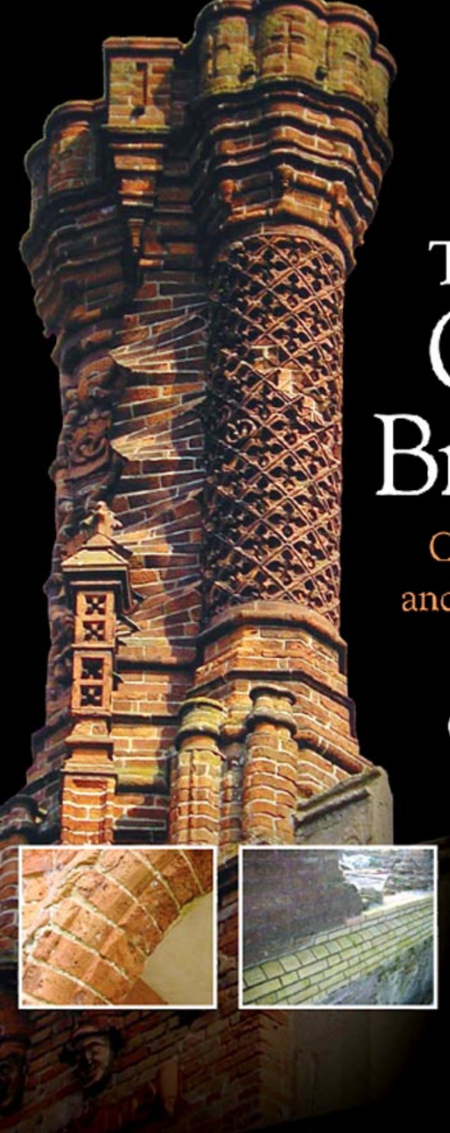

The History of Gauged Brickwork

Conservation, Repair and Modern Application

Gerard Lynch

The History of
Gauged Brickwork

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The History of Gauged Brickwork

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Produced from research conducted at De Montfort University, Leicester

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DEDICATION

To all of my Family.
My late Father, James Lynch (RIP) and my mother, Rosie,
who did so much to guide and support me.
Also my wife Fiona and our children, Rósalín and Liam,
who have continued that support.

Gerard Lynch

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FOREWORD

I would not have been surprised, over twenty years ago, had I been told that the Head Lecturer in Trowel Trades at Bedford College who I had just met would later become a world authority on his special subject of gauged brickwork; nor would I have found it difficult to imagine that his energy and enthusiasm would find receptive audiences everywhere and culminate in a book of this stature.

The present era is one of almost unprecedented interest in the exploration of the past and the conservation, or restoration, or re-creation of its physical aspects; it is also an era characterised by fast-track learning and consequent dilution of traditional professional and craft training. In the race for training results and the sometimes false security of 'accreditation' based on an accumulation of projects and attendances at seminars or workshops, the 'ballast' of history and culture often has to go; or it is transferred to an academic programme where it will have no practical influence on the way in which historic buildings and townscapes are perceived and conserved.

The truth is that the quality of work necessary to conserve historic fabric is dependent on a sound and comprehensive understanding of culture, technology and craft. When these three strands are disentwined there is a diminution of that quality, and conservation intervention degrades and confuses what should have been enhanced and made clear.

Gerard Lynch's new book is characteristically sound and informative and three-stranded; a work of great scholarship and sound technology which informs the practical business of conservation and repair. His personal interest in the times and minds of past craftsmen, his appreciation of their achievements and in the development of the manufacture and uses of gauged brickwork, are apparent throughout. As a craftsman who can write well and who is also a natural teacher he is the ideal and proper author for a work such as this; it is fortunate that he has had the patience and determination to record what will become the classic reference work on this subject for decades to come.

