[20] Bearing in mind the high cost of French cast iron, metal bridges costs almost the same as stone structures. The pont d'Austerlitz, for example, built by the engineer Lamandé 1800–6, cost 2.5 million francs.
[21] C. L. M. H. Navier, *Rapport à Monsieur Becquey . . .; et Mémoire sur les ponts suspendus* (Paris, 1823), pp. 3–61.
[22] Ibid. p. 61.
[23] Ibid. pp. 62–176.
[24] Ibid. pp. 211–24.
[25] T. M. Charlton, *A History of Theory of Structures in the nineteenth century* (Cambridge, 1982), pp. 49–50.
[26] See eg J. M. Delbecq, 'Analyse de la stabilité des voûtes en maçonnerie de Charles Augustin Coulomb à nos jours', in *Annales des Ponts et Chaussées*, 19 (Paris, 1981), pp. 36–43.
[27] Links between classical architectural principles and constructional theories were numerous, see engineers such as Bélidor or Frézier on questions of proportion. The famous treatise on stone cutting by Frézier begins with a 'Dissertation historique et critique sur les ordres d'architecture', published separately in 1769.
[28] Navier, *Rapport et Mémoire*, p. xvj.
[29] Tests were instituted to verify conformity to the norms for suspension bridges.
[30] Navier, *Rapport et Mémoire*, pp. 177–202.
[31] Ibid. p. xvj.
[32] J. Seguin, *Des ponts en fil de fer* (Paris, 1826), p. 37.
[33] Ecole Nationale des Ponts et Chaussées, MS 2348, 'Extrait d'une lettre adressée par M. Brunel à M. . . . Membre du Conseil Général des Ponts et Chaussées', London, 4 Oct. 1826.
[34] C. L. M. H. Navier, *De l'entreprise du pont des Invalides* (Paris, 1827), p. 4.
[35] Ibid. p. 6.
[36] E. Martin, *Pont de Cubzac. Dessins et description des piliers en fonte de fer* (Paris, 1841).
[37] See: L. Vicat, 'Note sur l'allongement du fil de fer soumis à diverses tensions', & 'Nouvelle manière de confectionner les cables en fil de fer', in *Annales des Ponts et Chaussées*, 1 (Paris, 1834), pp. 40–4, 129–42; E. Martin, 'Emploi du fil de fer dans les ponts suspendus', & L. Vicat, 'Observations sur un mémoire de M. E. Martin, touchant les ponts suspendus', in *Annales des Ponts et Chaussées*, 2 (1834), pp. 157–68, 169–72.
[38] Chains had thicker cross-section which rusted less than cables. However they were less economical and their connecting bolts were a weak point. See Leblanc, 'Observations comparatives sur les inconvénients qu'offre l'emploi des fils de fer, ou du fer en barre, dans la construction des ponts suspendus d'une grande ouverture', in *Annales des Ponts et Chaussées*, 1 (Paris, 1835), pp. 315–27.
[39] D. Amouroux, B. Lemoine, 'L'âge d'or des ponts suspendus', p. 60.
[40] Ecole Nationale des Ponts et Chaussées, MS 3130, 'Rapport de la Commission d'enquête nommée par arrêté de M. le Préfet de Maine et Loire en date du 20 avril 1850, pour rechercher les causes et les circonstances qui ont amené la chute du pont suspendu de la Basse-Chaîne, Angers, 9 mai 1850'.
[41] B. Lemoine, *Gustave Eiffel* (Paris, 1984), pp. 57–61.
[42] L. Vicat, *Description du pont suspendu construit sur la Dordogne à Argentat* (Paris, 1830), pp. 2–3.

Science and Art Closely Combined: the organisation of training in the terracotta industry, 1850–1939*

MICHAEL STRATTON

The terracotta industry gained an almost symbolic status in debates concerning architecture and building construction during the Victorian period and the early twentieth century. Moulded and highly ornamental ceramics offered a solution to some of the most pressing practical and artistic challenges faced by architects and builders on both sides of the Atlantic. There was an overwhelming demand for buildings that were highly decorated, colourful and that would appeal to a broad section of the public. This demand was accompanied by the growth of a market for a decorative material that could be easily and cheaply produced, avoiding the expense and organisational problems of employing stone masons and sculptors. Interest in terracotta and faience was crystallised by the crisis that emerged in Britain during the 1850s with the widespread failure of building stones due to attack by sulphurous smoke. Architects became disillusioned over lavishing time and expense on intricate stone carving if it was to be obscured by layers of soot and rapidly loose all its qualities of detail.

There has been a tendency to present iron-framing or other elements of 'functional' construction as the most progressive and contentious aspects of nineteenth century building. However, contemporary critics appear to have been far more concerned with the practical and ethical issues raised by the mass production of ornament, either in the form of cast-iron or ceramics pressed in moulds and coloured with glazes. To understand the strongly divergent reactions to factory made architectural terracotta and its glazed counterpart faience it is necessary to consider the ways in which artists and architects collaborated with the clayworking industry. It is also necessary to understand how mundane brick and pipemaking firms gained the necessary skills to be able to design and model detailing in a wide variety of styles, and how the construction industry reacted to the proliferation of this new material which threatened so many established trades and procedures. It is a story dominated by down-to-earth industrialists and architects, who welcomed any outlet for their artistic aspirations. Most of those involved in the terracotta revival openly accepted the industrial age and its ramifications for architecture and the building industry. Their pragmatism seems to have extended to the way in which they handled practical aspects of manufacture or building construction; both were characterised by make-do and mend to an extent that hardly matched the potential of terracotta and faience for mass-production and pre-fabrication.

