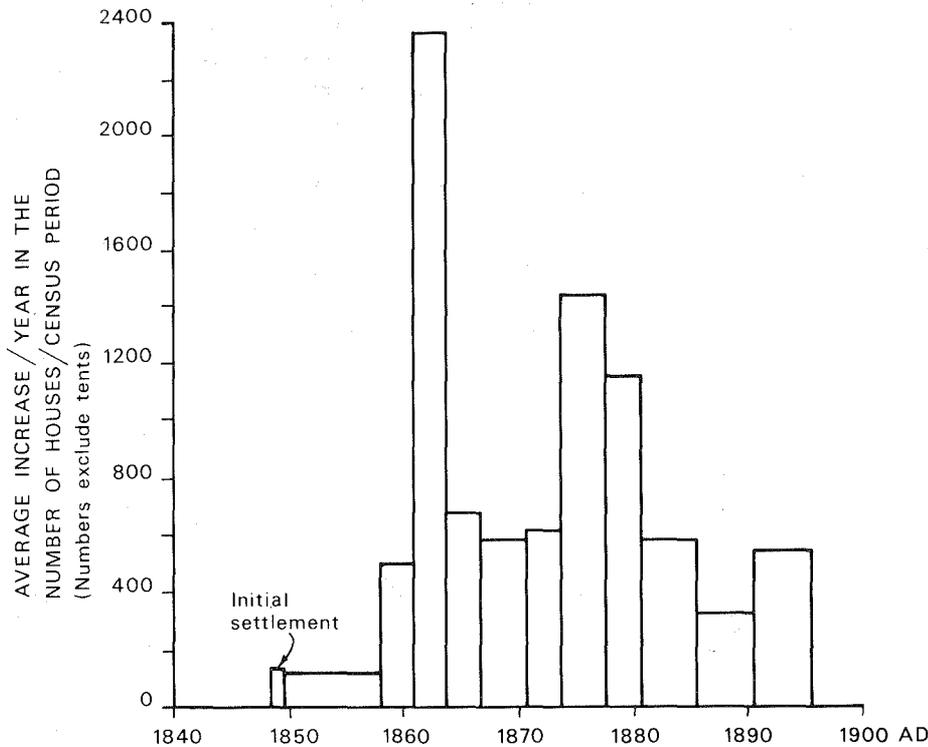


Fig. 1: Average increase per year in the number of houses during each census period. The peaks and troughs tend to correlate with periods of economic booms and depressions. (All data extracted from Statistics of the Colony of New Zealand.)

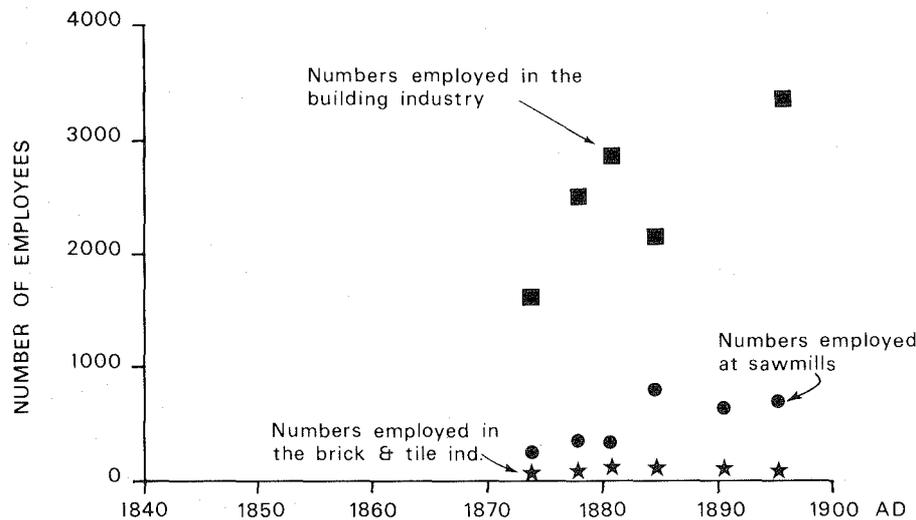


Fig. 2: Numbers of men employed in various branches of the building industry during the last three decades of the 19th century.

THE BUILDING INDUSTRY

Sources of information

Relevant sources for the first half of the 19th century are not common. They include the diaries, correspondence and papers from the Weller Brothers and Octavius Harwood who were linked with a whaling station situated at Otakou near the entrance to Otago Harbour; early volumes of the *Otago Journal* and *New Zealand Journal*; letters, and papers relating to the New Zealand Company and Dunedin settlement; and archaeological data from a whaling station which was situated on Taieri Island some 24km south of Dunedin.

By way of contrast there is an abundance of source material available for the second half of the 19th cen-

ture. This includes correspondence, drawings and diaries from the archives of the firm of architects Mason and Wales (dating from 1862); various newspapers, including the *Otago Daily Times*, *Otago Witness* and the *Daily Telegraph*; encyclopaedias (for the Otago and Southland area); records, letters and business documents from various business houses in Dunedin; numerous books, journals, diaries, letters, almanacs, business catalogues, congress reports and statistical data,⁹ contemporary documents housed in the Hocken Library, University of Otago, Dunedin; and most importantly there are still many well preserved examples of late 19th century houses in the

study area which are extant records of the building materials and construction techniques current during that period.

Timber

When the first Europeans arrived on the shores of southern New Zealand they could hardly fail to have been impressed by the magnificent podocarp forests which seemed to clothe the entire hinterland.¹⁰ Many of the forest trees had been growing for centuries barely disturbed by man and their great size, strength and accessibility must have enhanced their commercial prospects. Nevertheless, during the late 18th and early 19th centuries, these forests were hardly exploited because they were too remote from market centres.¹¹

During the first two decades of the 19th century the sealing industry reached its peak and quickly waned. It was then that ex-sealers began to turn their attention to the forests and by 1826 they had established a small shipbuilding industry on Stewart Island.¹² Towards the end of the 1820s the number of whalers increased and ultimately a number of shore-based stations were established between Preservation Inlet in Fiordland and Timaru on the east coast. These stations precipitated trade with the indigenous inhabitants and exploitation of local resources, so that soon after New Zealand products began to reach Sydney and other parts of the world.

