Abstracts of Periodical Literature

Compiled by Simon Pepper and Peter Richmond.

ROBERT BORK, **Into Thin Air: France, Germany and the Invention of the Openwork Spire**, *The Art Bulletin*, Vol. LXXXV, No. 1 (March 2003), pp. 25-30. Beauvais Cathedral marked an end point in the pursuit of height by French cathedral builders, not merely because of the well-known collapse of the choir vault, but because the original design with towered transepts had already been abandoned in favour of a new scheme featuring a tall choir and no towers at all. It was only in the Rhineland in the late thirteenth century that fa ade and spire design returned to the forefront of Gothic architectural culture, as French ideas spread into territory where patronage was more conducive to spire construction. In the cathedral workshops of Cologne and Strasbourg, especially, French Rayonnant ideas about skeletal construction were assimilated, elaborated and transmitted into the German-speaking world. It was the intersection between the workshop traditions of Cologne, Strasbourg and Freiburg im Breisgau that made possible the emergence of the first major open-work spire in Freiburg between 1300 and 1330. The social context in Cologne recalled those of Chartres and Reims in that the interests of the cathedral clergy frequently opposed those of the townspeople. In Strasbourg and Freiburg, however, and later in many other German cities, civic pride and burgher donations fuelled the construction of ambitious fa ade and spire projects, culminating in the north spire of Strasbourg in 1439 — which stands today as the tallest surviving medieval building. Metal played an important role in these later Gothic achievements, notably on the west front of Strasbourg where metal clamps, dowels and pins connected the skeletal components, and in Freiburg s spire where iron chains at each level of the cone contained the outward thrusts. The author s edited volume — *De Re Metallica: The Medieval Uses of Metal* —will shortly be published by Ashgate.

JOHN COX, **A Direct Bounty on Extravagant Quantities : Peto s Great Northern Contracts, 1847-50,** *Journal of the Railway and Canal Historical Society*, Vol. 34, Part 2 (July 2002), pp. 83-7. The viability of construction projects often turns as much on the financial arrangements and management as on any technology involved, and this journal carries numerous papers which give a proper place for these aspects of our subject. Cox s paper discusses the contractual arrangements agreed in February 1847 for the construction of the Great Northern Railway s (GNR) main line from London to Peterborough, and the 77-mile Lincolnshire Loop from just north of Peterborough to Gainsborough via Boston and Lincoln. Thomas Brassey was given the London to Peterborough contract, while the Loop went to Samuel Morton Peto: both contracts going to well-known contractors following direct negotiation, without apparently seeking other tenders. The GNR did not even negotiate an overall price for the line, agreeing instead to pay for materials and labour on a schedule of rates basis. Less concerned at this stage with overall cost than speed of execution, the GNR did however insist that the Loop should be completed within twelve months (with a fine of £1,000 a month for delay). By 1848 railway mania had collapsed, leaving the GNR short of capital, reducing Brassey s monthly spend to £10,000 a month but seeking completion on Peto s Loop by investing £50,000 monthly, and attempting without success to interest both contractors in part-payment by debentures. The crisis for the railway company forced the directors to review the rates paid, to question Peto s charging of 3s. 6d. a day for his labourers but paying only 2s.

6d. as well as to question the extravagant quantitites of the title. As in so many other cases, it was the contract gone wrong that yields the most interesting insights into nineteenth century business practices.

JAMES FREDERICK EDWARDS, **Building the Great Pyramid: Probable Construction Methods employed at Giza,** *Technology and Culture,* Vol. 44, No. 2 (April 2003), pp. 340-354. Ever since Herodotus speculated on the construction of the Great pyramid (which was, of course some 2,000 years after the event), academic opinion has been divided on the means by which the stone blocks (most of which weighed about 2 tons) were raised into position. Haulage ramps are the most favoured solution, but the use of small teams levering up individual blocks course by course, and the use of the traditional Middle Eastern *shaduf* (or counterbalanced crane) also have their supporters. The author — an engineer and physicist — casts doubts on the efficiency of levers, cranes, and earthwork ramps which (whether straight or, as has been suggested, cranked around the rising pyramid in a tightening spiral with 90 degree corners) would have had to be at least 1,500 metres in length to reach the top of the pyramid at a gradient of 1:10. The alternative thesis propounded here assumes the well-attested Egyptian use of sledges hauled by large teams for the movement of heavy stones or statuary; but argues that 2-ton loads could have more efficiently been drawn up prepared and lubricated dragways on the 52 degree semi-finished external stone face of the pyramid by teams working from the (diminishing) flat space at the top. Initially all four faces of the pyramid would have been used as dragways, reducing to two as the working platform reduced in area. This is a fascinating and challenging piece, but almost certainly not the last word on the subject.