Coade Stone to South Kensington

The terracotta revival commenced with the establishment of Coade's Manufactory at

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Lambeth, London in 1769. The mixture of china clay with grog, and the firing of goods in small muffle kilns were the two main factors contributing to the quality of Coade stone. The ability of the firm to supply ornaments that were correctly neo-classical in their design followed from a policy of engaging the best designers and modellers available. In the late eighteenth century there was nothing incongruous about sculptural work by Bacon or Flaxman being reproduced for mass-production. John Bacon probably modelled most of the designs which went into production over a period of 30 years [1]. The stability of neo-classical taste meant that models and moulds could continue to be used decades after they had first been made. Details were copied from pattern books while architects such as James Paine were employed as freelance designers. William Wilkins pursued the alternative and more expensive approach, supplying his own designs for the Coade stone decorations on Dalmeny House, near Edinburgh, rather than simply ordering forms from a catalogue. Most of the decorations were non-structural so that neither Wilkins or Coade had to worry about the structural strength of the ceramic chimney pots or panels, or the precise sequence in which they were delivered to Scotland in 1815–17 [2].

Drawing and modelling were the most expensive stages in the production of Coade stone. Considerable savings could be made by ordering from the extensive catalogue; the edition of 1784 ran to 778 items [3]. Nevertheless architects increasingly came to demand specially designed rather than stock details for their buildings. Most used terracotta as an artificial stone, directly as a substitute for carved stonework. The most fully developed example of this approach was St Pancras Church, London, built 1818–22 through a collaboration between H. W. and W. Inwood and a modeller who had left Coade by 1814, John Rossi. The four caryatids were moulded in ceramic sections and wrapped round cast-iron cores (Fig. 1). The runs of cyma and bead decoration which were set into grooves in the stonework forming the body of the church demonstrated the economies possible by repeatedly pressing running mouldings. The close colour match between the ceramic and surrounding stone ashlar succeeded in obscuring this innovation to all but the most discerning eye. St Pancras Church was strongly criticised by the Gothic Revivalists of the early Victorian period for the way in which terracotta had been used to imitate stone and for the application of a superficial slip to some of the material to give it a fine finish [4].

The achievements of Coade and her successors underwrote the blossoming of the terracotta revival in the Victorian period. After Coade's Manufactory closed down in 1839 many of the models and moulds were purchased by John Blashfield and Mark Blanchard. It is no surprise that these manufacturers produced neo-classical ware as well as more vigorously modelled Victorian designs, and for the most part continued to promote their terracotta as an alternative to stone. Being used primarily as a substitute material there was little need for the adoption of terracotta to be accompanied by new developments in terms of building construction. Once hollow ceramic columns or capitals had been filled with broken brick, rubble or cement they could be used exactly like blocks of stone.

The development of the cultural complex of South Kensington in London, including the Victoria and Albert Museum, the Royal Albert Hall and the Natural History Museum, brought a new ideology to terracotta and new approaches to its employment as a building material. From the mid-1850s the Department of Science and Art, under the figurehead of Prince Albert and the domineering secretaryship of Henry Cole, applied the zeal for improving standards of design generated by the Great Exhibition of 1851. Their development of a Museum and Art School was intended to

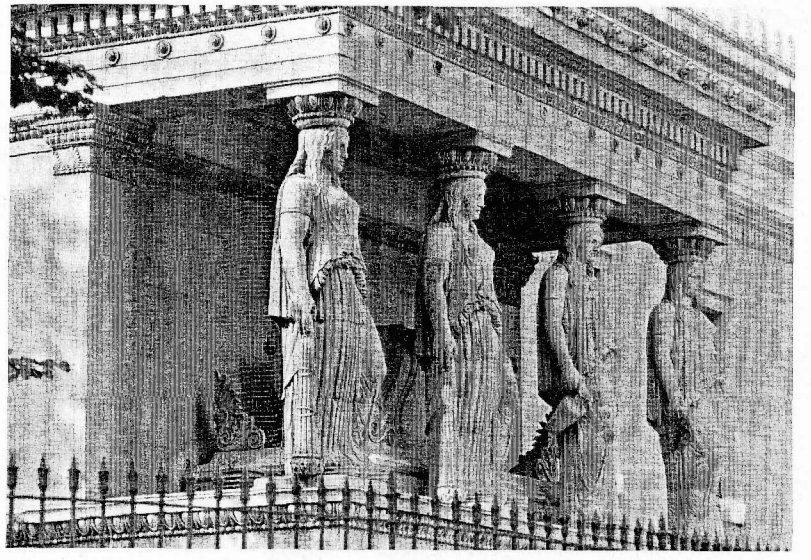

FIG. 1. Caryatids, St Pancras Church, London, by H. W. & W. Inwood, 1818–22 (Rossi).

advance public taste and the drawing skills of decorative artists. Through the example of Italian Renaissance architecture, and its emulation by various German states during the 1830s and 40s, terracotta became adopted as the ideal physical expression of a cultural centre. The centre presented the artistic values of a cultured elite to a broad public, but in a form that appeared to be appropriate to the contemporary industrial and democratic age. As South Kensington developed, the Science of 'Science and Art' became swamped by the pursuit of rich schemes of narrative decoration applied in a variety of decorative materials. These complemented the massive collections of highly ornate china, furniture and textiles that were purchased and presented as exemplars of good design.

The lavish use of terracotta, apparent in the Horticultural Society Gardens, the Victoria and Albert Museum, the Royal Albert Hall and the Natural History Museum, led by degrees to a more objective consideration of the design, manufacture and fixing of blocks or slabs. From studies of Renaissance arcades and fenestration in Italy to the training given to modellers in the art schools, aspects of art and design (rather than the practicalities of manufacture and construction) tended to preoccupy the minds of Cole and his team. Both the tests on crushing strength and fire resistance were undertaken by the Department of Science and Art and the manufacturer, Blanchard, who supplied the bulk of the terracotta used on the Victoria and Albert Museum. One demonstration at Blanchard's works of the qualities of terracotta in surviving fire, took on a circus-like character. Visitors stood on a roof made of patent ceramic blocks while straw, wood and tar were burnt underneath. As a finale, Blanchard's workmen jumped up and down on the surviving structure to demonstrate its unimpaired strength [5].

