The Analysis of Bricks from Archaeological Sites in Australia

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In the context of renewed interest in artefact analysis in Australian historical archaeology, this paper discusses the methods and attributes that have been used to analyse bricks in the past, and concludes by suggesting a standard set of attributes for future analysis.

INTRODUCTION

The practice of historical archaeology in Australia in recent years has refocused on the analysis of material evidence, in particular on artefact analysis from large urban excavations. While precise reasons for this change are unclear, what has been evident is that the change has resulted in the examination of the results of large salvage excavations and a fundamental critique and review of archaeological practice in the area of artefact cataloguing and analysis (e.g. Crook et al. 2000). Two outcomes of this process of reflection have been the identification of the need for better methods of identifying and cataloguing material evidence and the need to develop the analytical potential of material evidence through 'mid-range' theory, which would enable questions posed in research designs to be evaluated (Murray and Mayne 2002, Murray 2002).

This paper presents a review of the practice of analysing clay building bricks from Australian archaeological sites. Its aim is to look at current archaeological practice and make suggestions about ways of improving the methods used with the intention of producing results that contribute to the understanding of the past. In doing this, it is the intent of this paper to contribute to the analysis of a class of artefacts commonly found on most post-contact archaeological sites and to the overall improvement in historical archaeological practice.

REVIEW OF CURRENT PRACTICE IN THE ANALYSIS OF BRICKS

In order to understand how bricks have been analysed, a brief review of archaeological reports was undertaken. The report review was not intended to cover every project in which a brick was found, as not all projects were thought likely to have the resources or the need to intensively analyse bricks. Rather, an attempt was made to examine final reports of major projects where the analysis of bricks was undertaken, drawing upon examples either in: the author's personal library, the Godden Mackay Logan report library or in the library of the NSW Heritage Office. The review was based on a highly selective sample from a limited geographical area, and no doubt could be criticised on that basis. However, the purpose of the review was to identify whether there was an 'archaeological practice' for brick analysis. The reports examined are listed in Appendix One.

The review looked at each report in order to answer the following questions:

- What was the aim of the analysis and how did it fit into the overall research aims of the project?
- How was the collection made?
- What attributes were recorded and how were these decided?
- What reference was made to supporting material such as related studies, historical research, etc?

The answers varied considerably, although the variance was not necessarily over time but between the consulting groups working on each project, suggesting that there is a certain approach to research design and analysis that could be called analytical practice, adopted by each of the major consulting groups as a de facto house style. In some cases, the analytical practice seems not to have varied over the last ten years despite all the discussion in the discipline over that time.

Aims of the analysis and fit with the research aims of the project

The analysis of bricks was mostly considered as part of a broader analysis of building materials in general. Notably, specific research questions relating to building materials were rarely posed in most reports. Two examples of reports where such questions were asked are the work at Corinella (Victoria) and the Queen's Arms Inn (Western Sydney). The work at Corinella, which was aimed at locating evidence of the 1826–1828 settlement site, is an example of directly tying brick analysis into research aims. A team of specialists was used to attempt to identify some of the 10 000 bricks brought to the settlement from Sydney as a way of locating the settlement site (Coutts 1985; McConnell and Edwards 1983). Casey & Lowe's excavation of the site of RH/46, the Queen's Arms Inn, identified four specific questions about the nature of the building, which the building material analysis addressed (Casey & Lowe 1995). In contrast to these examples, detailed analysis of building materials and the typology of bricks developed during the archaeological excavations at the Cumberland/Gloucester Street site was only loosely tied into the overall research aims for the project (Barnes 1999). Some archaeological projects, however, never really progressed beyond the cataloguing of bricks, although in the analysis of archaeological contexts, bricks were used for dating strata (e.g. Higginbotham 1992).

How was the collection made?

On most excavations, there was a large degree of formal and informal discarding of bricks owing to the sheer numbers and weight of bricks. There was little quantification of the sampling process involved in creating the sample of bricks used for analysis (Casey & Lowe 1995 is a rare example where this was done), although the fact that the artefacts analysed represent a sample was regularly acknowledged in most reports. Noting that artefacts are a sample is of little utility unless some description of the universe from which they were sampled from is made. This raises a further point, in that no attempts seem to have been made to record bricks from 'demolition layers' or from 'in situ' structural features, such as

walls, and to integrate that data into the overall analysis of building material.

What attributes were recorded and how were these decided?

The published brick analysis from First Government House (Sydney) by the late Sue Pearson is one of the earliest available brick analyses, being undertaken in 1987 or 1988. Pearson developed her analysis based on earlier building materials research by George Gibbons (1980a, 1980b), described further below (Pearson 1988:1). Pearson's report includes a copy of the data sheet for recording building materials (Pearson 1988:9) and, from the sheet, it can be seen that length, width and thickness were recorded along with colour, using the Munsell Soil colour chart as a standard. Three attributes derived from Gibbons' research were recorded: body texture, constituents, and surface features. The type of brick was identified as being sandstock, fire brick, or CB (whatever that was). Frogs and other markings were also recorded. Use of these attributes seem to have been adopted as common practice in Sydney. A further procedure is the development of 'type series' in which the cataloguing of identical numbers of the same bricks are referred back to an 'ideal type', which is a distinct type of artefact within a broader class of artefacts. While this is an understandable approach in the context of an item that was mass produced (a brick machine would produce 1800 to 2500 identical bricks per hour), it is often difficult to ascertain the key attributes of the type in question, from the published reports.