Professor John Ashurst

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PREFACE

The brick buildings of our urban and rural English landscape have for centuries commanded a special place in the affections of its people. They remain a priceless legacy of the care and dedication that the designers, brickmakers and bricklayers bequeathed their work, and in turn, our nation. Each historical period in displaying the varying bricks and the manner the craftsmen chose to craft them to enrich their structures, has stamped an indelible mark on those particular times. The pinnacle of the bricklayers art, through succeeding centuries has always been the crafting of low-fired bricks or rubbers to shape for enrichments, manifesting itself first as cut and rubbed work and, from the seventeenth century onwards, as gauged work.

For almost thirty-five years working as a craftsman bricklayer I have taken every opportunity to learn more about the traditional practices of my once noble craft, many aspects of which have long disappeared from current knowledge and use. The art of gauged work, being the consummate expression of the finest bricklayers, I was determined not only to master its skills and underpinning knowledge, but also to research the subject in depth and answer the many questions that were not to be found in contemporary writings on the subject. This has provided the basis by which I sought to re-discover the origins of gauged brickwork; the developments of the various tools, materials, craft practices, and their associated technological aspects; and to make this information widely known through my practical work, writing, lectures, master-classes, and consultancy services.

A great deal has been written about our nation's historic brickwork since Nathaniel Lloyd's *A History of English Brickwork* of 1925, and most of these books, papers and articles have tended to be the work of architects or architectural historians. The British Brick Society (BBS) remains a wonderful source of information on aspects of the archaeology and history of bricks, brickmaking, and brickwork written by members who are drawn from many backgrounds such as geologists, archaeologists, historians, brickmakers, bricklayers etc within the Society's newsletter, 'Information'; published three times a year. Though many of the books, papers and articles written about bricks and brickwork may point out and discuss an element of cut and rubbed or gauged work, few give us a real insight into the historical materials, tools and of the craft techniques that created them.

For too long the master bricklayers, who down the centuries, skilfully crafted their rubbing bricks to create decorative 'cut and rubbed' chimney stacks or later, niches of gauged brickwork etc, have been given little credit for their wonderful skills; or worse have been simply ignored. Little has been written about how they actually achieved their work. Some of this blame, of course, lies with the craftsmen themselves and their secretive world of the cutting shed; where this work was prepared but little was recorded. Yet other crafts were equally as secretive of their 'mysteries' and much has been researched and written about them. Furthermore the once noble craft of the bricklayer in recent years has not always been accorded the respect it deserves, a problem made increasingly worse in how it is now patronisingly viewed by those in charge of directing modern craft training, and those seeking to place people into employment. This study, therefore, is about recognising the incredible contribution of fine brick buildings, enriched with beautiful examples of cut and rubbed and gauged work, to our nation's heritage and praising those unsung craftsmen whose skills created them.

Today an increasing number of our historic buildings need conservation through correct repair and restoration, and bricklayers engaged in this class of work are very likely to come into contact with cut and rubbed and gauged brickwork. Also some discerning clients and designers also wish to explore the possibilities of using traditional materials and skills on the erection of new buildings. Unfortunately, the modern system of training does not cater for the additional craft knowledge and refined craft skills that he, or she, will need. It provides no avenue of any worthwhile depth to gain a full and meaningful understanding of cut and rubbed and gauged brickwork, their historical development, and of the importance paid to those skills in the past.

I have always loved history and as an apprentice clearly recall thinking that it was a great pity that the history of my noble craft was not an integral part of college learning. I have always believed that it is important to try to get into the mind of the historic bricklayer to develop a deeper contextual understanding of the materials, tools and equipment as well as the varying methods of employing them. This can only be done by studying historic materials, tools and the post-fired worked brickwork on the buildings and noting the tell-tale signs of craftsmanship on the latter that speak to you if you have the eyes to read them. Working and re-creating with historic tools long-gone from living recollection, like the medieval brick axe and its eighteenth-century development, in order to re-evaluate how they were once used. By spending countless hours studying historical references, and applying an experienced craftsman's understanding of what that writer was actually telling you, couched within the terminology and style of that period.