Training Decorative Artists and Managers

Despite the efforts of such figures as Gottfried Semper, who tried to introduce a Germanic and more practical system of training in the architectural crafts, the curriculum used in the art schools from the late 1850s until 1889 reinforced an obsession. This was with drawing skills and the copying and emulating of historicist detailing. It was the art rather than the technical schools that were most closely involved in training those who designed and made late Victorian terracotta. It was only in the 1880s that technical schools started to offer courses on building construction that gave any detailed consideration to bricks and decorative ceramics, and the students were more likely to be builders than modellers or architects. Manufacturers appear to have believed that practical aspects of clay and kiln technology and of building construction were best learnt by apprenticeship and experience. Meanwhile they accepted the need for their modellers and decorative artists to receive outside training to develop skills in intricate detailing in a variety of styles.

The Victorian art schools have been condemned for failing to serve the design requirements of most types of industry, but the major firms producing architectural ceramics appear to have appreciated the meticulous training in drawing skills that was given to students who progressed through the national curriculum. Probably the largest of all the Victorian ceramic manufacturers, Doulton of London, gained many of their artists from the Lambeth School of Art. The headmaster at Lambeth, John Sparkes, subsequently became the Superintendent at the South London School of Art and the Principal of the National Art Training School at South Kensington. The greatest of all the terracotta manufacturers, J. C. Edwards, gave a Mr Bryan, who had been trained at South Kensington, the responsibility for developing the terracotta section at the Pen-y-bont works at Ruabon during the 1880s [6]. Early in the twentieth century Gibbs and Canning of Tamworth were employing modellers who had been trained at the Royal College of Art, the successor to the National Art Training School.

Several of the most successful artists or managers in the terracotta and faience industry followed the progression of being trained at a local art school while serving an apprenticeship, being sent to South Kensington to study under John Sparkes, Frank Moody, Hugh Stannus or other teachers specialising in architecture and the decorative arts, and then rejoining their firm to work their way up to the position of chief decorative artist or head of the terracotta department. The head of the faience section at Maw, the largest decorative tile works in Britain and located at Jackfield in Shropshire, was John W. Bradburn. Before attending the National Art Training School at South Kensington in 1882–5 he had studied at the Coalbrookdale Institute during the three previous years [7]. The ironfounding firm, the Coalbrookdale Company, had paid for the construction in 1859 of the Institute building which housed the art school. In the last quarter of the century it was probably the local ceramic firms which supplied the majority of both the teachers and students.

Weeks and months were spent working through each stage of the national course of instruction. At South Kensington Bradburn sat through laborious lectures by Hugh Stannus on decorative detailing. For example there were three sessions devoted to the various possible dispositions of ribbons in Renaissance style architecture. His notes show him also attending lectures on the practicalities of designing and producing architectural ceramics, but these appear to have been very much a means towards a predominantly artistic goal (Fig. 2).

Almost everything relating to the terracotta revival in the mid-Victorian period

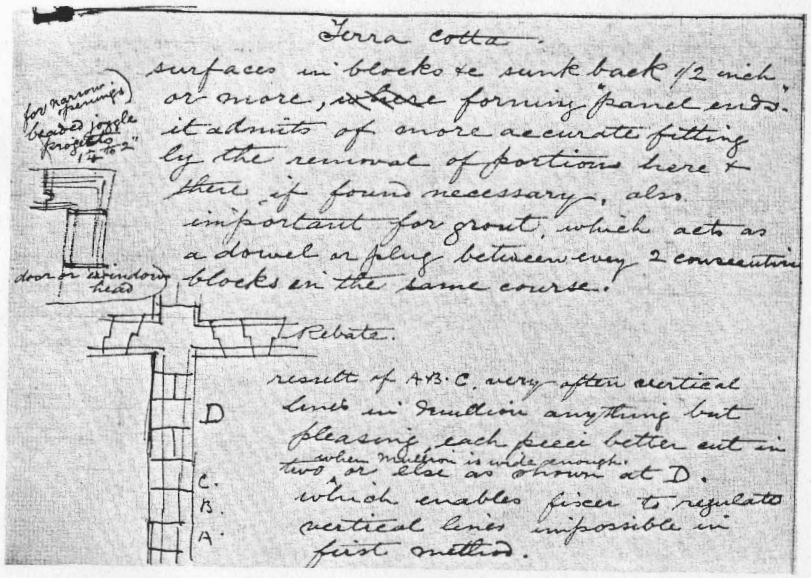

FIG. 2. Notes and sketches on terracotta construction taken by J. Bradburn at South Kensington. Source: J. Bradburn, Notebook, 1882–6.

worked to subsume a systematic consideration of the practical implications of large scale use of ceramics as a building material. Much of the terracotta used round the quadrangle of the Victoria and Albert Museum and the faience applied to parts of the interior during the 1860s and 1870s was applied as non-structural decoration. The material was supplied in numerous small contracts that might allow almost a year for delivery. Cole, Fowke and Sykes promoted a broad enthusiasm for richly modelled and colourful architecture, but hardly prepared the ceramics industry for the commercial rigours and tight timescales typical of commercial building [8]. With much of the work in South Kensington being undertaken by students, the costs of such schemes as the frieze of terracotta tesserae round the Albert Hall were dramatically reduced. Cole and his team gave architectural ceramics an unsustainable reputation for being a means of achieving rich decoration at extremely low cost.

The strongest provincial manifestation of the architectural philosophy of South Kensington, the Wedgwood Institute at Burslem, built 1863–73, highlights the way in which the practical implications of the terracotta revival were neglected. A design by R. Edgar and R. J. Morris for an ornamental frontage was imposed upon the architect, G. B. Nichols, who had already won an earlier competition to design the Institute. Some of the terracotta panels were produced by Blanchard at Bishops Waltham in Hampshire and others were by Blashfield at Stamford, Lincolnshire. With the clay being modelled in South Kensington, slabs had to be dispatched on complex journeys across the country. The project took 15 years to complete from its initial conception and one of the artists, Roland Morris, was described as descending into a state of mental derangement by the time that the statue of Josiah Wedgwood was set in place over the entrance [9] (Fig. 3).