The bricks from the 1983 and 1984 excavations at Corinella were measured in three dimensions: length, width and thickness, and weighed. Frogs and manufacturers' marks were also recorded. The project director, Dr Peter Coutts, determined what attributes were to be recorded and the level of precision required. Coutts referred to Gibbons' work and to research by a post-graduate student at the University of Sydney, Robert Varman. The attributes used seemed self-evident to the author, who undertook the initial cataloguing. Coutts then involved McConnell (a geo-archaeologist) and Edwards (a ceramicist) for a more specialist analysis of the bricks. McConnell and Edwards recorded the same basic set of attributes from the collection but also used a wider range of other attributes in their attempt to separate out any bricks made in Sydney. These attributes were mostly related to the composition of the bricks and were standard analytical techniques for the analysis of inorganic material (McConnell and Edwards 1983:3). The reason for choosing these techniques was simple: the authors searched for similar projects, found none, and then sought advice from experts who admitted that they had no experience with the question of sourcing bricks. Hence, they adopted a default position in order to undertake the analysis (McConnell and Edwards 1983:3).

What is notable from all the reports is that the basic attributes were taken as given, passed down from prior reports such as Pearson's. No attempt has been made to review critically the basic attributes of length, width, thickness, colour, brick type, and weight. These seem to be 'self evident' attributes (except for weight) that are passed down from one set of artefact cataloguers to another.

References to supporting material

Most of the reports on brick analysis in the 1980s refer to the work of George Gibbons, from the Department of Applied Geology, NSW Institute of Technology. In 1980 Gibbons undertook an important early study into the nature of bricks as a building material. Two reports on bricks are available (Gibbons 1980a, 1980b) although locating copies is difficult. It should be noted that Gibbons' work was part of a broader study on the conservation of building materials funded by the NSW Heritage Office, rather than specific research into bricks. Gibbons also lectured to historical archaeology students on building materials. Judging by citations and acknowledgements, Gibbons' reports were widely read and utilised by other archaeologists working in Sydney (e.g. Dillane 1992) and Gibbons was consulted as a technical expert in matters relating to bricks by many of those working on brick analysis (e.g. McConnell and Edwards 1983).

The only other consistent reference to supporting historical material was to Warwick Gemmell's *And So We Graft from Six to Six* (Gemmell 1986). This was an excellent summary history of brick making in NSW but was not intended as a technical study or an exhaustive study of the topic. Other relevant sources seem have been overlooked or ignored in brick analysis. For example, Patterson's recent report on Building Materials from the Casselden Place (Melbourne) excavations (Patterson 2004) does not refer to Miles Lewis' on-line work *Australian Building: a Cultural Investigation* that has a whole chapter on bricks and is a standard reference on building material in Australia (Lewis 2000).

There are no references in any of the archaeological studies reviewed to Australian Standards, which define technical specifications of bricks, nor their immediate British predecessors. Neither has there been any reference to technical material on the manufacture and use of bricks such as could have been obtained, from either the then Brick Research and Development Institute in Melbourne or the later Clay Brick and Pavers Institute. Certain technical illustrations ultimately sourced to Dobson's (1895) *Rudimentary Treatise on Bricks and Tiles* have been widely used to illustrate brick-making technology.

Surprisingly, there is no reference in the reviewed reports to two relevant archaeological studies on bricks: Harley's (1974) article *A Typology of Brick …* and Gurcke's (1987) *Bricks and Brickmaking: A Handbook for Historical Archaeology.* Gurcke's work in particular was aimed at historical archaeology, although in the American context, and is particularly strong in explaining the brick production process and in demonstrating non-metrical attributes of bricks related to their production. Harley's work is of less relevance for Australia but at the time analysis of bricks was beginning in Australia it was one of the few typological studies available.

During the 1980s and early 1990s Robert Varman was undertaking a doctorate at the University of Sydney on building material as means of dating archaeological sites, focusing on bricks and nails (Varman 1993). However, it is unclear from his thesis how his work engages with similar work undertaken by Gibbons, or with archaeological investigations in Sydney. On the evidence of citations in the reports reviewed, there seems to be little interest in the results of his research in studies undertaken since it became available.

In summary, the analysis of bricks has rarely been highlighted in research designs for archaeological excavations. There is little evidence of a systematic strategy to collect information on bricks from archaeological sites, while generally only a sample of the bricks on a site has been analysed. The methods of analysis have been largely a matter of repeating practices established in the early 1980s and do not seem to have been reviewed in the light of technical information about the manufacture of bricks or other information relating to the history of the brick industry. There is evidence of a standard practice of analysing or cataloguing bricks in Australian archaeology. This can be characterised as

using a standard set of metrical attributes, (length, width, thickness and colour) as well as separating bricks based on manufacturing techniques and manufacturers' markings, although the attributes relating to these categories of evidence are poorly researched.