The overall aims of this book are to develop a deeper contextual knowledge and understanding of the history and use of cut and rubbed brickwork from the medieval period, and the introduction of gauged brickwork into England from the Netherlands in the seventeenth century. To evaluate the application and development of the historic cutting tools and equipment; and to determine the similarities and differences between performance and physical characteristics of historic and contemporary rubbing bricks, in order to inform modern production.

The book includes several case studies of the authentic use cut and rubbed and gauged work on buildings in England, Ireland and America, from different historic periods, in which I have been honoured to act in a variety of differing consultative and training roles. The studies aim to show how the architects, surveyors, historians and the craftspersons invited to contribute their personal experience benefited through a deeper and more meaningful understanding of the original materials, tools and craft skills employed and the quality of the finished work.

Several case studies look at successful conservation, through appropriate repair and restoration of cut and rubbed and gauged work from the fifteenth through to the nineteenth century. One study looks at various aspects of the use of cut and rubbed on the re-construction of a seventeenth century brick-built Chapel in Virginia, North America, using materials, tools, equipment and techniques historically accurate to the original period of construction. Another looks at the successful use of gauged work, using pre-cut rubbing bricks, on a modern cavity-walled house. A case study examines the forging of a period brick axe through the eyes of a master blacksmith conversant with reproducing historic craft tools using traditional materials and craft techniques. The final case studies are both a practical and scientific examination of the behaviour and characteristics of rubbing bricks, exploring both modern and historic rubbing brick performance.

It is hoped that this work will promote understanding of the history and associated skills necessary to secure best practice methodologies, to safeguard the integrity of cut and rubbed and gauged brickwork. Furthermore that it will help to develop methods for the re-introduction of these aspects of the craft into current craft training programmes and encourage its use on new building work.

This book is not solely for bricklayers, but also for the architect, architectural historian, surveyor, those who specialise in conservation and restoration of historic brick buildings; as well as the period homeowner and those who simply enjoy reading about historic brickwork. It is also my hope that this will help ensure that cut and rubbed and gauged work can be better understood, specified and executed to the highest of standards with empathetic authenticity, using the correct materials and methods associated with the period of each property.

Dr Gerard C J Lynch LCG, Cert Ed. MA (Dist), PhD
'The Red Mason'

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Belinda Colston
Case study: Characteristics and Properties of Rubbing Bricks

Jay Close
Case study: Making of Brick Axe

Bricklayers-Work is an Art Manual, which Joins ſeveral Bodies ſo together, that they adhere like one entire Body.

Whether the *White Maſon*, which is the Hewer of Stone, or the *Red Maſon*, which is the Hewer of Brick, be the moſt Ancient, I know not: but in Holy Writ, we read of making of Bricks, before we read of Digging or Hewing of Stones; therefore we may ſuppoſe the *Red Maſon* (or *Bricklayer*) to be the moſt Ancient.

Joseph Moxon (1627–91), *Mechanick Exercises or the Doctrine of Handy-works,* London, 1703.

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INTRODUCTION

Gauged brickwork is an English term defined as brickwork where a superior finish in the detail of an important brickwork elevation is required, such as moulded reveals, arches, string courses and other forms of ornamentation. The term may appear paradoxical as all brickwork may be considered gauged, but it serves to distinguish a special branch of bricklaying work to very accurate measurements, which raised artisans of the craft to the status of masons. By definition, to gauge is to measure, set out, and work exactly objects of standard size so as to conform to strictly defined limits, and this term is eminently suitable for this class of brickwork.