MICHAEL GOULD, **The Ritchie System of Reinforced Concrete,** *Transactions of the Newcomen Society,* Vol. 73, No. 2 (2003), pp. 275-91. In 1924 and 1925 Mr H. C Ritchie of Liverpool made application for two British patents for an improved system of reinforced concrete, sometimes known as reinforced steelwork but more often referred to as the Ritchie system . Michael Gould s paper deals mainly with the second patent which was widely used in the construction of water towers and the coverings of service reservoirs (see his other papers abstracted in previous numbers of this journal). Derived initially from the jack-arching techniques used in numerous early fireproof buildings (shallow brick vaults springing between cast-iron I-beams), Ritchie proposed the combination of steel I-beams and conventional steel-rod reinforcing bars. The framework of I-beams came into its own in the construction of tall structures (the water towers) and extensive roofing schemes (the reservoirs) because, as well as contributing to the strength of the completed structure and providing secure fixings for the other reinforcement, it could be erected quickly and then used to hang the shuttering for the slabs and downstands, thus saving on what otherwise would be veritable forests of supports.

NICK HILL, **The Manor House, Medbourne: The Development of Leicestershire s Earliest Manor House**, *Transactions of the Leicestershire Archaeological and Historical Society,* Vol. 75 (2001), pp. 36-61. The development of this important manor house has been the subject of a recent programme of detailed recording and analysis, accompanied by dendrochronology. A complex sequence of building phases has been established, dating back to the earlier thirteenth century, with major rebuilding in the late thirteenth century and the sixteenth century. It is suggested that an aisled hall of c.1238, possibly timber-framed, was replaced in c.1288 with a stone-built hall and cross wing containing service rooms below a solar. In national terms it provides an excellent example of the transition from aisled hall to a base cruck or short principal type of roof structure, with unusually precise dating of both phases. Regionally, it is argued, it is a representative example

of a great rebuilding in this stone belt district, probably marking the transition from timber-framed construction to stone, and using the base cruck/ short principal roof structure within stone walls. Excellent, clear drawings of the roof timbers, jointing, and one interesting asymmetric truss are included.

I. B. HOOLEY JR, **Blacktop: How Asphalt Paving Came to the Urban United States,** *Technology and Culture*, Vol. 44, No. 4 (October 2003), pp. 703-33. Asphalt is today one of the most ubiquitous of construction materials, covering a significant proportion of the developed world s roofs, as well as the highways and parking lots which are the subject of this paper. Hard when cold, fluid when hot: asphalt was a difficult material to transport and to lay when the construction site was often miles from the heating plant. Before steam-heated railroad cars were developed, asphalt hardened in the wagons. Railroad companies, unsurprisingly, took a dim view of contractors lighting fires under their rolling stock to soften the asphalt before unloading it! The development of mobile asphalt melting plants which could operate at the road-surfacing site, and the near-contemporary development of the heavy steam roller with its water-lubricated rollers were both decisive in opening the outer suburban and country roads to the new product. The spread of bicycles (and the clubs which promoted recreational cycling) was perhaps even more significant than private car ownership in stimulating local and state political pressures for the grading and asphalting of the dirt road network in the early twentieth-century. This is one of those rare papers which effectively combines fine detail with a commanding overview of complex relationships. Beginning with McAdam s early nineteenth-century techniques in consolidating crushed stone, Professor Hooley discusses the competing claims advanced for cobbles, granite blocks, wood blocks and bricks as urban street surfaces, before proceeding to conduct the reader through the development of the asphalt import industry in the last thirty years of the nineteenth century, its sales and promotion, its failures and the gradual growth of scientific and engineering understanding of the properties of what is in fact a group of materials with surprisingly wide variations in their chemical properties which demanded different handling and laying techniques. If the securing of raw materials from the Caribbean and South America (and later in the western states of the USA) brought out the robber baron tendency in American big business, the other side of this coin was the American ability to develop research centres and with them the expertise needed to master the material. What stands out as the thesis of this study, the author concludes, is the necessity of bridging the gap between pure and applied science, between theory and practice. Running through the whole story of asphalt as a paving material is the essential role of expertise, political no less than scientific and technical.