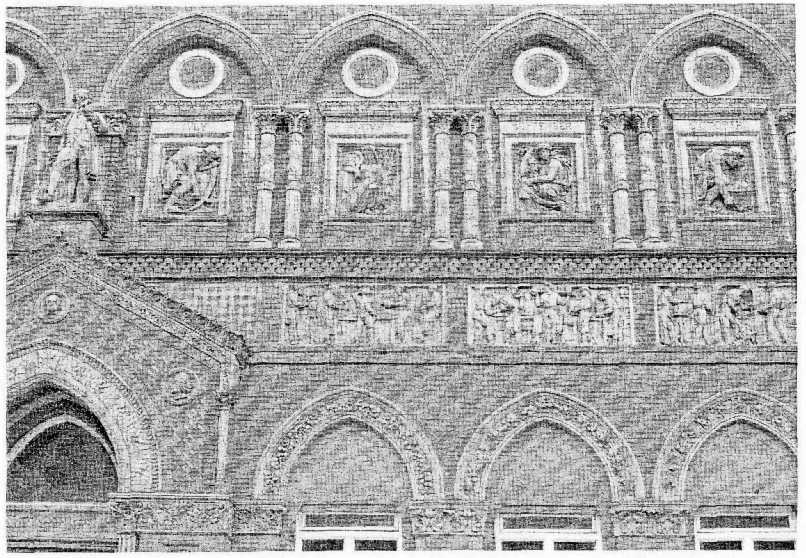

FIG. 3. Wedgwood Institute, Burslem, Staffordshire, R. Edgar, R. J. Morris and W. Wright, 1863–73 (Blanchard and Blashfield).

The architectural press of the Victorian period consistently glossed over such organisational disasters. The largely favourable reaction to the Natural History Museum, completed in 1881 to designs by Alfred Waterhouse, blotted out the problems over the supply of terracotta that had helped to drive the builders into bankruptcy. The material was supplied by one firm, Gibbs and Canning, whose only previous experience of undertaking large contracts had been for the Albert Hall. In that instance the designer, Colonel Scott, employed the extra labour force at Tamworth under his own supervision to ensure that the 80,000 blocks required were made to standard and without too much delay [10]. When the supply of terracotta for the Natural History Museum slipped behind schedule, largely due to technical difficulties in making the blue coloured blocks, Messrs. Baker & Sons sent a representative to the works to try and ensure that the pieces were produced in the order that they were required on the site [11].

South Kensington's enthusiasm for terracotta was exported overseas, along with the emulation of Britain's art school system. In 1865 one of the decorative artists involved both with the Wedgwood Institute and work at the Victoria and Albert Museum, John Lockwood Kipling, went to India to be headmaster of the Bombay School of Art. His arrival coincided with the introduction of terracotta into the city's architecture, as can be seen in the gateway and the Sassoon clock tower erected in the Victoria Gardens in about 1865–7.

More significantly, the art school system was the vehicle whereby the terracotta revival spread to the United States. Walter Smith, the headmaster of Leeds School of Art, emigrated to Boston in 1870 and was entrusted with establishing a museum and art school. The Boston Museum of Fine Arts was completed in 1876 to a design by

Sturgis and Brigham and with materials supplied by Blashfield from Stamford [12]. One of Blashfield's managers, James Taylor, who left for America around the time that the Museum was being erected, was to be instrumental in developing a terracotta industry in Chicago, then Boston and finally New York. He directly applied Blashfield's manufacturing technology, which in turn derived from Coade's Manufactory, to the challenge of cladding the first generation of American skyscrapers. He collaborated successfully with architects such as H. H. Richardson and Montgomery Meigs to produce schemes of startling aesthetic confidence (Fig. 4). However his career, like that of his former employer Blashfield, was characterised by organisational inefficiency and financial collapses.

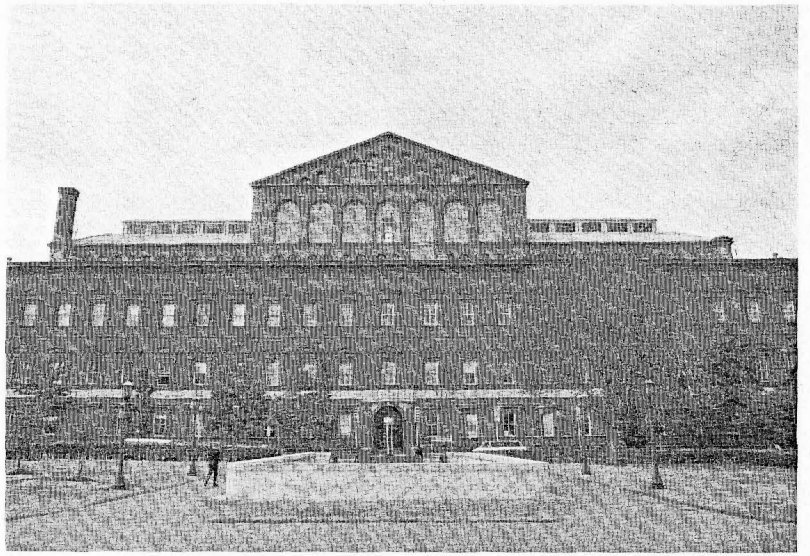

FIG. 4. Pension Building, Judiciary Square, Washington, by General M. Meigs, 1882–5 (Boston, A. Hall).