RESEARCH DIRECTIONS

Lest anyone think that the first brick has been cast unduly or rashly, the author freely confesses to undertaking such analysis of bricks in the manner characterised above. The issue is not one of assigning blame, but how to move on to improved methods. As a way of developing the potential of brick analysis, research directions to which they might contribute and the possibilities for contributing to a broader series of archaeological and historical research questions are discussed below.

Identification and dating of bricks

Firstly, the most obvious research direction lies in the identification and dating of bricks. Being able to assign a date to a brick type helps in the identification, assessment and interpretation of historical archaeological sites. In the context of survey, knowing the date of a brick can help in dating a particular site or site feature in the field. In archaeological excavations they may be used to date stratigraphic features, as well as to date structural elements in archaeological approaches to standing structures. If the bricks are of a special shape or type such as firebricks, they can also help in identifying the function of specific sites or site features.

Research into the broad chronologies of brick manufacturing (both manufacturers and the technology used) and brick markings is necessary if bricks are to be used as a tool for dating. Manufacturers frequently marked their bricks with their names or brand names and these can be dated by reference to historical documents. Gemmell gives a very general but useful list of brick makers in Sydney and surrounding areas (1986:62–84), while Gibbons provides a list of brick manufacturers and their marks in NSW dating from 1855 (1980a:65–70). Varman has also produced a detailed list of mainly Sydney brick manufacturers (1993:82–138). It would be interesting to collate all this information and put it in a more accessible forum.

For Victoria, there are several papers on the brick and tile industries which provide a useful source of information on brick manufacturers (Bain and Spencer-Jones 1952a, 1952b, 1953). These could be supplemented by research into trade directories and other sources to produce a list of Victorian brick makers. No doubt similar basic lists could be established for other states and regions.

From manufacturers' catalogues and other trade documents it is evident that in addition to the standard rectangular brick most manufacturers produced 'specials': bricks of non-standard shapes for which they could charge a premium. These shapes were a mixture of decorative items such as 'bullnose' (used for capping wall tops) and functional items such as crown bricks used for keystones in arches. Information about how a special brick would be used in a structure or in an industrial process can be obtained from trade literature.

Attributes that have been used to determine the date of manufacture of bricks are: the nature of the frog, manufacturers' marks (typically located in the frog), and brick size (a more detailed discussion is provided in a following section). The manufacturing process used to make the brick has also been suggested as a means of dating, and this is expressed in the term 'brick type' (i.e. sandstock, machine made … etc). Shape has been the primary attribute used to identify special bricks types, although some types of firebricks also have a number impressed in them indicating the standard shape type.

Building quality

Another research direction is the issue of building quality, a point previously raised by Barnes (1999). In his research discussion on the bricks from the Cumberland/Gloucester Street excavations in the Rocks, Barnes drew attention to the building regulations in Sydney at the time and the extent to which buildings on the site complied (1999:173–174). However, concerned as it was with bricks and building material in isolation from their role as part of the site's architecture, his analysis failed to address the issue raised. The question of building quality is one that remains to be addressed, especially for urban areas where at least the perception of poor building quality by slum landlords is rife. Barnes saw quality as being linked to compliance with the regulations for brick construction in Sydney, but this approach may be limited due to the general lack of regulations across Australia until comparatively recently. Assessment of quality might involve notions of regular size, colour and conformity with known standards for brick manufacture (see below).

Buildings archaeology

Buildings archaeology is the analysis of buildings and other built structures through archaeological means including: analysis of building materials, construction techniques, building style and building stratigraphic sequences. It aims to treat the whole building as an item of material culture, just as their contents and underfloor deposits would be. Despite having a well-developed methodology for integrating architectural and archaeological evidence (e.g. Davies and Buckley 1987, Davies and Egloff 1984), the development of buildings archaeology as a separate area of archaeological research in Australia is embryonic. Architecture is not simply the backdrop onto which artefacts are deposited; architecture shapes the space in which humans interact and, just as much as any transfer-printed ceramic bowl, architecture expresses through its design and decoration notions of social status, order, taste, class and so on. In American historical archaeology, there is a tradition of integrating material evidence and architecture (both built and landscape) as shown for example in the works of Leone (1988) and Deetz (1977) and in the general appropriation of Henry Glassie's *Folk Housing in Middle Virginia* (1979) as an almost archaeological study.

Bricks were often an important part of architectural design and formed key elements of some architectural styles, particularly as polychrome brickwork and in the dominance of red brick and terracotta tiles and finials for the various Federation styles (Apperly et al. 1989). Part of the design effect was the colour of the brick and its quality. It is known that architects had special requirements for quality bricks for use in building facades. These were: colour, even texture on the face and straight arrises. Bricks with these qualities were sold as facing bricks. Evidence from bricks, in the form of colour and quality, points to the nature of the architecture on a particular site.

An important consideration is the location of bricks of particular types in relation to the structural elements on a particular site. Facing bricks typically were used on a building's façade and common bricks were used for interior, side and rear external walls. Context is therefore important in arguing that particular bricks form part of the architectural style of a particular building or not. It may be critical to

understand from where on an archaeological site the bricks being analysed come from.