DAVID JOHNSON, **Friedrich Edouard Hoffmann and the Invention of Continuous Kiln Technology: The Archaeology of the Hoffmann Kiln and 19th-century Industrial Development (Part I),** *Industrial Archaeology Review*, Vol. XXIV, 2 (2002), pp. 9-32. The production of important construction materials and the technology that made it possible is covered by two papers abstracted in this volume (see also Holley on Asphalt). Friedrich Edouard Hoffman (1818-1900) was born in Gr ningen in north-central Germany to school-teacher parents, and was to become prominent in industrial circles in Prussia and later in a unified Germany, not only for the kiln that bears his name: he was also the designer of a hydraulic excavator, a pneumatic mill and for important improvements to railway technology. He became Surveyor of Works for Berlin and was on friendly terms with Bismark. In construction history circles it is his development of the continuously-burning kiln — used for lime-burning and for brick manufacture — that he is best known. This paper, the first of two, provides a historical overview of kiln technology, focussing on the revolution which was prompted by the increased use for lime in improved intensive agriculture as well as its application in the housebuilding booms and railway construction programmes of the nineteenth century, and by the enormously expanding demand for bricks. Johnson makes clear that Hoffmann s design was only one of a number of closely-related developments patented in Britain and in continental Europe which moved away from the traditional vertical, top-fed kilns (which had been in use for centuries) to horizontal systems which allowed for fire to be advanced from one compartment to another in a linked system, always maintaining at least one fire-box at operating temperature, while others cooled, and saving on fuel as well as improving the complete firing of limestone or bricks, by means of a variety of pre-heating and hot air re-circulation systems, as well as by making use of substantial shared flue and chimney arrangements. Hoffmann and his collaborator Licht took out their first patent in Austria in 1858 and in Britain in 1859 for a circular design, followed by others for oval, rectangular, concentric and even two-tiered arrangements with increasing sophistication for the control of ventilation and fuel feeding. A later paper on the wider significance of the Hoffmann kiln is promised, with a gazetteer of Hoffmann lime kilns in England and Wales.

MARK WILSON JONES, **Tripods, Triglyphs, and the Origin of the Doric Frieze,** *American Journal of Archaeology,* Vol. 106, No. 3 (July 2002), pp. 353-390. The standard wisdom on the origins of the Doric order revolves around the doctrine of petrification, by which a previously established timber vocabulary came to be perpetuated in stone once society acquired the means to build in this material. While the petrification doctrine takes its authority from Vitruvius, and is supported from parallel processes elsewhere, it none the less copes inadequately with the archaeological realities of Greece in the late Geometric and early Archaic periods. In particular, the form, size, and placement of the triglyphs (the end beam cover in the Vitruvian scheme) in the frieze are not necessarily demanded by the logic of timber construction and the configuration of early temple superstructures. A growing number of scholars accordingly challenge the Vitruvian consensus, whether by tracing the Doric frieze back to Mycenae, Egypt, the Orient, and idioms of pattern-making in Geometric art, or by arguing for symbolic modes of interpretation. The author is one of the challengers and, after reviewing and dismissing the petrification doctrine in its simplistic form, suggests that the origins of the three distinctive verticals of the Doric triglyph may well be found in stylised references to the tripod, which had numerous associations with heroic gifts, prizes, Apolline symbolism and as the most important of the Greeks votive offerings.