The Organisation of the Industry

Consideration of the early years of the terracotta revival begs a fundamental issue that remained unresolved well into the twentieth century. Why was the production and use of a material that was usually regarded as being essentially modern and highly economical, dominated by inefficient enthusiasm rather than systematic training, organisation and accounting? The answer emerges through consideration of the process of manufacture and the way that production was organised within a burgeoning brick, pipe and tile industry. The shift in location of the major terracotta firms from the young Quaternary and Tertiary clays of the south coast and south-east of England to works on the coalfields might have been expected to have brought a more structured approach to mass-production. This, as the material became part of a broad range of

ceramics manufactured at large, permanent works. Apart from the relatively simple task of pressing clay into moulds, most of the stages of production, and particularly the making of models and moulds, required skilled labour (Figs. 5 and 6). At the quarry, nicknamed the 'Clayworkers' Eldorado', at J. C. Edwards' works at Pen-y-bont, Ruabon, the clay used for terracotta came from a narrow layer and hence had to be worked largely by hand. At many works different clays were mixed to achieve the best possible balance of qualities.

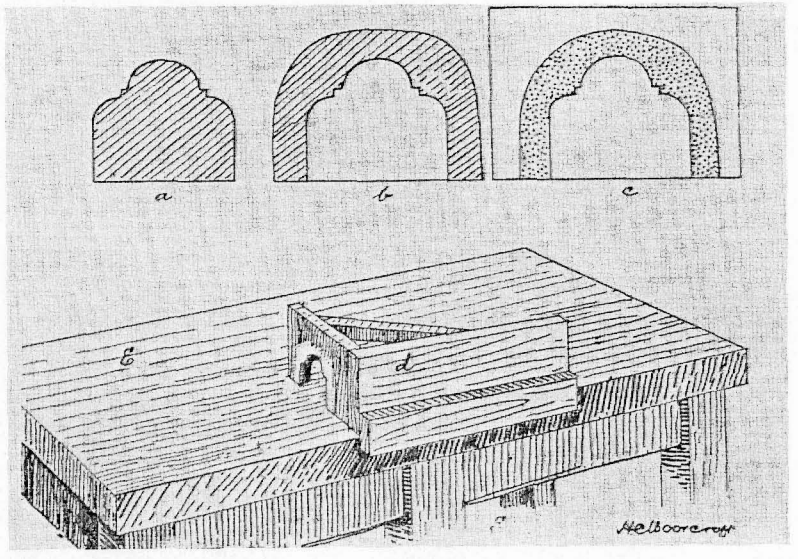

FIG. 5. Model, template, mounted template and horse for running a moulding in plaster. Source: *W. J. Furnival: Leadless Decorative Tiles, Faience and Mosaic* (W. J. Furnival, Stone (1904), p. 766).

Many owners and managers seem to have revelled in having a section within their works where production was characterised by skilled handworking, complexity and experiment. The clayworkers who came to specialise in terracotta, such as J. C. Edwards and Jabez Thompson, were attracted towards a line of production that was prestigious and would therefore elevate their personal status above that of mere brickmakers. Some manufacturers were strongly motivated into making technically challenging forms of ceramic by an interest in geology. George Maw toured the country collecting clay samples to add to his geological collection at the same time as he was developing a wide range of manufactures at Jackfield. In terms of both skills and management a terracotta section became something of a world apart from the mechanical pressing of bricks or the extrusion of pipes. While most Victorian brickmaking was undertaken through a series of sub-contracts given to pressers or kilnmen, who were taken on and laid off according to demand, the greater skills needed for terracotta meant that most workers were paid weekly with some element of stability of employment.

FIG. 6. The production line for pressing terracotta blocks at the Hathernware Ceramics Works, Leicestershire, 1983.

For most of the nineteenth century it was modellers who were most likely to be entrusted with supervising the work of a terracotta department. As the complexities of contracts increased so it tended to be people who had been trained in architectural practices who gained supervisory responsibility. A Mr Richardson, a pupil of the architect Frank Verity, came to supervise the drawing office at J. C. Edwards. Similarly the well known designer W. J. Neatby, who worked at both Leeds Fireclay and Doulton, had trained with an architect rather than at an art school [13] (Fig. 7). The draughtsman emerged as the central figure of most terracotta departments after the turn of the century. He supervised the taking out of quantities and the making up of an estimate, and then, if the tender was successful, the drawing of shrinkage scale plans and the arrangement of the detailing. Mr Harrison, a draughtsman at Gibbs and Canning, was entrusted with control of the terracotta section at the works by 1908. The manager of the Huncoat Terracotta Works in the early years of the twentieth century had progressed from being the senior draughtsman at the J. C. Edwards Works at Pen-y-bont [14].

There was no direct precursor for the combination of skills required by the senior figures in terracotta departments. Many of the brickmakers who attempted to exploit the demand for the material failed to recruit sufficiently qualified staff. It was considered that one of the main reasons why there were so many problems with terracotta in the decades up to the turn of the century was that the draughtsmen, modellers, mould makers, pressers and finishers had been drawn from dissimilar trades