Two basic requirements of the whalers—shelter and fuel—resulted in commercial exploitation of the coastal forests. In some cases the timber for the whalers' buildings was imported, but most of it was cut locally. In addition, large quantities of timber were required to heat the try-pots, though some stations used locally mined coal. The most successful whaling stations diversified their commercial activities and sent shiploads of timber and potatoes back to Sydney. Both whalers and Maori were employed cutting timber.¹³

The merits of New Zealand timbers were not at once apparent, though it did not take first settlers long to assess them. During the early years large quantities of North Island kauri were exported to Australia for ships' spars and for building, but there was no overseas demand for other New Zealand timbers, in spite of favourable reports.¹⁴ Petre,¹⁵ for example, wrote glowing accounts of the timbers being used by settlers in the Wellington area. He found that kahikatea was popular because it could be worked easily and was 'admirably adapted for the pioneer work of houses', as well as for ships' spars. Totara, he claimed, was very hard and worked well and was particularly suitable for making furniture. Rata could be used for almost any purpose, being close-grained and 'well adapted for ships and ship building'. At that time most houses in the Wellington area were made from wood, so that the demand for sawn timber was excessive, causing prices to rise. Later on a similar situation prevailed during the first years of the Dunedin settlement.

When the New Zealand Company pioneers sailed up Otago Harbour in 1848, they were flanked on either side by hilly terrain swathed in rich podocarp forest.¹⁶ It consisted of large amounts of red pine, black pine, miro and rata with some totara and 'in certain areas as at the head of the harbour, the white pine or kahikatea, all interlaced with laways and supplejacks and all protected by dense and tangled undergrowth'.¹⁷

However, there was a short delay before the settlers were able to exploit this rich source of raw materials. Their first preoccupation was with building shelters to secure themselves from the weather. These building activities were carried out speedily, using whatever materials were at hand. The major problems with exploiting the timber stands were that they had to be sought on foot and, once found, the timber had to be cut by hand and then dragged back to the building sites without the aid of bullocks or machines. This was an arduous and time-consuming process and shelters were necessary while the timbers were being cut. Indeed in 1832 Busby had recommended that New Zealand settlers bring timber with them because of the difficulties of winning it from the indigenous forest and doubts about its suitability for building.¹⁸

In 1848 the Sawyers Bay area was reputed to have been a major source of timber. Timber was cut there and floated to the town on rafts.¹⁹ However, the timber was expensive,²⁰ the sawyers being paid at the rate of sixteen shillings per hundred feet of timber in 1849,²¹ and Maori sawyers at the rate of three shillings per day in 1848.²² In 1849 sawn timber cost between twelve shillings and twenty shillings per hundred feet and twelve shillings to eighteen shillings per 1000 shingles.²³ At that time one of the biggest problems was a shortage of sawyers. The first census from Otago, dated 31 March 1849, lists only one male out of a total of 297 in that trade and although this cannot be a true reflection of the situation it is not surprising that cheap timber was imported from Auckland.²⁴ The general shortage of cut timber is reflected in the early export figures for Otago-Southland where between 1853 and 1863 only 4500 feet of timber was exported.²⁵ During the same period small amounts of timber and shingles were imported (Table 1).

Many settlers were ill equipped to take on the felling of trees. Some of them found that their English axes soon blunted on the hard timbers. Consequently, American axes were in great demand as they proved well able to cope with local timbers.²⁶ The problems of getting timber increased when it was found that the forests were not solid blocks of good timber; instead the best trees were situated in scattered stands necessitating periodic removal of the saw-pits. Since there were no roads the timber had to be hauled out of the forests over rough ground by hand and at ever increasing distances from the markets.²⁷

Indigenous timbers continued to be used in preference to overseas varieties, since although the latter were often held in higher regard they were slightly more expensive.²⁸ Timber was imported into Otago and Southland from Tasmania, Sydney, Europe, America and the North Island of New Zealand: blue gum from Sydney (for house piles and scantling), shingles and hard-wood from Tasmania, shingles from America, lumber such as oregon also from America (popular for tongue and groove boards, windows and doors), Baltic deals (for windows and doors), ash from England, and kauri from the North Island of New Zealand (used for a variety of purposes including window sashes).²⁹ By the mid 1880s less than 2 per cent of its total annual timber consumption was imported into New Zealand.³⁰

The number of sawmills increased dramatically throughout Otago in response to growing local and overseas markets for New Zealand timbers. The first

Table 1: Select list of building materials imported and exported from Otago-Southland during the early years of settlement.

	1853		1854		1855		1856		1857	
	Quantity	£	Quantity	£	Quantity	£	Quantity	£	Quantity	£
IMPORTS—OTAGO										
Bricks							500	8.00.0	5500	43.00.0
Cement (casks)	45	23.10.0							701	1299.00.0
Marble slabs (pks)	2	20.00.0								
Paving stones (tons)					25	20.00.0				
Shingles					10,000	12.10.0			1,112,600	949.00.0
Slates			3000	23.00.0	10,000	70.00.0				
Window glass	2600	31.10.0	2200	25.00.0	8000	105.00.0	10,200	105.00.0	1685 pks	4615.00.0
	sq ft		sq ft		sq ft		sq ft			
Camp ovens & pots	988	71.00.0					557	61.00.0		
Hardware & ironmongery (pks)	104	587.10.0	168	1688.05.0	340	2383.10.0	262	1110.07.0	6467	38,500.00.0
Nails (cwt)	14½	14.10.0	65	69.10.0	135	205.00.0	1200	333.10.0	5498	12,912.00.0
House framing timber (pks)	84	154.00.0			132	373.10.0				
Sawn timber (ft)					4300	43.00.0	4900	71.10.0	2,628,530	29,988.00.0
Paint (cwt)	18½	30.00.0	26½	34.05.0	51	84.05.0	43¾	103.10.0	2935	6353.00.0
EXPORTS—OTAGO										
Sawn timber (ft)*	1000	8.00.0	3500	35.00.0						
IMPORTS—BLUFF										
Doors							21	16.05.0		
Houses (wood)							2	39.00.0		
Ironmongery (pks)							13	140.08.0	24	82.00.0
Timber (ft)							2200	22.00.0		
Value of exports (£)—N.Z.	92,984.10.9		46,097.03.1		9392.11.0		23,008.09.0			

*Most of this timber was imported from Auckland before 1857.

mill in Otago was situated on the Taieri River³¹ and a little later, in 1850, Valpy erected a mill on the Leith River in Dunedin that turned out 400–500 feet of sawn timber per day.³² Other mills were started in the Catlins area in the mid-fifties. All these early Otago mills were water-powered, although there was one early steam-powered mill operating in the Wellington area at the time.³⁴ The first steam-powered mill in southern New Zealand was built on Stewart Island in 1862 when it turned out the staggering amount of 60,000 feet of sawn timber per week.³⁵ Faced with this large output, the cost of locally sawn timber fell and some sawyers must have been forced out of business.