CHRISTINA MARANCI, **The Architect Trdat: Building Practices and Cross-Cultural Exchange in Byzantium and Armenia,** *Journal of the Society of Architectural Historians,* Vol. 62, No. 3 (September 2003), pp. 294-306. Numerous Byzantine sources report the devastation of the earthquake of 989, the collapse of the dome of the Hagia Sophia, and its subsequent repair under Emperor Basil II (r. 976-1025). None mentions the builder involved in the reconstruction project. It is in the early-eleventh-century Armenian source, however, the three-volume *Universal History* by Step anos Tarŷnec«i, that the identity of the builder is given as the architect and stonemason Trdat of the Armenians who happened to be there [in Constantinople], presented a plan, and with wise understanding prepared a model, and began to undertake the initial construction, so that [the church] was rebuilt more handsomely than before. Christina Maranci argues that Trdat was not just fortunate to have been on the spot when the disaster occurred, but was summoned to the Byzantine capital because of his specialist expertise in dome and pendentive construction — both features of contemporary Armenian church design, but carried out in ways that are distinctively different from the great Byzantine churches. Hence the problems of cross-cultural exchange indicated in the title. Maranci s paper, however, identifies Armenian elements in the reconstruction

of Hagia Sofia, notably the thickness of the western great arch (which is probably his work) and the use of blind windows in dome (possibly borrowed from the Armenia practice of alternating narrow openings with blind windows). Another aspect of even wider interest concerns the chronicler s mention of the architect s use of preparatory studies. The chronicler, Step anos Tarŷnec«i, uses two different words in connection with the plan and model used in the reconstruction design: *awrinak* (meaning a type or model, or more precisely graphic media such as drawings or plans), and *kalabar* (indicating a three-dimensional medium, such as a cast, shape or mould). This account thus provides support for one of the earliest documented uses of both graphic and plastic preliminary studies in large-scale construction.

ROBERT A. OTTER, **The Construction of Dry Docks: Some Nineteenth-Century Perspectives,** *Transactions of the Newcomen Society,* Vol. 73, No. 2 (2003), pp. 241-55. Although dry docks in the modern sense have been a feature of Britain s maritime history for some 500 years, growth and change in the size and cross-sectional shape of ships — two trends which accelerated dramatically during the course of the nineteenth century — drove important developments in the design and construction of the dry docks which contained them, and in the technology for the opening and closing of the gates that made them dry. Otter s paper provides an overview of these changes and draws attention to the replacement of timber construction, first by masonry and then from mid-century by concrete; the continuing debate about the relative merits of caissons and double-hinged leaf gates as closing mechanisms; and the use of steam, hydraulic and later electric power for pumps and cranes. For construction historians one of the most important developments was that of pressure relief, which was pioneered in dry docks but later applied to other foundation and underground structures. An impermeable dry dock can be conceived as a very large concrete boat, with a tendency to float on the below-ground water, but kept down by the combined weight of its walls and floor. The inverted masonry floor arch was a refinement of this approach. For very large docks, such as the four-vessel basins opened in Barry in 1889 and measuring 724 ft by 100 ft on the floor, massive and hugely expensive walls and floors would have been needed for it to function as a gravity structure. By letting the ground-water in through a porous structure, draining it to sumps, and pumping it out again, substantially lighter concrete walls were designed. An even earlier graving dock at Greenock (1869-73) had perhaps given Barry s designer the idea, because here a timber grid-iron floor (using traditional construction) was pumped out from a series of longitudinal arterial drains.

JOHN R. PANNABECKER, **School for Industry: L cole d Arts et M tiers of Ch lons-sur-Marne under Napol on and the Restoration,** *Technology and Culture,* Vol. 43, No.2 (April 2002), pp. 254-90. Before the Revolution of 1789-94 the French tried to accelerate industrial growth by importing English machines and workers, with only limited success. As part of their reaction against state control of the economy, moderate leaders of the Revolution eliminated the trade guilds and the apprentice system in hopes of increasing social and economic mobility and technological innovation. But the constant warfare of the 1790s depleted the supply of skilled workers and so widened the industrial gap between France and England that in 1803 Bonaparte created schools of arts and crafts in hopes of jump-starting French industry competing more effectively. Napoleon viewed technical schools as a means not only of training military leaders but also of injecting into industry a new type of educated worker who could modernise industry. Initially located at Compi gne, the first school moved to Ch lons-sur-Marne (now Ch lons-en-Champagne) in 1806, from where it eventually spawned a nation-wide network of technical training centres producing many of France s engineers and engineering technicians (in addition to the elite products of the Øcole Polytechnique. From the circumstances of its origins, the initiative was always going to be political — only surviving the wartime years to 1814 because of its success in mass-producing improved artillery caissons (ammunition wagons) when the students workshops were concentrated on this effort — and narrowly weathered another crisis when the radicalism of its students brought it to the attention of the ultra-Right following the Restoration of the Old Regime. This paper is an important contribution to the growing literature on technical education, and contains much useful material on the debate between creativity and standardisation, the role of technical drawings and of scale model-making as features of an educational programme which combined theory (mathematics, descriptive geometry, etc. taught by mathematicians) with workshop training (directed by foremen).