There is also the related question of the recycling of bricks. In the context of research at Corinella, where the bricks from the 1828 settlement were removed by subsequent settlers, much time was spent examining nearby early homestead sites and structures looking for recycled bricks. Shortages of material are presumed to be the prime reason for recycling bricks in Australia, however this may be a simplistic assumption. The issue of identifying recycling of building material in general has been discussed by Windsor (2004). Windsor (2004:4) notes that the key for identifying recycling is the context of the material suspected of being recycled. Removal of mortar with a high cement content is very difficult from bricks and so recycled bricks may have bits of old mortar adhering to them. There is, however, no recognised method for identifying recycled bricks.

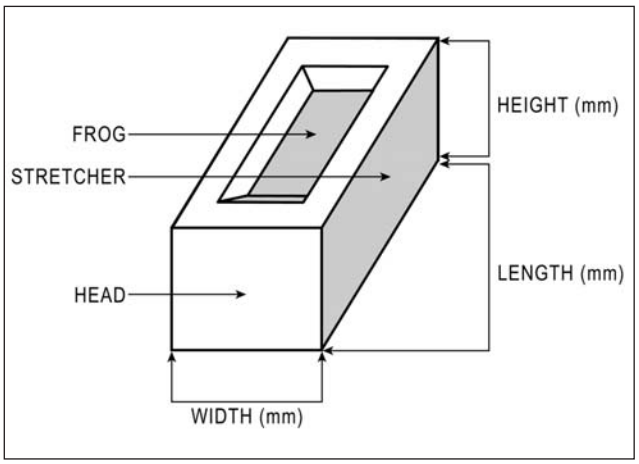

Fig. 1: The parts of a brick.

Bricks in industrial archaeological research

Bricks in themselves are material evidence of the technological nature of the brick industry in a particular area and at a particular time. From the examination of a brick, evidence of manufacturing techniques and production quality in the brick industry can be ascertained. This often forms a useful counterpoint to documentary evidence, which is often in the form of a manufacturer's own assessment of their product. The location of bricks from a particular manufacturer on archaeological sites can point to trade networks. Bricks provide evidence of the nature of the brick industry that complement or even challenge the documentary evidence.

ATTRIBUTES FOR BRICK ANALYSIS

The broad attributes used in brick analysis are now discussed in detail in order to identify key metrical and non-metrical data that can be used in the analysis of bricks (see also Appendix 2). This discussion is based upon historical information relating to the production of bricks and technical information on current brick making practice.

Bricks and their parts

A brick is defined as a solid or perforated block of material moulded from clay or cement used for building (typically bonded masonry), industrial or paving purposes (after McLaglan 1978; Milton 1994).

The longest axis of a brick is the length, the second longest axis is the width, and the narrowest axis is called the height. Bricks frequently have an indentation on the top surface, called a 'frog' (Fig. 1). Occasionally there were frogs on the top and bottom of bricks – referred to as double frogged. Frogs in machine-made bricks may have a raised section across their middle – this is called the bridge. Often frogs contain raised, conical lumps, originally used to identify the machine making the brick for quality control purposes, although for the archaeologist deciphering these markings may be a challenge. Bricks can also be perforated with holes running from top to bottom. Bricks with holes running through from head to head are hollow bricks. Wire cut bricks have no frogs but have perforations. Further definitions are provided in Appendix 2.

Bricks are laid with the longest axis facing outwards to form a stretcher or the width axis facing outwards to form a 'header'. Two headers plus mortar equals a 'stretcher'. This ratio is critical in the construction of masonry structures using bricks, as the mortar joints in the bond cannot overlap without significantly weakening the structure. However, buildings are not often designed with walls that are the correct size for bricks to fit in. Typically, a brick wall requires parts of a brick, called 'closers', to be used to make up the length. Closers are defined as 'a brick less than full size used to bring the end of a wall to a vertical face' (Scully 2001:7). Half bricks and quarter bricks are used in this way. Scully (2001:7) also identified 'bevelled closers', 'king closers' and 'queen closers'. Nangle et al. (1951:93) identify a queen closure as being a brick halved along its longest axis, while a king closure is 'a brick with its head cut off so as to reduce its head to show as a quarter brick on the surface of a wall'.

A bricklayer simply made closures with a sharp blow from the trowel on a normal sized brick or used a mechanised brick cutter. This created a near-vertical straight edge that would assist in identifying closures from simply broken bricks.

Counting bricks

It is important to quantify how many bricks one has in a collection or sample to allow comparison to other collections or samples. However, relying on simple counts produces meaningless data; to say a collection has 15 bricks and 10 green bottles is nice but of little relevance. The idea of weighing artefacts is sometimes put forward as a way of making meaningful comparisons (e.g. in the City Link report by Wilson 1990), but this too is meaningless unless the specific gravity of all artefacts is the same. Nevertheless, the problem of how to get an overview of the brick collection remains.

The basic analytical unit is a whole brick, although as discussed above, half bricks, closures and special shapes (relatively easy to identify based on manufacturers' catalogues) can form part of the collection. A simple counting of bricks, half bricks, closures and specials could be easily made.