The timber industry continued to thrive and more mills were started on Stewart Island,³⁶ and in other parts of Southland. Large scale timber cutting commenced in Southland at Riverton in 1862.³⁷ Sawmills were numerous during the 1860s and 1870s with as many as 16 in the Invercargill area alone in 1876.³⁸ By 1886 838 men were employed in the industry in Otago-Southland at 50 mills which produced 15 per cent of all new timber in the region. Even at this late date many indigenous timbers were still regarded with suspicion and a number of potentially useful species remained unexploited.³⁹

Although earlier reports had adequately described New Zealand timbers, the Jurors' reports of the New Zealand Exhibition held in Dunedin in 1865 were widely circulated and were probably quite influential.⁴⁰ These reports included a list of principal trees

and shrubs found in the Otago Province and their common usages. They were followed by several others later in the century, all of them spelling out the quality and utility of New Zealand timbers.⁴¹

The two most versatile timbers were held to be totara (*Podocarpus totara*) and rimu (*Dacrydium cupressinum*). The former was clear grained, durable timber, available in large dimensions. It was ideally suited for making shingles, or for cutting into planks and lumber of most sizes. It resisted attack from most insects and could be used in the construction of everything from houses to marine wharves. Rimu is also extremely clear grained, but less durable than totara and is liable to rot when subjected to damp conditions. However, it is a strong timber and was used extensively for joisting and lumber in building construction.

Other useful timbers were silver beech (*Fagus menziesii*), a durable wood often used for making boards, red beech (*Fagus fusca*), a very durable timber suitable for most purposes but very hard to cut, miro (*Podocarpus ferrugineus*), a close grained, hard, durable timber which does not survive in damp conditions and matai (*Podocarpus spicatus*), highly durable and suited to most purposes particularly flooring and piles for jetties. Cedar (*Libocedrus bidwillii*) and kahikatea (*Podocarpus dacrydioides*) were two timbers frequently employed in interior work. Cedar is brittle but much more durable than was thought in 1865, while kahikatea is a useful, white, tough wood, which in ear-

lier years had been written off for building purposes.

The preparation of pit-sawn timber for house building was extremely tedious.⁴² Joists, scantling and sleepers had to be cut to size and while these could be left rough, other timbers such as weatherboards and flooring had to be carefully planed down. In the first years tongue and groove and simple feather-edged weatherboards were in common usage.⁴³ Tongues and grooves, mouldings for doors, windows, architraves, skirting and cornices were all made with special tools and complex mouldings were made up from several separate pieces. Later, when power machinery was in general usage, much of the labour in preparing timbers was removed and very complex mouldings could be made in a single operation. Likewise, boarding, particularly tongue and groove, was made with greater speed and precision which meant that houses could be erected more rapidly. During the late 1870s rusticated weatherboard was introduced in Otago and it quickly grew in popularity. It has been used extensively in Otago and Southland buildings ever since.

For many years items such as doors, door frames, window frames, elaborate architraves, cornices, skirting and other mouldings were also imported. They were available in a great variety of sizes.⁴⁴ Windows were normally double-hung, although in the early years the top sash was usually fixed. Size and design tended to be dictated by the size of the panes available.

Thus in the first years of settlement small panes of the order of 10 inches x 8 inches were normal, and the joiners incorporated four to six of these in sashes. Later a greater variety of glass sizes became available, ranging from 8 inches x 10 inches to 28 inches x 15 inches in size. Casement windows⁴⁵ were also imported for bay windows and dormers.

Bricks and clay

From the very first days of settlement clay was an important raw material. Certainly it was abundant in the Dunedin area, and deposits at North-East Valley, Andersons Bay, Tainui, Caversham, Green Island, Fairfield and Wingatui were all exploited for brick-making later in the century.⁴⁶ During the first years, however, the clay was used extensively in the construction of more temporary wattle-and-daub dwellings.⁴⁷ After the clay was dug from the ground it was mixed with chopped tussock grass and water, the whole being puddled to a suitable consistency. The mixing was usually carried out by trampling, sometimes using horses. When ready the plastic mix was transferred to the building site and trowelled onto a lattice work of horizontal wattles inserted between vertical posts set in the ground. It was usually applied in several courses. Sun-dried clay bricks were made occasionally. Pise or solid clay houses were rare but were constructed occasionally.⁴⁸

As sawn timber became available these primitive modes of construction disappeared (Fig. 3). Very soon after settlement tradesmen began to experiment with the local clays in the hope of producing good quality bricks. Indeed, because of the climate in southern New Zealand bricks were a highly desirable building material being much more durable than timber.

The history of brickmaking in Otago-Southland has been reviewed by Elizabeth Seed⁴⁹ and it is only relevant here to summarise the general course of events and dates of major technological innovations

in southern New Zealand. In addition it is important to be aware that the brickmaking industry produced goods other than bricks which were important in the building industry. These included bath, paving, fire and roofing tiles, drainage pipes and bends.

Bricks were being produced in New Zealand some time before Dunedin was founded.⁵⁰ Four brickyards were in operation in Nelson in 1846, with prices ranging from eighteen shillings to twenty shillings per thousand bricks. A brick kiln was opened in Auckland in 1847. In Dunedin, bricks were made as early as 1848, but they were not offered for sale on a commercial basis until a few years later.⁵¹ In 1851 H. Ridley of Portobello⁵² advertised 50,000 well burnt, large-sized bricks, moulded in sand. MacAndrew joined the industry in the following year, announcing that he had 15,000 kiln bricks for sale.⁵³ By 1862 there were 4 brick makers established in Dunedin,⁵⁴ in 1864 14, and by the end of the seventies there were 35 brick and tile yards in the southern provinces.⁵⁵ By 1881 28,500,000 bricks were being produced annually in New Zealand and 35 per cent of these were made in Otago-Southland.⁵⁶ However, the number of brick and tile yards in the south had diminished to 25 by 1902 in spite of the fact that the industry enjoyed a good reputation at that time.⁵⁷ Technical improvements had increased the efficiency of the industry making it more competitive.

Until about 1862 many of the bricks made in Otago-Southland were still being sun-dried and for that reason were not very satisfactory; they tended to 'melt away' in the rain. Moreover, many kiln burnt bricks were little better, since most of them were badly fired, often in open kilns. The bricks tended to be soft and very porous. Inferior quality bricks were manufactured up until the early 1880s, seriously affecting the growth of the industry because builders were reluctant to use a material whose durability was questionable.