DENNIS J. POGUE, **The Domestic Architecture of Slavery at George Washington s Mount Vernon,** *Winterthur Portfolio,* Vol. 37, No. 1 (Spring 2002), pp. 3-22. Mount Vernon, Virginia, the eighteenth-century plantation of George Washington, was home to a large, dispersed, and highly organised community of enslaved workers. Washington himself owned only 123 out of the 316 slaves living on the plantation and, although his will gave freedom to his own people, he had hesitated to grant manumission during his lifetime because of the disruption he knew would result amongst families extending across the two groups. The President was a relatively enlightened owner and agricultural manager, and the range of accommodation reflected an evolving attitude to slavery and a variety of building forms which included log-built family cabins and quarters for single field hands, brick quarters providing barrack-style housing at the Mansion House farm where the Washington family lived, and an extremely well-appointed brick-built Servants Hall (1775) for the accommodation of the slaves of guests at Mount Vernon. Dennis Pogue was the chief archaeologist at Mount Vernon for many years and the paper has its origins in a project for the reconstruction of slave cabins at the historic site. Information available in the form of documentary evidence, archaeological data, and extant structures was collected with an eye for building construction as well as the whole system of slave management and housing in use in a progressive example of the peculiar institution .

CHRISTOPHER POWELL, **Specialities Still Continue to Increase Amazingly : Division of Labour among Building-Related Firms,** *Accounting, Business and Financial History,* Vol. 12, No. 1 (March 2002), pp. 43-72. A major building project may be undertaken by a single integrated firm or alternatively by numerous firms, each producing a small specialised part of the whole works. The adoption of either the integrated or the divided model is a matter of some consequence in the organisation of building — or any other — industry, and this study plots the path of division of labour among building-related firms mainly in Bristol (but also in London) from the mid-nineteenth century to World War II, and attempts to identify the causes for what was a virtually continuous growth in the division of labour, with the fastest growth between c.1900 and 1920. Probable influences favouring growth included the extent of the market (following Adam Smith s observation that larger markets increased the scope for specialised goods and services), the difficulties faced by established integrated firms in securing continuous employment for all of their specialised skills and equipment, and their reluctance to risk investment in the emerging new technologies which accompanied the increasing complexity of building. Falling transaction costs also encouraged buying in the work of specialists unless it was clearly cheaper to carry it out in-house. A counter-trend which favoured the integrated firm was the preference — commonly shared by both customers and their architects — for working with a single, reputable firm which could more easily be supervised than a series of separate and unknown nominated sub-contractors. The overall picture emerging from Powell s analysis is consistent with a division of labour being borne upward throughout the period on a rising tide of market growth. Sharper impetus from time to time came

from clusters of technical innovations bearing on the performance of buildings (telephones, ventilation and fireproofing, for example) as well as the substitution of newly engineered technology replacing old craft work (metal frames and cladding replacing masonry walls) and the introduction of electrical systems or lift installations which were both technically demanding and infrequently needed.