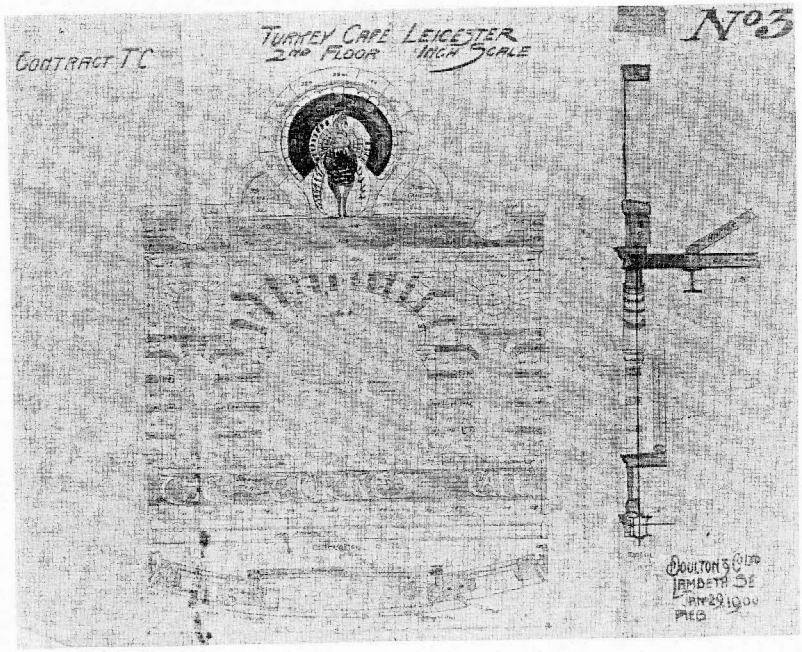

FIG. 7. Contract drawing for the Turkey Cafe, Granby Street, Leicester, by A. Wakerley with W. J. Neatby, 29 January 1900 (Doulton). Source: Royal Doulton Tableware Ltd.

and 'pitch-forked' into the business [15]. The consequence was not just a combination of low standards and mistakes but an inconsistency even on a particular building contract. It was noted in 1901 that the differences in the way that individual draughtsmen and modellers produced scrolled curves or cartouches, or designed joints, could be all too obvious across a completed frontage [16].

The need for the rapid execution of contracts worked against any more rational approach. Architects were always impatient for the first deliveries of terracotta, because the material was largely used as an integral part of the building structure. In the inter-war period pressing often commenced in the same week that the modellers started work. By rushing through each stage a small shop front could be made in five weeks. To achieve such speed, sufficient staff had to be kept on during lean periods so that a start could be made on a large contract or several smaller ones as soon as the tenders were accepted.

The actual production of the terracotta blocks was highly labour intensive, with most pieces being pressed into their moulds by hand. Workers gained the skills for hand finishing clay blocks through years of experience. A pattern became established at two of the major works, Gibbs and Canning, and Hathern, that apprentices were taken on from school, were bound for probably three years, and worked their way up within either the draughtsmens' office, the modellers' studio or one of the workshops. Medals

from the Clayworkers Institute were presented for 50 years continual service. During the inter-war period there was a prevailing attitude at Hathern that rather than recruit young architects or artists it was best to introduce the peculiarities of terracotta working to employees at the outset of their careers. Most of their draughtsmen started as office boys directly after leaving school. The managing director at Hathern during the early 1930s, G. A. Hodson, was loath to loose staff during slumps in demand. In a recession he was more likely to resort to wage cutting than redundancies. An element of job security was counterbalanced by a strict paternalism. Staff might be dismissed for minor misdemeanours. A register compiled at Hathern shows people being reprimanded for 'being cheeky', 'always grumbling', 'having long hair' and in one case 'being convicted in a peeping tom case' [17].

The ultimate results of keeping on staff through recessions and the lack of mechanisation was that labour costs became a heavy burden when works were not working to full capacity. This could threaten the profitability of the terracotta section, and at times the viability of the entire company. In the inter-war period there was a saying at Shaws of Darwen that the firm only charged for labour and supplied the clay and the coal for firing the ware for free. Escalating labour costs ultimately led to the introduction of standard faience slabs, typically measuring 2×1 ft, cast in banks and applied as a non-structural cladding to buildings.

One manifestation of the financial instability of the terracotta trade was an unwillingness to commit large sums of money towards modernising and expanding plant. Most works consisted of a loose collection of scruffy buildings that contrasted dramatically with the crisp, clean image which was used to promote terracotta and faience. Sheds could readily be used for making different products, as chimney pots, sinks or glazed bricks passed in and out of demand. Waste and surplus materials were used for constructing walls, spare pieces made for the Natural History Museum being incorporated into some of Gibbs and Canning's workshops. The need for introducing new technology in the form of tunnel kilns was appreciated by the board of Gibbs and Canning in the 1920s but they never felt sufficiently confident of future demand to commit the necessary funds [18]. Some managers and owners consciously resisted the introduction of machinery. Basil Rathbone condemned the use of any power in his Della Robbia works at Birkenhead as "paralysing artistic development" [19]. Most of the firms did use machines for preparing their clays but bought pugmills and blungers on an ad-hoc basis and often second-hand. In the twentieth century the clayworking industry came to regard terracotta plants as being completely antiquated, in contrast to the modern factories erected in Bedfordshire to produce Fletton bricks.

The emphasis on enthusiasm and individuality above efficient mass-production pervaded the marketing policies used to sell terracotta and faience. Stands, whether at international exhibitions or at the annual Building Trades shows emphasised the more bizarre aspects of a firm's productions. Sales representatives adopted more down-to-earth approaches to marketing terracotta and faience. However their rivalry in gaining orders during the inter-war period resulted in a rapid fall in prices, despite the establishment of the Terra Cotta Association to try and keep levels reasonably economic.

The major companies accepted that most of their orders would be for specially designed blocks and slabs rather than stock forms chosen from a catalogue. For most of the period of the terracotta revival it was impossible to use stock components for structural work. Most terracotta dressings had to course in with two, three or four layers of brickwork. With the sizes of bricks not being standardised in the nineteenth

century it was impossible for any degree of regulation to be achieved in the dimensions of even the simplest terracotta ashlar. Even for modest features, such as a bay window on a terraced house, the builder/architect would typically supply a sketch design. It would be developed by the draughtsman of the terracotta works who would send back a scale drawing illustrating how the suggested composition could be executed most effectively in ceramic.

The American terracotta industry was initially dependent on Europe for its supply of draughtsmen and modellers. Skilled staff emigrated in large numbers from Britain and elsewhere in northern Europe, many of them frustrated at the job insecurity caused by periodic collapses in demand. The extent to which the American firms gained their staff from Britain is exemplified by the Woolworth building in New York, designed by Cass Gilbert. Completed in 1913 as the tallest building in the world, 52 of the 55 storeys were clad in a matt cream faience made at the Perth Amboy Works of the Atlantic Terracotta Company. The superintendent and his assistant, the head of the construction and drafting department and 21 of the draughtsmen at the works were migrants from England [20]. The growth of the Californian terracotta industry around the turn of the century was assisted by the arrival of workers from Ruabon, who had left Wales following the decline of demand for red terracotta just after the turn of the century.