Before 1868 all locally made bricks were hand-made and although there was considerable variation in their sizes and weights the 9 inches x 4 $\frac{7}{8}$ inches x 2 $\frac{3}{4}$ inches brick (dimensions after firing) was recognised as a standard.⁵⁸ From 1868 the 9 inches x 4 $\frac{3}{8}$ inches x 3 inches became local standard, while English bricks were normally 10 inches x 4 $\frac{3}{4}$ inches x 3 inches. The clay mix was taken from a pugmill or mixing bay and thrown into a mould. The moulder then cut off any superfluous clay with a special stick he kept in a bowl of water nearby. After the back and side parts of the mould were removed, the brick was deposited on a flat length of wood so that it could be removed. The bricks were sun-dried for a period of time before being fired in a kiln. The firing was a highly skilled operation and was the key to producing good bricks. In general it took 25 to 30 days, so that mistakes were costly.⁵⁹

In 1868 a major technological innovation was adopted in Dunedin. The Hutchinson and Co's patent brick and tile works imported a machine for producing wire-cut bricks.⁶⁰ A screw plunger pushed the clay from the pugmill through an orifice whence it emerged as a continuous brick. At a predetermined time in the process, wire choppers cut the block to produce bricks of the required size.

Another innovation was introduced about 1882 enabling bricks to be die-pressed.⁶¹ Die-pressed bricks are much heavier than either hand-made or wire-cut

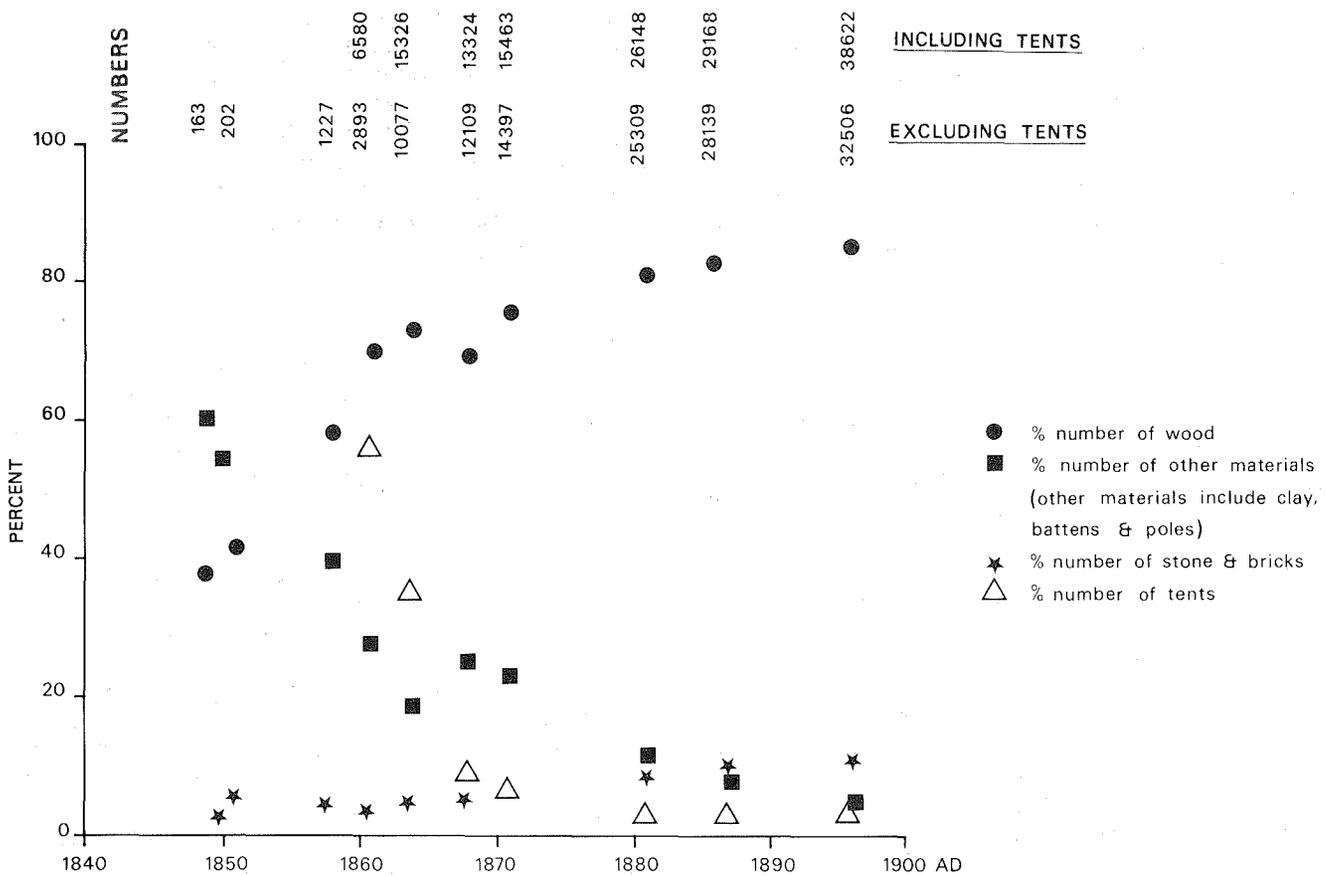


Fig. 3: Percentage number of houses built of each major type of building material for the Otago-Southland area and for all New Zealand (data extracted from Statistics of the Colony of New Zealand). The gradual increase in the number of dwellings made from brick, stone and wood as alternatives to other less durable materials is readily apparent.

bricks. This method produced an extremely accurate brick with precise features.