Bricks are also amenable to being analysed using the 'type series' approach especially as they were manufactured and sold as quantities of the same type. The type series approach identifies each different brick as a type and describes the brick based on certain attributes, typically size, method of manufacture, frog shape, manufacturer, etc). Identical items of the same type are simply counted and can be discarded. Two bricks of each type should be kept to allow one for accession as part of a permanent collection and the other to be sampled should analysis of the fabric be undertaken.

A simple approach to quantifying bricks would seem to be identifying numbers of brick types and the numbers of bricks, half bricks, and closures in each type. This would be relatively easy to do with a high level of precision. A further level of meaning would be added if brick types were identified during

excavation and related to features on the site, so that the end result could be say 35 bricks of type A that are known to have come from a wall foundation and 67 bricks of type C that have come from a well. Such an approach could be easily applied across a site and include bricks not typically collected, such as bricks in fill deposits and in architectural features.

Size – does it matter?

The question of the relationship between brick size and date of production has been of interest to Australian archaeologists as it is believed that bricks became larger over time (Jeans 1983: 103). It would appear that Gibbons was pursuing this question but, from his interim report, no strong pattern over time was demonstrated (1980a:29). According to Searle, in Great Britain (or England, it is not clear which) brick sizes were regulated from 1625 until the repeal of the tax on bricks after which 'manufacturers made bricks of any size they pleased' (Searle 1956:12). Lewis discussed brick size, arguing that 'brickmakers brought moulds with them' when coming to Australia which established an Australian size, although he noted that 'variation is considerable' (Lewis 2000:6.01.10). Lewis also suggested an approximate date of 1860 when brick sizes became more standardised, although if Searle's view is correct, English sizes varied after 1850, which presumably would have been reflected in Australian sizes. It has also been suggested that when the Hoffman Brick Company in Victoria commenced manufacturing, in 1870, it introduced a 9 in x 4.5 in x 3in sized brick which was larger than the size in general use in Victoria at that time (Parsons 1970:419). This was referred to as the 'German' size, although the brick machines were in fact British. Certainly, with the introduction of mechanisation through brick presses and better quality kilns it became possible to produce bricks of a consistent size and to develop an industry-wide standard.

In 1904, The Royal Institute of British Architects and the Institute of Clayworkers agreed to a standard set of brick sizes giving minimum and maximum dimensions (Searle 1920: 20–21). In 1941, the first British Standard for clay building bricks was produced (Searle 1956:32–33), but by then the first Australian Standard for Building Bricks had been issued as AS A21 in 1934. The 1941 British brick sizes were slightly different from the Australian Standard, being 2mm shorter and 4mm wider and a length/width ratio of 0.5 rather than 0.48. A standard 'traditional' brick is defined in the 1984 Australian Standard as being 230 mm x 110 mm x 76 mm (AS 1225–1984). The Australian Standard allows for a variation of +/- 90mm in the length of 20 bricks; for a variation of +/- 50mm in the width of 20 bricks and a variation of +/- 50 mm in a height of 20 bricks. A modular brick standard has also been introduced with metric dimensions being 290 mm x 90mm x 90mm changing the length width ratio to from 2:1 to 3:1. However, these modular bricks are usually cement bricks rather than clay bricks (Scully 2001:6; Ward-Harvey 1984:34).

It is not necessarily the size of a brick that is critical – it is the relationship between the length (the stretcher) and the width (the header) that is important in brickwork. Two headers plus mortar should fit on a stretcher so the length width ratio should be just under 0.5. Australian Standard AS 1225 notes that 'length shall not be less than 1.5 times width'. As previously discussed, length is the longest axis on a complete brick. In archaeological analysis, the dimensions of a brick should be measured as if the brick was complete, which in most cases should be easily determined from an examination of surfaces. The rationale behind this is to help distinguish closures from broken bricks.

Given the variation allowed in modern brick production, precision in the measurement of bricks is not particularly important. Measuring to the nearest 2mm seems a useful archaeological standard which should detect significant variation. Clearly, an analysis that placed great emphasis on variations of less than the current manufacturing tolerances would be spurious. Major variations in brick size are unlikely as this would throw out the whole system of building structures and tie the builder into a single source for the bricks.

Another attribute occasionally measured in bricks is weight, but it is not clear if weighing bricks achieves any analytical purpose. As brick production was mechanised, greater density of clay material could be achieved, thus weight could distinguish between hand made and machine-made bricks. However, other morphological features of bricks could do this just as well. At the moment there seems to be no compelling reason to weigh bricks.

Colour

Bricks were deliberately coloured for decoration. In many cases the desired colour was achieved by selecting the appropriate clay body such as kaolin, or by adding material such as manganese or iron when the clay was being pugged (Searle 1921: 7–10). Generally this occurred in the mechanised era where greater control on colour could be obtained by adding material to the clay and by controlled burning in the kiln (Rowden 1964: 30). Before mechanisation and in particular with Scotch or Colonial kilns or clamps, the process of burning was not uniform and bricks were discoloured in the kilns. This colouring was a guide to potential strength and durability, with bricks being roughly graded according to colour. It can be seen therefore that brick colour is a mixture of deliberate preparation of clay bodies and burning in the kiln.