The bricks for this class of brickwork have, in England, always been referred to as 'rubbing bricks' or 'rubbers'. A 'rubbing brick' or 'rubber' can be defined as a masonry unit, made from a brickearth or topmost clay, possessing high natural silica content. It is low-fired, or baked, to a point just below vitrification (900°C, 1,652°F) so the resultant burnt brick possesses no fireskin normal to other fired bricks. The rubbing brick has the same uniform characteristics of soft body and close texture throughout. This allows it to be worked in a post-fired state so that it can easily be cut, carved, filed, and rubbed (abraded) to present smooth accurate finishes and sharp arrises (edges) without detriment to its long-term durability. In England, for several centuries, this has made the rubber prized for use on all forms of enrichments where precision and fineness of joints were essential in the days that preceded the mass production of mechanised quality-controlled and regular-shaped bricks.

Historical perspective

As a study by Gunther (1928, 232) reveals, the term gauged brickwork, or gauged work, appears in England during the seventeenth century. Then it defined a new class of brickwork that was an ultimate refining in quality and accuracy of working bricks in the post-fired state, and setting them, as had been practised in England from the early fifteenth century. Simpson (1960, 26) explains that in 1438–9, for example, the accounts for Tattershall Castle (Lincolnshire) records payment for 2,200 de tegulis operatis vocatis hewentile, or worked bricks called hewentile for the construction of chimneys (sadly gone) and windows in the stable. By the sixteenth century one begins to see references to this practice of post-fired working of bricks for enrichments as 'cutting and rubbing', such as at Hengrave Hall (Suffolk) of *c.*1530, which states that the cut chimneys were to be of 'roubed bryck' (Moore, 1991, 227; citing Gage, 1822, 42).

The term cut and rubbed work has remained in use from the fifteenth century through to the present, but after the Restoration (1660) was understood to refer to tightly-jointed gauged brickwork, as opposed to the earlier, less refined work set within nominal sized mortar joints.

Bricks capable of being worked in the post-fired state, before and after laying, similar to how a mason works his stone for architectural enrichments, have a long history that pre-dates Roman or Paleo-Christian times (L Binda, 1999; L Marino, 1999).

From the great civilisations of Assyria and Mesopotamia the skills of working post-fired bricks were retained and advanced by the ancient Romans, as seen in the ruins of Ostia (the port of Rome) in late first century AD; and these skills were not entirely lost with the fall of Rome. Fine examples of dressed bricks and brickwork are still to be seen on some eleventh-century classical façades in the Tuscan region of Italy. In particular, on the façade of the church of Santa Maria Della Scala, Sienna (AD 1090), where the large bricks are precisely finished to be laid with joints averaging 6 mm (Fig. 1). The faces of the bricks clearly reveal *in situ* finishing using some form of mason's drag in places. In other parts of the building, dressing appears to be by the use of a form of cutting tool to provide a regular herringbone pattern on the individual stretcher faces. Forms and decoration characteristic of stone were often imitated in brick, in many parts of Italy up to the seventeenth century, as Giovannoni (1925, xiv–xv) records:

> Thus we often find at Parma, Piacenza, Modena, and Bologna … capitals executed in brick, vault ribs, window and door frames with mouldings carved in brick, as if they were stone.

The use of post-fired cut and rubbed bricks for arch voussoirs and ashlared bricks laid with fine joints carried on in Italy through the following centuries, and can be seen as gauged work in the fine face brickwork of the 'Sacro Cuore di Gesu', Via Marsala, Rome *d.*1880.

The influence of Italian architecture and building craft practices gradually spread to northern Europe, mainly through the work of the Cistercian order and their monastic trading links. In the Netherlands, this began to be seen first in the prosperous region of Flanders. The Cloth Hall in Brugge (Bruges) of *c.*1280 is mainly a brick building with stone enrichments where the overall face brickwork is 'drag'-finished exactly as the surrounding stonework dressings.

Documentary evidence suggests that the skills in post-fired working of bricks to produce 'hewen' and 'roubed' enrichments in the fifteenth and sixteenth

Figure 1

Herringbone tool markings to cut brickwork in Sienna (Italy), 1090. (Courtesy of Joop Hofmiejer)

centuries were introduced into England by Flemish mason-bricklayers (Moore, 1991, 214). These craftsmen were highly proficient in this art, developed from craft practices in their native Flanders, and were being requested to work in England on important royal, merchant, or municipal building programmes, where brick was playing an ever more important role over that of stonework.