JOHN WYN PRITCHARD, **Water Supply in Welsh Towns, 1840-1900: Control, Conflict and Development,** *The Welsh History Review,* Vol. 21, No. 1 (June 2002), pp. 24-47. Much construction history concerns the infrastructure of urban services. Here technical advances and the working practices of the engineers and entrepreneurs responsible for vast sanitary programmes often held the key to urban growth and the defeat of cholera. But what of the politics? One of the primary issues in many Welsh towns was the ownership of water supply ventures and the conflict between public and private control. There was a hard technological issue at stake here, in addition to the business of investment, because water supply needed to be integrated with other sanitation services — including drainage and sewerage — and while commercial interests may initially have provided an attractive and inexpensive way forward for many local government bodies, any lack of integration had potentially grave implications for other sanitation services. This paper touches on the politics of water supply in Cardiff and Swansea, but focusses on the cases of Denbigh and Merthyr Tydfil, where ownership and control were central issues, and where cost and private interests dictated the effectiveness of reform. In Merthyr it was a case of the private act enshrining the rights of the local iron industry, while in Denbigh the act passed allowed the water company to make commercial supply its main interest. The profit-driven short-termism of many water companies came under increasingly close scrutiny in the latter nineteenth century, and many communities eventually were driven to acquire the private concerns as well as developing publicly owned reservoirs and distribution systems. From being pioneers, commercial ventures began to fall victim to the progressive view that supplying water should be integrated with other elements of sanitary reform.

JAMES ROBERTSON, **Jamaican Architectures before Georgian,** *Winterthur Portfolio,* Vol. 36, Nos. 2/3 (Summer/ Autumn 2001), pp. 73-95. Jamaica was seized by the British from Spain in 1655 and, although some Spanish traces survived, practically all of the early British buildings were destroyed in the disastrous earthquake of 1692. The subsequent eighteenth-century colonial architecture of Jamaica has attracted much attention. The product of enormous prosperity, this later Palladianised Georgian, seldom higher than two-storeys, often largely of timber with verandas, screens and breezeways was adapted both to the local climate and to the lessons of 1692. But what of the pre-earthquake Jamaican buildings? Robertson s paper employs a variety of estate records, interprets surveys with crude but useful illustrations, and draws upon an impressively wide bibliography on the vernacular importations into the Caribbean and its broader American context to reconstruct the first two generations of colonial building and its adaption to the local environment. Ironically, it seems, many of the more modest structures performed much better than the ambitious creations of Jamaica s business leaders who imported the Baroque fashions of post-Fire London only to see the ruin of their brick-built mansions. Just before jumping from the attic window of a four-storey brick house, one survivor of 1692 recalled seeing the Water at the top of the Garret Stairs as it sank into the sea.

NORMAN A. F. SMITH, **Cathedral Studies: Engineering or History,** *Transactions of the Newcomen Society,* Vol. 73, No. 1 (2001-02), pp. 95-137. The title of this paper really ought to end in a question mark. It is an extended think piece which provides few answers but asks a very large number of questions — generally stimulating and often prompting the feeling that reader really ought to have thought of that without this reminder. It embraces an enormously broad range of topics, times, and tomes; but is loosely focussed (if that is not a contradiction in terms) onto the ways that studies of medieval cathedrals have generated a rich variety of approaches to the history of their structures, construction, and design, as well as the influence of potential Islamic sources for ribbed vaults, lessons from military structures, or spectacular failures, and the wider effects of Europe-wide disasters such as the Black Death. As an engineer, the author is well equipped to comment on the methodological problems associated with what he calls retrospective analysis — the use of modern mathematical and experimental techniques applied to historic structures — and the blind spots inherent in techniques such as photo-elastic analysis. An engineering background also draws attention to the frequent occurrence of failure whilst construction is in progress, of thermal effects, and the effects of relatively small movements or inaccuracies in the craftsmanship of construction.

GLENN R. STOREY, **Regionaries-Type Insulae 2: Architectural Residential Units at Rome,** *American Journal of Archaeology,* Vol. 106, No. 3 (July 2002), pp. 411-434. The Regionaries, or Regionary Catalogues, are two documents from ancient Rome that provide lists of landmarks and summary statistics about features in the city arranged according to their location in the 14 internal regions established by Augustus. Their exact date is unknown, but the majority view is that they are fourth-century AD compilations, most likely dating from the reign of Constantine and probably compiled for administrative purposes (although some scholars have argued for a propagandistic or public relations motive, which, if true, would raise obvious question marks over the reliability of the statistics). Other uncertainties concern the precise meaning of terms: for example *insula* was once thought to mean a street block, but nowadays opinion divides between a freestanding building, or a closed-off portion of a building such as a suite of rooms forming an apartment. Using a variety of sophisticated statistical techniques, the author addresses these problems and by employing GIS technology plots the results on maps of Rome s regions to determine their feasibility. He concludes that *insulae* (at any rate in the Regionaries) must mean various units within buildings, rather than the buildings themselves, and employs a number of historic residential density comparisons as well as the physical plots generated by GIS to take us an important step forward in our understanding of what ancient Rome might have looked like at the time of its most intense development.