Munsell Soil Colour charts have been used for recording colours on bricks (e.g. Gibbons 1980) and some standard colour charts for recording earthenware pottery are also useful. The disadvantage of all these charts is that the full range of potential colours is unlikely to be contained within the one chart. This is particularly the case with the Munsell Soil Colour Charts, which are an extract from the Munsell Book of Colour specifically designed for recording soils. The important point to stress is that some sort of reference standard, be it the Munsell standard or the Australian or British Colour Standards, should be used to record brick colour. Whatever standard is used should be noted in any catalogues or reports so there is no doubt which standard was used.

Bricks are rarely uniform in colour: even monochrome bricks show minor variations in hue. Generally, these can be discounted and the dominant colour recorded but deliberate mottling effects were produced which should be recorded. The standards for recording mottles and other colour patterns in soils in The Australian Soil and Land Survey Field Handbook (McDonald et al. 1990:114–115) are a useful way of recording mottling in bricks.

Evidence of manufacture

There are four types of manufacturing process used to make bricks: Hand Manufacture, Mechanical extrusion (also called Stiff-mud in American literature), Semi Dry Press and Stiff Plastic. Detailed descriptions of manufacturing processes can be found in the literature (Brick Industry Association 1989, Dobson 1895, Goodson 1962, Gurcke 1987, Searle 1920, 1921, 1956) and it is not proposed to discuss these in detail.

In the context of identifying evidence of manufacture, it is of relevance to note that there is little obvious difference in the bricks made by Semi Dry Press and the Stiff Plastic method and the author has not been able to find clearly definable attributes to separate bricks made by these processes. Because

the processes are similar, the bricks have similar moisture contents when green and typically have the same type of repress. The raw material types are usually different but this is not reflected in the surface morphology of the brick.[1] It is possible that further discussion may assist in developing attributes to distinguish bricks made by these two processes.

A summary of the manufacturing processes and related attributes found on bricks is presented in Table 1. Most of these attributes can be simply recorded as being present or absent. The shape and number of perforations in an extruded brick should also be recorded as these vary widely. From the 1880s onwards bricks became more decorative. Extruded bricks in particular have decorative textures and patterns on their sides which were important in establishing different product lines. Some attempt should be made to record these patterns, as well as frogs and manufacturers' marks. Frog shapes should be recorded with reference to standard geometric shapes or dictionaries of ornament. The lettering in manufacturers' marks should be recorded along with font size and type, if this can be established.

Quality of bricks

Quality is a difficult concept to apply in any analysis as it is such a subjective term (see Pirsig 1974 for elaboration). Yet quality is identified as being a critical concept in the research directions discussed above. It is not the production of bricks, so much as their nature and quality, that allows many potential research questions to be addressed. Therefore, some approach to the issue must be made. In contemporary society, quality is seen in relation to some form of standard or benchmark. In relation to manufactured goods, this is usually some form of Australian Standard or Industry Code of Practice providing parameters that the item has to meet for it to be considered to be of good quality. If an item exceeds these parameters to a great extent, it might be considered to be of 'excellent' quality. This assumes that the standards being used actually represent 'quality'.

If the aim of the analysis is to understand the past, the quality of an item must be assessed in the context of our understanding of what that quality may have meant in the past. For clay bricks, this can be partially be established based on historical documents such as standards, legislation, technical manuals, professional journals and information on building practice from sources such as newspapers or diaries. Much of this information for bricks generally dates from the twentieth century. The question of quality in nineteenth-century bricks has not been researched to any great extent. It is also important to think of attributes that will not be altered by the brick entering the archaeological record and its subsequent recovery. Despite these difficulties some attributes are put forward as indicating the quality of an individual brick.

Four main attributes indicative of quality are presented: consistent shape, straight lines, consistent colour and good even firing. These are discussed below; however other attributes may emerge following further research.

A consistently rectangular shape is desirable as the brick should be a rectangle with parallel straight edges. If a brick does not have parallel edges, it is not much use as a brick, although a small amount of distortion in a brick could be covered up by mortar during the construction of a wall. Note that some special bricks are deliberately curved or wedged and these should not be confused with poor quality bricks.

Table 1: Summary of processes and attributes.