Seventeenth-century classical English gauged work had its influence, not from Flanders but the Netherlands and, in particular, the architecturally influential city of Amsterdam in the province of Noord [North] Holland. In the highly skilled hands of the English City [London] bricklayers, working to the designs of great architects like Wren, Hooke, May, and Pratt in post-Restoration England, gauged brickwork became the consummate expression of the finest brick craftsmanship. Its use was, from then, to proliferate on the principal facades of the very best brick edifices.

The brickwork of the Georgian period served only to confirm the status of gauged work. Its use became ubiquitous for most dressings, such as arches, aprons, plat bands, and cornices; these being the enrichments that adorned the street-facing elevations, especially on the brick-built terraced houses for which this period is normally associated.

The early Victorian period saw a decline in the ornate articulation of brick buildings due to changing architectural tastes, the need for mass-produced cheap housing for workers in the ever-expanding industrial landscape, and the emergence of cheaper machine produced and regular-sized bricks. Only with the return to favour of fair-faced brickwork after the 1840s, particularly with the encouragement of the Arts and Crafts Movement in the 1880s, did brickwork standards again rise. With the latter movement, hand-crafting practices enjoyed a revival that, in brickwork, led to gauged work re-establishing itself as the highest form of brickwork for producing architectural dressings on the show faces. This survived virtually unchallenged, until the changing economic and social circumstances in England that followed the First World War (1914–18).

The skills of gauged brickwork were less called upon as the intervening years passed, yet remained an important part of the measure of a first-rate bricklayer, and its use was not infrequent throughout the years until the Second World War (1939–45). After 1945 a need to quickly re-build the blitzed towns and cities, providing improved homes for a rapidly growing population, made use of changing construction technologies that were faster, cheaper, and required less skill. Better suited to the speed of delivery that these circumstances demanded (compared with the slower traditional and highly skilled practices), it sounded the death-knell for the more refined areas of the noble art of bricklaying, such as expensive gauged work.

Throughout the 1950s, '60s and '70s ever more functional buildings of plain brickwork had neither need of expensive bricks or handcrafted dressings. This was reflected in a reduction in the period of apprenticeships from five down to three years. With it, came the removal of the more advanced areas of craft skills and knowledge from the City and Guilds brickwork craft and advanced craft syllabi. This was accompanied by a continuing loss of traditional handmaking brickyards, especially those making rubbing bricks for the production of gauged work.

In 1990, through the publication of *Gauged Brickwork: A Technical Handbook* (1st edition, 1990, Gower, 2nd edition, 2006, Donhead), the author sought to ensure that this neglected branch of the craft was returned to national prominence. In his lectures, master-classes and published work, he has emphasised the pressing need to revive the skills and knowledge of gauged brickwork for apprentices and established craftsmen denied the opportunity to learn. This initiative saw the need to provide both traditional and modern craft skills and knowledge, necessary to produce fully rounded, holistic, craftsmen. Some ideals were further consolidated by the publication of *Brickwork: History, Technology and Practice* (two volumes) in 1994; and numerous papers and articles written since.

As Head of Trowel Trades at Bedford College of Higher Education, (Bedfordshire), in 1987–92, the author's pioneering work in broadening the curriculum for apprentice bricklayers sought to embrace many traditional skills, including gauged work. This was just one of many highly skilled areas of the craft selected to complement the essential modern elements demanded by the relevant City and Guilds syllabus. Unfortunately this period coincided with the demise of traditional time-served, linear, apprenticeships bound to a qualified bricklayer within a company, and the advent of short, competence-based modular training based on National Vocational Qualifications (NVQs) which could not facilitate such lofty ideals. This system of training is tailored solely to produce bricklayers with a narrow range of basic skills for the modern site environment and is combined with only an elementary theoretical and technical understanding of the principles underlying the trade.