As in England the training provided for those working in the American terracotta industry initially centred more on art than practical aspects of manufacture and construction. The Pennsylvania Academy of Fine Art, which had been founded in 1806, only gained a clay working department in 1880, shortly after the establishment of a School of Industrial Art in 1876. The course evolved to provide a more solidly industrial training than anything available within the British art schools. In 1896 one of the professors in the Industrial School of Art was working with nine assistants in the modelling shop of the terracotta works of Stevens, Conkling and Armstrong in Philadelphia [21]. The development of other schools specialising in clay modelling often paralleled the establishment of factories making terracotta, pottery or porcelain. The Art School at Trenton, New Jersey, developed a specialisation in ceramics to serve the local firms. Its first director, from 1898, was Charles F. Binns, who had previously worked for Royal Worcester Porcelain in England [22]. The training provided in the Art Schools at Boston, Philadelphia, Trenton and Cleveland were soon to be complemented by much more technical courses instigated by the Universities of Ohio and Illinois.

After an early period marked by many bankruptcies, the American terracotta industry became dominated by a number of large firms which proved to be far more willing to invest in machinery that would permit mass production (Fig. 8). In the 1920s the works of the North Western Terracotta Company at Amboig, New Jersey, had shaping machines to cut the plaster moulds and the blocks were burnt in an oil fired tunnel kiln [23]. The National Terracotta Society, the American equivalent of the Terra Cotta Association, served to promote research into the technology and the most efficient production of terracotta as well as acting to prevent excessive price cutting.

Fixing Terracotta

The inconsistencies and illogicalities of the terracotta industry were matched by some confusion and inefficiency in the way in which the material was used and fixed. During the 1860s and 1870s there was a vigorous debate as to whether terracotta should be

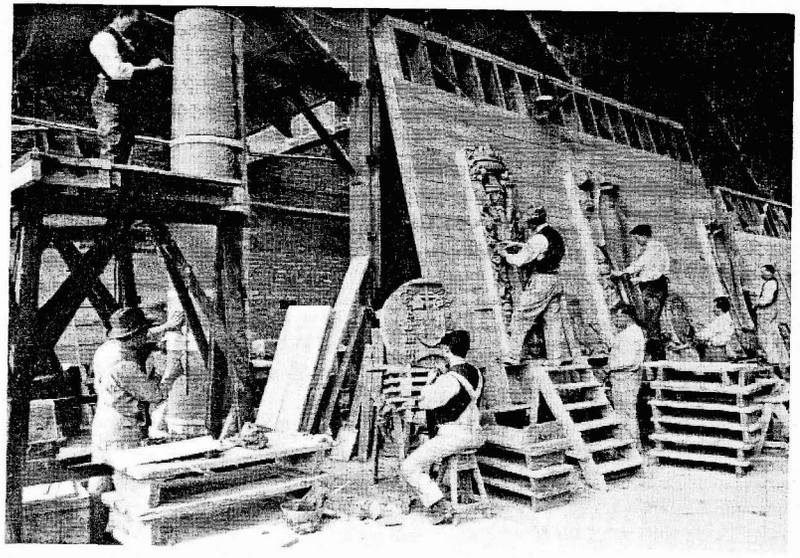

FIG. 8. The modelling room at the works of the Northwestern Terracotta Company Works, Chicago, c.1925

regarded as a substitute for stone or as a more prestigious type of brick. Partly as a result of such contention there was considerable inconsistency in the way that blocks were filled and fixed. Cement, brick-bats and flints were all used for filling hollow blocks used on the Victoria and Albert Museum. Similarly many different types of cement were employed for fixing terracotta, among which the use of hard Portland cement often caused failure, with blocks shattering as the cement expanded [24]. A variety of rebate, joggle, butt and lip joints were used to ensure that window lintels and transoms, and other architectural features were securely fixed.

The problems of fixing terracotta were compounded by a confusion as to which trade should be responsible. This issue came to a head partly as a result of a prolonged labour dispute in London that ran from 1876 into the following year. During the construction of Doulton's new studios along the Albert Embankment, two plasterers were taken on to assist with the fixing of the terracotta decorations on the building. The bricklayers already working on the project protested and went on strike, claiming that this was their work. In fact it was plasterers who had fixed the majority of early schemes including the Horticultural Society Gardens and the Victoria and Albert Museum in South Kensington [25]. More recently bricklayers had carried out the work on the Natural History Museum and on the Prudential Offices in Holborn. It was to be bricklayers or specialists employed by manufacturers or major building contractors who were to fix the majority of later schemes.

Stonemasons often claimed that they had the requisite skills for fixing terracotta, but this trade was most vociferous in opposing the use of ceramics at all. They sent a deputation to protest to the Mayor of Birmingham when it was announced that terracotta was to be used on the Assize Courts. This was promptly followed by a visit