Manufacturing Process	Attribute	Comments
Hand Made		
Pugged clay, termed the clot, is thrown into a mould on a table, pressed in and excess clay cut off from the top of the mould. The formed brick is then knocked out of the mould and stacked for drying prior to firing in the kiln.	Thumbprint	There are at least seven explanations for thumbprints: irrespective of which if any is correct, thumbprints are exclusively found on hand made bricks.
	Hack Mark	A thin raised line along the stretcher side of the brick formed by stacking green bricks for drying.
	Sand struck	To release the clot from the mould it was sometimes dusted with fine sand which adhered to the clot and is burnt with it.
	Wet Struck	To release the clot from the mould, it was sometimes wet producing a series of distinct but ill-defined vertical lines along the stretcher edge.
	Strike	To scrape off excess clay from the mould a board was used leading a series of parallel lines running along the top of longest axis of the brick known as a strike.
Mechanical Extrusion		
The clay is mixed inside the brick press through a series of pug mills and augers and extruded through a rectangular nozzle out onto a table where the billet of clay is cut into brick. This is usually done by wire, hence the name "wire cut".	Perforation	All bricks with perforations through the body of the brick have been extruded.
	Wire Cut mark	Semi-circular lines along the top and bottom of the brick.
	Texture	The stretcher and header sides are frequently decorated.
Semi-Dry Press		
Clay (or shale) was ground to powder, then a measured amount of powder mixed with water is pushed into a mould which is then compressed at least twice to form a brick. The material was consolidated into a brick by the pressure.	Circular mark	Circular marks on the top and bottom surface of the brick.
	General appearance	Denser brick with sharper edges and smoother faces.
Stiff Plastic		
Clay was ground to powder and mixed with some water. It fed intoa mould in which the clot is compressed to form a brick.	Circular mark	Circular marks on the top and bottom surface of the brick.
	General appearance	Denser brick with sharper edges and smoother faces.

Architects picked facing bricks for their straight edges (arrises) and smooth faces (see evidence by George Pender to the Industrial Court's Enquiry into the price of bricks, Court Reporting Office 1939:52). Faces should be smooth and free of even hairline cracks for a facing brick (Searle 1920:13–14).

Consistent colour is important as a quality in the decorative use of bricks, as well as being an indicator of the quality of burning. A blue brick for example results from poor firing and possibly indicates that the brick is unsound. The colour should be even across the brick unless some particular type of colour effect is being attempted.

Good consistent firing is indicated by colour, lack of distortion, lack of evidence of over-firing (e.g. the brick turning to glass) and by a clear ringing sound when two bricks are hit together (Nagel 1955:87). Under-fired bricks called 'callows' have a tendency to crumble and hold water (i.e. increased porosity due to lack of vitrification) (Nagel 1955:86–87, Searle 1920:14). Over-fired bricks tend to be more likely to fracture.

Unfortunately, quality assessment is not this simple. Anecdotal evidence suggests for example that the Glen Innes brickworks were deliberately making over-burnt clinkers or blue bricks to sell to Sydneysiders for feature walls in renovated houses (apparently in Balmain). Clifton-Nubrick's 'tumbled range' of Semi-Dry pressed bricks was produced by tumbling perfectly good green bricks to remove their sharp edges, so in this case a presumed measure of quality was not a straight edge. They also produced an 'old world classic' clinker brick 'inspired from our glorious past' (Nubrick 1988). This is a salutatory warning that one manufacturer's poor quality brick can be another's key selling point and that such analysis needs to proceed with care.

When constructed into masonry, bricks can exhibit efflorescence or surface fretting of the brick itself. Efflorescence is usually caused by ground water, wet mortar, or even salt laden air depositing salts which are absorbed into the brick pores in solution. As the brick dries the salt crystalizes, and where this occurs near the surface of the brick, the structure of the brick may fail, causing fretting. Salts can also cause staining of the brick masonry (see Zsembery 2001). While the bricks themselves are generally considered not to be a source of salt attack (due to the nature of clays in Australia) the porosity of the brick is a contributing factor, allowing the salt to penetrate in solution. Generally, efflorescence is not a sign of poor quality bricks.[2]

CONCLUSIONS

Ultimately, the brick attributes used will depend on the underlying research design and the nature of the brick collection. However some basic approaches to brick analysis are proposed below.

The recording and analysis of bricks should, *inter alia*, be considered during the research design development and planning phase of an archaeological program so that appropriate data collection is planned and can be accommodated in field and laboratory work. The recording of bricks from both standing structures on a site as well as archaeological deposits should be undertaken as a way of systematically obtaining information on bricks from a particular site. It seems inadequate to consider only bricks collected during excavation and ignore bricks in structures.

Ultimately, it is recognised that the nature and level of collecting and recording of bricks will vary between each project. Accompanying a basic recording of bricks should be a discussion of the recording strategy so that it is clear which part of the overall deposit of bricks on a site was sampled or was not sampled. It is important that a record be kept of decisions regarding the collection of brick samples and any attributes analysed so that future researchers can gain insight into the processes that led to the archaeological collection.

At a minimum, the basic recording of bricks should aim to identify the numbers of bricks, half bricks and closures, the variety of bricks types (including fire bricks and special bricks) on a site and their archaeological or structural context. It is recommended that a sample of each brick type be kept. Typically, two bricks should be a minimum for each type as this allows one brick to be sampled if required.

A suggested set of attributes for describing brick types is presented in Table 2. These can be utilised in a simple database. In addition, photographs of each brick type can be taken and added to the database. In the author's experience,

Table 2: Suggested attributes for describing brick types.