In spite of these technical innovations hand-made bricks were still made in their thousands up to the turn of the century, and sun-dried bricks were being produced as late as 1875.⁶² However, as mentioned above, the last two decades of the 19th century saw fierce competition between brickyards and this, in combination with a general slump in the building industry, produced a situation where only those yards which produced cheap, good quality bricks survived the turn of the century.⁶³

Locally made bricks also had to compete with imported varieties. Bricks had been brought to southern New Zealand during the whaling era, when they were used to make the foundations for try-pots.⁶⁴ Many thousands of bricks were brought out in the first emigrant ships⁶⁵ and later they were sent out with the vessels as ballast. However, after 1853 they were no longer a serious threat to those produced locally, though they were still being imported during the 1870s. Imported bricks were available in Dunedin from 1848.⁶⁶

At the time of the New Zealand Exhibition of 1865, Otago manufacturers were making paving tiles, and drainpipes.⁶⁷ The availability of drainpipes was particularly significant, as by this time Dunedin's population had mushroomed; but a building boom had

not been accompanied by imaginative town planning. An inquiry into the sanitary conditions in Dunedin in 1865 revealed a serious state of affairs.⁶⁸

In 1863/4 the death rate in Dunedin was as high as 35.3 per 1000. Open drains and inadequate toilets aggravated the problem.⁶⁹ John Henderson, writing under the pseudonym of Aliquis, discussing Dunedin's merits in 1866 reckoned that a more unpleasant place could not be found with its 'rain and its mud, its wind and its dust, its rickety wooden buildings, with the wind howling and the rain pouring through them; its close packed blocks of houses, . . . devoid of all water supply . . . its frequent fires'.⁷⁰ However, although the problem was recognised and the means of improving the situation were available nothing was done about it until the mid 70s, and the whole problem was not satisfactorily resolved until around the turn of the century.⁷¹

The first drainpipes were produced in 1862. They were unflanged and not very straight, 24 inches long and came in a range of diameters from 2 inches to 6 inches. Sewerage pipes had 1 inch flanges put on by hand and were lead glazed on the inside. Later, in the 1870s, these pipes were glazed on both sides by salt firing in an oven. As the century wore on technology improved and the pipes were sometimes made by machine; they were much straighter and of uniform thickness, though the flanges were still on by hand.⁷² During the early 20th century perfectly straight pipes of uniform length were manufactured.⁷³ Up until the mid 1890s Otago-Southland produced over 50 per cent of all drainpipes manufactured in New Zealand.⁷⁴

Chimney pots became fashionable in the late 19th century and most brickyards produced a great variety.⁷⁵

Lime and cement

There were two major types of mortar: lime and Portland cement.⁷⁶ Up until 1884 all cement was imported in casks and, for this reason, it was expensive. Moreover cement, as used to make concrete, was a little-understood building material. Possibly the cost and associated problems of transporting the cement and other bulky materials made it less attractive than alternative more conventional building materials. Portland cement was imported from a very early date, before 1860.⁷⁷ In 1884 Portland cement was manufactured in New Zealand at Warkworth, north of Auckland, by the Wilson's Cement Co. Ltd.

By the early 1900s architects and engineers had begun to experiment with reinforced concrete. Up to that time, concrete had been used in an auxiliary capacity to line floors, for building foundations, for plaster mixes for roughcasting, pointing and bricklaying. However, concrete was used occasionally on a large scale in Otago. A two-storey farmstead called 'Auchmore' built by Alexander and Robert Campbell shortly after 1863, still standing on the Taieri Plain, was made entirely of reinforced concrete. The walls of this home are very rough and are thicker at the bottom than the top with a maximum thickness of about two feet. Clearly the original boxing was not strong enough to withstand the weight of the concrete. The cement was mixed with aggregate from a local river bed. There was no attempt to interleave the corners of the building and the walls merely lie one against the other.

One of the earliest and perhaps the most ambitious projects which used large quantities of concrete was the construction of the graving dock at Port Chalmers. This was begun in 1868 and continued for four years. It involved 14,000 tons of Portland cement and about 90,000 cubic yards of locally quarried stone. It proved to be a tremendous undertaking, especially when it is realised that all the concrete had to be mixed by hand. Mr. Nathaniel Wales, the pioneering partner of the still extant architectural firm of Mason and Wales, was appointed Clerk of Works for the job and he has left a journal which describes the difficulties of the job.⁷⁸ He found that the men took every opportunity to reduce the amount of concrete mixing, to the detriment of its quality and it is clear from his account that the contractors did not appreciate the critical nature of the mix. In fact the only thing which saved the dock from complete failure was the timely silting up of its walls.

In New Zealand lime was the most important ingredient for mortar throughout the 19th century and it was still used in quantity as late as 1900. It was mixed with sand to form mortar. The first settlers improvised until local sources of lime could be exploited. They collected old seashells on shores of the lower harbour, burnt them and shipped the lime to Dunedin.⁷⁹ Thus one man who set out to build a stone house in Dunedin in 1848 employed four men for quarrying the stone, two for lime burning, and two sawyers to cut timber.⁸⁰ The shell method of lime production was short-lived around Dunedin itself,⁸¹ but was still used in the early 1860s at Port Adventure on Stewart Island where shells were burnt and the lime shipped to the mainland.⁸² Other areas of Southland where fossil shells abounded were similarly exploited.⁸³ By 1851 sources of limestone had been discovered at

Kaikorai and Caversham near Dunedin and the mineral was soon being burnt and offered for sale.⁸⁴ Later in the century extensive lime deposits were also opened up on the Otago Peninsula.⁸⁵ It is worth noting that the demand for lime did not arise solely from the building industry. Soon after settlement it was discovered that it was essential for agricultural purposes and newly cleared land needed to be treated with lime in order to ensure that crops would grow in the first season.

Stone

The Dunedin pioneers arrived with a tradition of building in stone, so it was natural that they should look for suitable sources of this material in their new homeland. They did not have to look far, and during the very first year of settlement a quarry of freestone was opened up near Dunedin.⁸⁶ However, quarrying stone was a time consuming and therefore expensive business and it is not surprising to find that only a few of the first dwellings were constructed of stone. It was, however, used extensively in commercial and public buildings.

There was no shortage of building stone elsewhere in Otago-Southland either.⁸⁷ Surveyor Thomson's report of 1858 contains numerous references to potential sources.⁸⁸ He had observed limestone in many parts of the province from Shag River to Waiau River.⁸⁹ There was granite at Bluff and stone suitable for flagstones and roofing slates at Maruwhenua and Kakanui. The white freestone found at Oamaru was exploited quickly since it could be sawn and moulded easily and a 'volcanic breccia' at Port Chalmers proved to be popular.⁹⁰ Further south a quarry was opened at Mokemoke in 1864. The site was only 16km from Invercargill but it proved difficult to remove the stone since it had to be loaded on to rafts and floated downstream.⁹¹ Even though sources of good roofing slate were available in the province this material was imported from Cornwall and Wales throughout the 19th century (Table 1).⁹²

Metal goods

In the first two decades of the 19th century all metal items were imported and in the initial years of settlement these items were always in great demand.⁹³ During the sealing and whaling days large quantities of hoop iron, brass and wrought iron nails were imported for local use as well as for trading with the indigenous population. More sophisticated iron-mongery such as hinges and door locks remained scarce.