RABUN TAYLOR, **Temples and Terracottas at Cosa**, *American Journal of Archaeology,* Vol. 106, No. 1 (2002), pp. 59-83. Most of what is known about the construction of Greek and Roman temples leans heavily on the conclusions which can be drawn from holes for the seating of beams and rafters which can still be found in the stones, although the structural timbers themselves have long since rotted away. An additional source of data is the terracotta panels which often decorated the cornices and eaves, and sometimes also protected the exposed end grain of rafters and beams. Rabun Taylor s paper is principally concerned with the dangers of over-reliance on stylistic dating techniques applied to the large number of finely decorated terracotta excavated in successive American digs at the Roman colony of Cosa. But in the course of this debate much is revealed about the terracotta panels themselves, their production, and the hypothetical arrangement of the timber structural and secondary members to which they would have been fixed.

KATHLEEN WATT, **Making Drain Tiles a Home Manufacture : Agricultural Consumers and the Social Construction of Clayworking Technology in the 1840s,** *Rural History*, Vol. 13, No. 1 (2002), pp. 39-60. During the nineteenth century newly invented clayworking machinery offered potential solutions to production problems in the British brickmaking industry. Three different mechanical brickmaking processes were available, but a combination of design imperfections and restrictions imposed by the excise duties on bricks discouraged their adoption in ordinary brickyards for many decades. This posed a serious dilemma for machine inventors. Without an opportunity to test machinery in brickmaking situations, they were unable to correct defects and produce implements that were clearly superior to hand brickmaking methods. For as long as brickmakers rejected mechanisation, the technical development of the machinery was effectively halted. A breakthrough occurred in the 1840s when a lucrative new market emerged for machines capable of manufacturing large quantities of drainage pipes and tiles for use in rural locations. The exhibitions and implement trials at meetings of the Royal Agricultural Society of England were a decisive factor in the continuing technical development of clayworking machinery. Agricultural consumers, through debate, evaluation and negotiation with machine makers, ultimately determined the success of one mechanical clayworking process over others — the extrusion, or wire cut method — which established the direction of future technological change in the brickmaking industry.

JEFFREY WELLS, **Engineering Aspects of the Mersey Railway, 1881-86,** *Journal of the Railway and Canal Historical Society,* Vol. 34, Part 2 (July 2002), pp. 100-6. As early as 1825 the idea of a tunnel beneath the Mersey had been proposed, but it was not until 1866 that the The Mersey Pneumatic Railway Company was incorporated by Act of Parliament with powers to raise capital and to build a passage one-and-a-half miles long connecting Liverpool with Birkenhead. By 1879 the project seemed doomed for lack of capital, but in Major Samuel Isaac the project found an entrepreneur brave enough to raise the necessary funds and between December 1879 and January 1886 the project was completed. By this time river tunnelling techniques were much more advanced than those which so nearly cost Brunel his life when water burst into the Thames drilling shield. Shafts were sunk from each bank, from which narrow trial drifts — roughly horizontal headways — were taken out under the river to explore the strata and the problems to be faced in cutting. Although roughly horizontal, the drifts were actually cut with a slight upward gradient towards the centre of the river, so that penetrating water drained to the edges from where pumps took it to the surface. This system also drained the lowest run of the main tunnel where it passed under the river, as well as the inclined sections from each bank. A parallel ventilation tunnel was constructed with eight extract links to the main carriageway tunnel, protected by safety doors, allowing fresh air to be drawn into the main tunnel where it was a vital element in maintaining an environment that was potentially poluted by the steam trains and gas lighting serving pedestrian tunnels, platforms, and rolling stock. The towers on this tunnel carried water tanks which provided a 120 ft head for the hydraulic system for the passenger lifts.