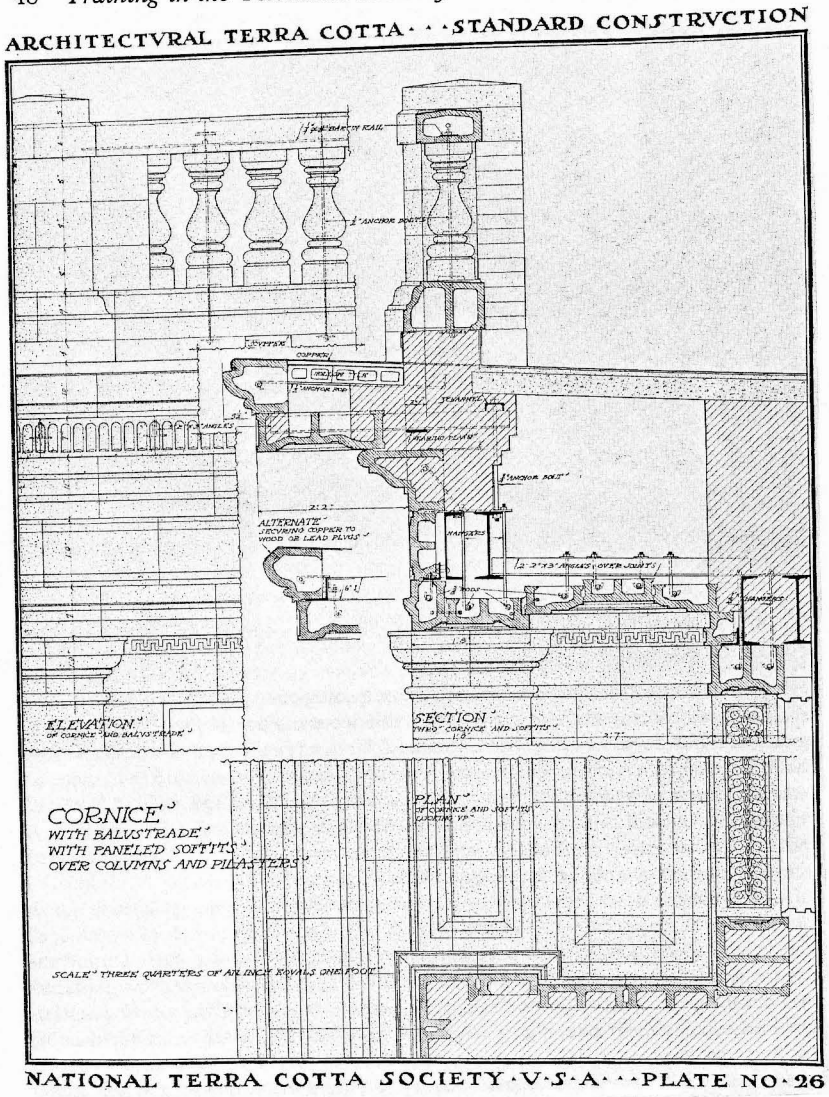

FIG. 9. Section of a cornice showing the use of metal supports. Source: *Architectural Terracotta: standard construction* National Terracotta Society, New York (1914), Plate 26.

from the members of the Operative Bricklayers Societies, reassuring the Council of the astuteness of its choice of material [26].

In general the building trades appear to have shown little enthusiasm for architectural ceramics. The materials could generate considerable extra complications and

there were frequent complaints over the inability of terracotta manufacturers to supply to schedule. One architect considered that it was the delay caused by the need to replace blocks broken in transit or on site, and the consequent disruption to the execution of building contracts, that did most to make terracotta unpopular. Their prejudices were furthered by the material having only a borderline economic advantage over most building stones [27].

In America there was a comparable debate as to who should be responsible for fixing terracotta, but the massive growth of the industry from the turn of the century spawned specialist firms who were skilled at fixing the material. The construction companies that were responsible for both designing and building many of the more prosaic tower blocks often undertook their own fixing. Due to the great height of cornices on skyscrapers, terracotta was frequently projected several feet forward of the main building line, considerable ingenuity being used in suspending blocks from complex systems of metal cramps [28] (Fig. 9).

Terracotta and faience passed out of favour as much because of frustrations roused by the problems of their use as any changes in architectural taste. Most fundamentally, the apparently logical and economical approach of repeating designs and hence the forms of individual blocks was rarely exploited to the full. Architects preferred to retain their independence in designing the elevations of their commissions. At the same time most manufacturers submitted to a subservience to architects' demands, instead of promoting a degree of standardisation that would permit the introduction of profitable techniques of mass production. In most instances architects and manufacturers worked in complete accord. The commercial architects who used terracotta and faience and the manufacturers who supplied the material, for the most part, agreed in their taste for exuberant decoration. Their shared enthusiasm for intricate modelling in plastic clay outweighed the rationality of repeated and low relief forms.

By the twentieth century the managements of many terracotta firms were somewhat fatalistic in their attitudes. They regarded their market as being largely dictated by the building cycle and by the number of commissions gained by the architects with which they had close ties. They wished desperately to retain their skilled staff and to maintain their industrial plants in order that they could quote short delivery times when large jobs came in for tender. The management in British firms tended to put off the installation of more economical means of manufacture such as continuous or tunnel kilns, using the justification that such technology restricted the variety of ornamental work that could be handled. In contrast the terracotta industry in the United States accepted the use of tunnel kilns by the 1920s and rapidly introduced machine pressing and even the extrusion of simple architectural sections.

It was the continuation of pragmatic approaches to management, such as prevailed at Hathern, and Gibbs and Canning in the inter-war period, that promoted a reaction in the increasing standardisation of products and a policy of tight cost control. Prestige lines that failed to cover their overheads, and historicist decoration had become anathema to both industrial management and forward-looking architects by the 1960s.

The chronology of the terracotta revival suggests that building technology and the relative costs of different materials never gained the full attention of either the architects, manufacturers or the heads of art and technical schools. Even the owners and managers of the major factories appear to have been motivated primarily by an enthusiasm for producing richly moulded and coloured facing materials. Few sought to realise the profits that could have followed from the mass-production of standardised components. The massive demand for simple forms of ceramic fire-

proofing, especially to protect the steel frames of American skyscrapers, had little influence on the economics of the firms producing decorative terracotta and faience, since different companies supplied these two closely associated markets. Blashfield, Doulton and Taylor found a remarkable tie with the mainstream of commercial architects who sought to satisfy the demands of their clients with a modern and yet decorative building material. The main victims were, in the early years of the revival, the builders who had to suffer frequent delays in supply of blocks and slabs and, ultimately, the general status of architectural ceramics.

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