Attribute		Comments
Manufacture of brick	Use attributes in Table 1 to determine the method of manufacture.	
Part of brick	Identify whether it is a whole brick, half brick, closer or special.	There are standard shapes and sizes in manufacturers' catalogues, which will help identify some brick shapes.
Dimensions	Measure the three axis to nearest mm.	It is very easy to measure a brick if you set up a simple measuring board using graph paper and a straight edge.
Length width ratio	Ratio of length over width can easily be calculated on a spreadsheet.	Useful for detecting odd-shaped bricks.
Is a frog present?	Yes/No	If yes, describe with reference to a standard shape note whether it is bridged or otherwise marked. Measurement of frog dimensions is often useful where it is likely there are different types of brick with the same frog shape.
Are two frogs present?	Yes/No	As above.
Record manufacturers marks	Simply record all characters recording spaces and unreadable characters.	
Colour	Identify the main colour of the brick and the colour of any other features such as mottling.	Use an appropriate colour standard. Mottling can be described using the method in MacDonald et al. (1990:114-115). Note consistency of colour.
Quality attributes	Straight edges.	Place along straight edge.
Quality attributes	Rectangular shape.	Use a builders square.
Quality attributes	Clear ringing sound when two are banged together.	Watch fingers!
Quality attributes	Colour and "glassy patches".	Evidence of poor firing
Manufacturing attributes	Record attributes in Table 1.	Record as presence/absence and detail as necessary.

once all the forms and measuring guides are established, the description of a brick is relatively quick and uncomplicated. The longest part in the process is the cleaning of the brick, which is recommended to make the colours and attributes more visible. Water is the best cleaning agent with a light scrub (be careful as some bricks can be quite soft).

The potential for using the recording of bricks as a means of answering detailed questions about a site has been identified, although how this potential is utilised has to be left to the individual researcher or research team and depends on the specifics and context of the site and the broader research program involved.

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ENDNOTES

1. The Stiff Plastic process was typically used in Melbourne while the Semi Dry pressed process was typically used in Sydney.
2. An interesting exception to this rule is the bricks from Port Arthur. Hutton, in discussing the problem of salt attack and deterioration of brickwork at Port Arthur, identified salt in the fabric of the brick itself that and suggested this was due to clay pugging in salt water (1981:158). Poor firing (it was estimated the bricks were fired to c400ºC) contributed to the deterioration, as the temperature reached did not melt the sea salts, which remained in the body of the brick after firing.

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APPENDIX TWO: GLOSSARY OF BRICK TERMS

Term	Description	Source
	Brick Manufacturing	
Dry pressed	Machine made (generic term)	Nangle 1951:86
Extruded	Bricks made by extruding from a brick press and being cut by wire (wire cut).	Scully 2001:6
Plastics	Machine made or wire cut	Nangle 1951:86
Re-pressed	Brick made by extruding clay with a 14% to 17% moisture content into a mould to give a clot that is compacted and repressed (Stiff Plastic brick)	Scully 2001:6
Sandstock	Hand made (generic term)	Nangle 1951:86
Semi-dry pressed	Clay ground to powder compressed to brick, 10%-19% water.	Goodson, 1962, Searle 1956
Stiff- plastic	Powdered clay mixed with water and compressed into a stiff paste, 10-14% water.	Goodson, 1962; Searle 1956
	Types of Brick	
Air	Perforated bricks used for ventilation.	Maclagan 1978:10
Callows	Underburnt bricks, underfired brick.	Maclagan 1978:11, Nangle 1951:86, Scully 2001:6
Clinkers	Misshapen and over burnt bricks, produced by firing to the point of complete vitrification.	Maclagan 1978:11, Nangle 1951:86-87, Scully 2001:6
Common	Any brick made primarily for building purposes and not especially treated for texture or colour; reject facing bricks of a quality suitable for use where they will not be visible in the finished wall.	Maclagan 1978:11, Scully 2001:6
Commons, Picked, Selected	The best of ordinary of common bricks. Maclagan 1978:11, Scully	Maclagan 1978:11
Dough-boy	Callow brick	2001:6
Faced	Best quality bricks used for face or external work or for other special work.	Maclagan 1978:11
Fire brick	Brick made from refractory clay that will withstand high temperatures.	
Hard-fired/ burned	Brick fired at high temperatures to near vitrification.	Scully 2001:6
Heeler	Face bricks of normal length and width with a height of approximately half that of an ordinary brick.	Maclagan 1978:11
Ordinary	Good common bricks.	Nangle 1951:86-87
Picked	The best quality bricks among the common bricks – typically specially picked out.	Nangle 1951:86-87
O.K.	Open kiln bricks, made by dry-pressed process and burned in the 'old type of kiln' (not sure what this means – possibly Scotch kilns or down draft kilns).	Nangle 1951:86-87
Double-pressed	Typically wire cuts that have been repressed, often used for facing	Nangle 1951:86-87
Double frogged	Bricks with frogs on both sides, typically made during the late 19th c.	Stuart
Enamelled bricks	Bricks that are glazed.	Nangle 1951:86-87
Texture Bricks	Special brick – marketed under different trade names; bricks with patterned sides usually wire cut.	Maclagan 1978:11, Nangle 1951:86, 88
Modular brick	Brick with dimensions that are a multiple of a 100mm module.	Scully 2001:6
Modulated brick	Brick with dimensions in length and width that are a multiple of a 100mm module but whose height is less than a module; several are required to achieve a multi-module.	Scully 2001:6
Run of kiln brick	Ungraded and unsorted bricks from a single kiln.	Scully 2001:16