In the first years of the Dunedin settlement nails and screws were the most sought-after items. These were available in a variety of forms, either cut, pressed, cast or wrought.⁹⁴ These early nails were nearly all chisel-ended and often rectangular in cross-section. The cut nails were formed from metal strips. The wrought iron nails tended to be stronger and more versatile, but they were also nearly eight times as expensive as nails manufactured by other means. However, a demand for these wrought nails persisted for much of the century. By 1864 copper tacks, flooring brads, wrought clasp nails, shingle nails, galvanised nails and screws and galvanised rivets and washers in a range of sizes were being offered for sale in Dunedin.⁹⁵ For much of the 19th century, tradesmen fixed galvanised iron and ridging with screws and

it was not until the 1880s that galvanised nails with lead washers began to be used instead. The latter enabled roofs to be erected much more rapidly.

Invention of the wire-drawn nail had a significant impact on building costs.⁹⁶ This nail could be produced for a fraction of the cost of other types of nails, enabling builders to use vast numbers of them during construction. Previously, nails had been used with great economy and carpenters employed all manner of skills to avoid their use. However, when cheaper nails were available the need for making elaborate joints was removed, and frames could be knocked together in a fraction of the time. Although wire-drawn nails had been invented much earlier, they did not start to have any impact on the Otago building industry until the late 1870s when they began to be imported into New Zealand in large quantities.

Necessary items such as locks and hinges, iron and lead pipes, spouting and ridging were either unavailable or excessively expensive in the first years of the Otago settlement and colonists were often forced to improvise. However, by the early 1860s the situation had improved and a great variety of metal goods were being sold. These included rim, mortise, stock, dead and drawback locks, butt, 'T', edge and tail hinges, lead pipes, iron gas pipes, copper tube and sheet copper, lead and zinc.⁹⁷ Cast iron sinks, basins, ranges and grates, and wrought iron tanks and cisterns, and plain and ornamental castings for verandas were available before 1870.⁹⁸ In 1864 there were a variety of ranges being offered under the exotic trade names of 'Etnean', 'Metropolitan', 'Cosmopolitan', 'Antipodean' and 'Australian'—all made by Watson, Gay & Co. Glasgow.

As the century progressed there was an increasing demand for more cast and wrought iron fittings such as friezes for verandas and balconies, veranda columns, stoves and ranges and tiled cast-iron fireplaces. Although this demand was to some extent satisfied by local foundries, a considerable quantity of ironmongery continued to be imported.⁹⁹

One of the oldest local firms is A. & T. Burt which was established in 1862 and is still operating today.¹⁰⁰ Unfortunately, a disastrous fire destroyed many of the early records and it is therefore not possible to trace the firm's commercial history in any detail. However, it is known that they were casting iron in 1871 and that the brass foundry started before this date. This firm manufactured a wide range of cast-iron articles including fireplaces, grates, air vents, gates, rain-water heads, balustrades and staircases, veranda posts and friezes as well as lamp-posts. They were making lead pipe and lead traps as early as 1875. As in Australia all the pig-iron for the furnaces had to be imported.¹⁰¹ Another old firm, founded in 1873, was H. E. Shacklock & Co. which made stoves and ranges such as the famous 'Sirius'.¹⁰² They also made veranda castings during the 1880s. Farrar Brothers, founded in 1863, made colonial ovens, spouting and ridging, and Cossens and Black, founded in 1874, had a large foundry which turned out a wide range of products. Ironmongery and hardware merchants such as Briscoe & Co. Ltd., established in Dunedin in 1862, and which had been founded in Melbourne in 1853, and John Edmonds (established in 1862) also supplied the local markets with both locally produced and imported goods. Towards the end of the century Thompson,

Bridger and Co. Ltd. were making spouting and ridging and selling a staggering variety of goods, from brass bedsteads to washing machines.¹⁰³

The discovery of the galvanising process (*circa* 1837) was a major technological innovation with profound implications for methods of housing construction.¹⁰⁴ Iron could be conveniently and inexpensively protected from weathering. Thin sheets thus treated and corrugated provided a cheap, relatively light, durable roofing material which could be easily transported and erected quickly. Moreover, the same material could be used to cover the exterior walls of the buildings. Indeed, it was ideal for cheap, portable housing such as was required by miners. Consequently it was heavily exploited during the 1850s in Australia and, following major gold discoveries in Otago around 1861, it began to be imported into New Zealand in ever increasing quantities.¹⁰⁵ However, both non-galvanised corrugated and galvanised corrugated iron were imported well before this date,¹⁰⁶ and one of the very first commercial buildings in Dunedin had black iron walls.¹⁰⁷ Nineteenth-century brand names included Gospel Oak (established 1842), Morewood, Hamilton and Scotch.¹⁰⁸

Galvanised iron gutters, gutter angles and ridge caps were also imported from an early date,¹⁰⁹ although cast-iron slip-joint guttering, down-pipe heads, down-piping and wrought iron brackets were far more common and remained so for some time.¹¹⁰

Other materials

Many other auxiliary building materials had to be imported (Table 1). These included felt for lining roofs, calico for lining walls,¹¹¹ paper to cover the calico lining,¹¹² paint,¹¹³ glass,¹¹⁴ chimney pieces,¹¹⁵ in the early years water casks,¹¹⁶ and plaster of paris and horse hair (for mixing with cement or plaster).¹¹⁷ The paints were lead or zinc based and fairly expensive. Chimney pieces were available in wood, slate or marble and ranged in price from ten shillings to five pounds. Water casks were essential to catch rainwater, in the absence of a regular water supply and drainage system. Regular glass manufacture (excluding window glass) did not start in New Zealand until 1922 when the New Zealand Glass Manufacturers commenced production at Penrose. Previous attempts by other people had been unsuccessful. Up until this date all glass was imported into New Zealand. As methods of packaging and transport improved, larger sheets of glass were sent out but, in the initial years, difficulties in these respects limited the size of the glass sheets. Later in the century coloured panes became available, including those with floral and other decorative motifs in complex designs. The small glass pieces were sometimes held in position by lead glazing bars.

Two local commodities were used extensively. The most important of these was flax, which was used to make ropes and twine.¹¹⁸ By 1881 there were over 40 mills operating in New Zealand,¹¹⁹ but only 2 of these were located in Otago-Southland. However, long before this date the settlers had proved the merits of the plant.¹²⁰ Another useful local product was pitch which was exploited for paving backyards and cellars.

Summary

The form of buildings constructed in the Otago-Southland area throughout the 19th century depended

to some extent on the cultural and economic background of the colonists, but equally it was influenced by local conditions, particularly topography, the types and varieties of building materials available, and the cost of transporting them. The coastal areas of the Otago-Southland region were rich in natural resources such as timber, clay, stone and lime. However, it took a little time to develop them, so that at first the settlers had to erect rudimentary habitations from a variety of handy materials. The relative importance of each type of material changed with time and circumstances (Fig. 3). As New Zealand developed economically, Otago was visited by an increasing number of vessels bringing both essential and exotic building materials from England, Australia and America, which were used to construct and embellish the better classes of buildings. Houses became larger and more ostentatious. Local clay was used to make bricks, tiles and drain-pipes, imported galvanised iron sheets replaced shingles, and galvanised or cast-iron gutters replaced their wooden counterparts. This process tended to be modulated by transport costs, both from abroad and within the colony. For many years there were no adequate roads into the interior and housing in the country regions was often more primitive than in sea-board and easily accessible areas.

Although the building industry eventually obtained most of its materials, including bricks, timber and Portland cement from New Zealand sources, at the end of the 19th century items such as nails, glass, slate, galvanised iron and pig-iron for the foundries were still imported. Local buildings continued to be constructed from a blend of local and imported materials. The introduction of new building materials often heralded changes in building construction. With the advent of galvanised iron, for example, roof frames were lightened. The parallel development of the balloon frame construction and popularisation of the cheap wire-drawn nail precipitated a further lightening of house frames and greatly increased the rate at which houses could be constructed.

In the wider context of New Zealand's economic history, the building industry has always played an important role. The fluctuation in prices of building materials, for example, gives some indication of the magnitude of inflationary trends; bricks cost about 18 shillings per 1000 in 1846 and 37 shillings and 6 pence in 1903, concrete cost 3 shillings per yard in 1875 and 6 shillings per yard in 1900, and sawn timber cost about 10 shillings to 16 shillings per 100 feet in 1848 and around 20 shillings to 30 shillings per 100 feet in 1900. During the 19th century large numbers of men were employed in the many lime kilns, brick fields, timber mills and iron factories throughout New Zealand (Fig. 2). Even larger numbers were employed in dependent trades, particularly carpenters, plumbers, joiners, slaters and plasterers. In 1881, for example, nearly a quarter of the entire manufacturing workforce in New Zealand was employed in sawmills and wood factories alone and over 50 per cent of this labour was located in Otago-Southland.¹²¹ Clearly a buoyant building industry reflected a buoyant national economy, an equation which is equally true today.

Many potentially rewarding aspects of this topic remain to be explored. There is an urgent need for more detailed studies of how each building material and its availability contributed to the economic and

social development of the colony. The internal dynamics of each industry and its dependent trades have not been considered in depth, nor has the extent and use of each respective technology. In spite of these shortcomings, it is hoped that this paper can serve as an introduction to a much neglected aspect of New Zealand history and encourage others to pursue such studies in greater detail.

ACKNOWLEDGEMENTS

The author wishes to thank the staff of the Hocken Library for their valuable assistance in locating reference material. This research was conducted while the author was in receipt of a William Evans Fellowship.

NOTES

1. Coutts and Jurisich 1972.
2. Coutts 1972.
3. Coutts 1977; Knight and Coutts 1975.
4. Coutts 1976.
5. Coutts 1973.
6. e.g. Kennedy 1969.
7. See Bloomfield 1968; Hargreaves 1962; Higham *et al.* 1976; Oliver 1979; Prickett 1978a and b; Richie 1979a and b.
8. There a number of ways of illustrating this correlation. For example, the average number of houses constructed *per annum* during each census period or, alternatively, the total number of men employed in the building industry or in any of the component industries (such as saw milling) during each year can be plotted (Fig. 1 and 2, data from *Statistics of the Colony of New Zealand*).
9. These data vary in usefulness as the printed format changed from time to time, obscuring trends. For example, the early statistical reports (1853-1856) give detailed lists of imports from each major port, but later lists are only available for the whole of New Zealand. Again the earlier reports do not provide detailed breakdowns by occupation so that it is difficult to estimate the numbers employed in branches of the building industry during this period.
10. McNab 1907: 105, 228; McLintock 1959.
11. Busby 1857: 12. They were mainly exploited for fuel, spars and occasionally for ship-building (Howard 1940: 14). Kauri was the only timber in demand, but this was found on the North Island.
12. Howard 1940: 71.
13. Octavius Harwood *Journal and Papers*; Weller brothers *Letters and Correspondence*.
14. *Statistics of the Colony of New Zealand 1853-1856*; Otago Association 1845: 25; Blair 1884: 6; Busby 1857: 12.
15. Petre 1841.
16. Otago Association 1845: 42.
17. McLintock 1951: 7.
18. Stacpoole 1971: 12.
19. Wilson 1912: 60.
20. *O.J.* No. IV, August 1849: 61. $\frac{3}{4}$ inch sawn boards were selling at 20 shillings per 100 feet. In 1840 sawn timber could be obtained for only 10 shillings per 100 feet (Octavius Harwood *Correspondence*).
21. *O.J.* No. V, November 1849: 74.
22. Adam 1876: 37.

23. *O.J.* No. V, November 1850: 85; *F. & J.* 2/25: 29.
24. *F. & J.* 2/21; Brown 1884: 23. 30,000 feet of sawn timber were landed from the schooner *Eagle* in 1848 (*O.J.* No. III, November 1848: 47).
25. *Statistics of the Colony of New Zealand 1853-1863.*
26. *O.J.* No. III, November 1848: 46; No. V, November 1850: 85, 90.
27. *O.J.* No. IV, August 1849: 61.
28. Blair 1884: 36-37.
29. *O.C.* 30/12/1859, *O.D.T.* 19/12/1864, 16/1/1875; *O.N.* 23/6/1849; *D.T.* 19/12/1864. Newspaper clippings from the *Southland Times*: 56.
30. *Statistics of the Colony of New Zealand*; Stout 1886: 27.
31. *O.J.* No. V, November 1850: 85.
32. *O.J.* No. VII, May 1851: III.
33. Waite 1948: 3; Wilson 1912: 140; *Otago Almanac* 1859.
34. Petre 1841: 75.
35. *O.D.T.* 27/7/1862.
36. Howard 1940: 196-8.
37. *Western Star* 26/9/1934.
38. Adam 1876: 139; Pam. 6/6/1868: 52, Hocken Library.
39. Blair 1884: 37.
40. *N.Z. Exhibition 1865 Reports of the Jurors*: 65 ff.
41. e.g. Pam. 6/6/1886, Hocken Library; Blair 1884; *The N.Z. Mining Handbook* 1887.
42. See Orbell *Diary* for an excellent description.
43. e.g. *O.C.* 5/2/1938; *D.T.* 19/2/1964.
44. e.g. *O.C.* 30/12/1859; *O.N.* 28/7/1850, 22/2/1851; *O.D.T.* 10/8/1862, 1/1/1870, 1/7/1870, 16/1/1875.
45. *O.N.* 30/10/1852.
46. Wekey 1862: 16; see map in Seed 1954: 12.
47. *Ferens Diary*; Wilson 1912: 171.
48. *O.J.* No. V. November 1850: 85.
49. Seed 1954.
50. *N.Z. Gazette and Wellington Spectator* 13/12/1840; *The New Zealander* 25/9/1847, 2/10/1847; *D.T.* 10/3/1863. See *N.Z.G.W.S.* 2/5/1840 where a Mr. J. Telford was advertising for 3 steady workmen for his brickyard in Wellington and bricks were being sold for 60 shillings per 1000 (*N.Z.G.W.S.* 11/12/1841).
51. *O.J.* No. III November 1848: 47, 61.
52. *O.W.* 6/12/1851.
53. *O.N.* 31/1/1852.
54. *Southern Provinces Almanac* 1862.
55. Seed 1954: 38.
56. *Statistics of the Colony of New Zealand* 1881; Blair 1884: 20.
57. *Encyclopaedia of New Zealand*—Otago 1905: 268.
58. *O.W.* 25/7/1868.
59. *Penny Cyclopaedia* No. 323 Vol. V.
60. Seed 1954: 24.
61. op. cit. 76-78; *O.W.* 22/2/1882.
62. Seed 1954: 28.
63. The output from the brickyards dropped dramatically during this period—1881: 9,952,000; 1886: 7,275,264; 1891: 3,954,000; 1896: 5,781,000. *Statistics of the Colony of New Zealand.*
64. Huggett 1966: 1. If the statistical data was to be taken at its face value, only a few hundred bricks were imported into Otago-Southland between 1853 and 1863 (*Statistics of the Colony of New Zealand*). However, it is clear from shipping lists reported in newspapers that both tiles and fire bricks were being imported in large quantities and these do not appear to be included in the official statistical data. Such items are listed in later reports (e.g. 1870) but for the whole of New Zealand and not by provinces. Judging from the large quantities being imported, few fire bricks were made locally.
65. McLintock 1949: 232.
66. loc. cit.
67. *N.Z. Exhibition 1865: Reports of the Jurors*: 309.
68. Aliquis 1866: 51.
69. McDonald 1965: 83.
70. Aliquis 1866: 51.
71. McDonald 1965: 126-7.
72. Seed 1954: 87.
73. op. cit. 93.
74. *Statistics of the Colony of New Zealand.*
75. For example chimney pots were advertised in *O.D.T.* 1/7/1870, 16/1/1875.
76. The history of the growth of the cement industry in New Zealand is summarised in Hudson 1960.
77. *Statistics of the Colony of New Zealand; O.D.T.* 20/6/1862, 1/7/1862, 16/1/1875.
78. Copy held in Archives at Hocken Library, Otago University.
79. Brown 1884: 3; Reed 1956: 52.
80. *O.J.* No. IV June 1849: 58.
81. *O.J.* 13/10/1849.
82. *Southland Newspaper Clippings*: 159.
83. Wekey 1862: 16.
84. *O.N.* 30/8/1851, 29/11/1851.
85. Blair 1884: 35; Huggett 1966: 109.
86. *O.J.* No. IV June 1849: 58.
87. Wekey 1862: 47.
88. Thomson 1858: 9-10.
89. See also Wekey 1862: 16.
90. Pam. 6/6/1868: 37.
91. *Southern Provinces Almanac* 1864.
92. Beattie 1909: 111; McIndoe 1878: 35; Thomson 1858: 10; *O.D.T.* 16/1/1875.
93. *O.J.* No. III November 1848: 44.
94. See *I.C.S. Reference Library* 1914 section dealing with ironmongery: 2 ff. Excellent histories of the technological and functional aspects of 19th century nails will be found in Fontana 1965, Larrabee 1967 and Fontana & Greenleaf 1962.
95. *S.N.F.S.H.* 9/3/1861; *D.T.* 19/2/1864; *O.D.T.* 1/7/1862.
96. Cox et al. 1969.
97. *D.T.* 19/2/1864; *O.N.* 6/3/1852, 7/8/1852, 30/10/1852, 21/5/1853; *S.N.F.S.H.* 9/3/1861; *O.D.T.* 1/7/1862, 1/1/1870.
98. *O.D.T.* 1/7/1862, 27/9/1862; *O.W.* 6/3/1868; *D.T.* 19/2/1864, 1/1/1870.
99. *Statistics of the Colony of New Zealand.*
100. *An Illustrated Guide to Dunedin etc.* 1883: 104.
101. *Statistics of the Colony of New Zealand.*
102. Advertised in various issues of *O.W.* in 1886.
103. Thompson Bridger & Co. Ltd. Catalogue.

104. Cox et al. 1969: 59.
105. See *Harnett's Directory* from 1863; *Statistics of the Colony of New Zealand*; *Southern Provinces Almanac* from 1862. In 1864 the Dunedin firm of Russell & Richie landed over 300 cases of galvanised iron (Parry 1964).
106. e.g. *O.C.* 23/10/1857, 15/1/1858, 29/4/1859, 15/7/1859, 30/12/1859.
107. Roberts 1895: 25.
108. *O.D.T.* 14/1/1880; *D.T.* 19/2/1864.
109. Wekey 1862: 4.
110. *O.C.* 15/1/1858, 15/7/1859.
111. *O.D.T.* 1/9/1862. Calico was still used in the 1870s.
112. *O.C.* 15/1/1858; *O.J.* No. IV. June 1849: 58.
113. *O.D.T.* 20/6/1862.
114. *O.N.* 13/12/1848, 27/10/1849; *O.D.T.* 16/8/1862.
115. *O.D.T.* 16/8/1862, 14/1/1880.
116. *O.N.* 20/1/1850, 7/8/1852; *S.N.F.S.H.* 9/3/1861.
117. *O.D.T.* 1/7/1862, 1/1/1870, 16/1/1875.
118. *Pam.* 6/6/1868: 34; Wilson 1912: 140.
119. Blair 1884: 7.
120. See Roberts 1895: 65; McCay 1952.
121. Blair 1884: 20.

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