Today, however, an increasing number of our historic buildings need repair and restoration, and bricklayers engaged in this type of work are very likely to come into contact with cut and rubbed and gauged brickwork. Unfortunately, the modern system of training has not fully catered for the additional craft knowledge and refined skills that he, or she, would need. It has provided no avenue of any worthwhile depth to gain a full and meaningful understanding of cut and rubbed and gauged work, their historical development, and of the importance paid to them in the past. Few tutors have any real on-site experience, pragmatic depth or technical knowledge of the subject. It is at best, only a rudimentary awareness. A National Heritage Training Group (NHTG) initiative, 'Training the Trainers', supported by English Heritage and the Construction Industry Training Board (CITB) Construction Skills, is helping to address some of these concerns. This is being achieved by utilising masters of the various building crafts, including the author, to teach aspects of their knowledge and skills to craft tutors to help enable them to deliver NVQs in Heritage Skills, and is to be welcomed. It is vital we address these issues properly, not only ensuring that we can care for our nation's heritage of fine brick buildings, displaying superb craftsmanship, but also nurture the bricklayer's craft, of which the art of gauged brickwork was, and rightly remains, its highest expression.

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1

Medieval and Tudor Brickwork (1485–1603)

Introduction

Following the departure of the Romans from Britain in AD 412, the brickmaking craft declined. During the Saxon and early Norman periods there was a movement towards permanence in the building of ecclesiastical and certain public buildings, and builders were quick to remove and re-use bricks from dilapidated Roman buildings. Brick was essentially utilised as a courseable element for quoins, dressings to doors and windows, and for vaults.

All Saints' Church in Brixworth (Northamptonshire) believed to date from the seventh century, is an early example of re-use, as is the tower of St Alban's Abbey in St Albans (*Verulamium*) (Hertfordshire). It became apparent to the Saxon builders that the supply of this very handy source of building material was going to run out and that new bricks would be needed.

The earliest known use of Post-Roman bricks in England is Little Coggeshall Abbey (Essex) *c*.1200–20, where new bricks were used for strengthening the flint Abbot's Lodging.

Of particular interest with regard to the brickwork is where Wight (1972, 25) explains:

> … Most of the shaping was done by moulding, but sometimes – as in the hollow chamfer of the Chapel's East window (strictly, three lancets) – carving exposed the dark, less well-fired core of the bricks. The abbey bricks are vital to the buildings, providing windows, doors, jambs, quoins and vaulting … The shaped bricks are singular for their date, unmatched by dressings of any elaboration till the mid fifteenth century.

This reference to carving the hollow chamfer, exposing the core (French 'coeur' meaning heart) of the brick, is of singular interest as it highlights an early English example of a 'cut and rubbed' moulded enrichment; a brick worked in a post-fired state.

Wight (1972, 26) concludes:

> …The shapes include segmental bricks for round columns, lobed bricks for roll-mouldings, chamfered bricks and diamonds… At the Belgian Cistercian Abbey of Coxyde [Koksijde] are similar shaped bricks. The conclusion must be that Cistercians from the Continent, where brick was already established…carried out or at least supervised the brick-making here…

The Cistercian monks revived the use of brick as a principal building material in masonry in Flanders and the Netherlands during the late twelfth century. By the thirteenth century Flemish bricks were being exported to England. Certainly during the Middle Ages there was a tremendous increase in social and economic intercourse between eastern counties and ports of England and the Continent. Brickmaking and bricklaying were experiencing a powerful revival in the Netherlands, particularly in Flanders, and North Germany – areas short in stone and which were united in trade and industrial discourse through the founding of the powerful Hanseatic League in 1241.

Through ports at Norwich, Lynn, Boston and Hull, the east of England forged trade links with the league, which were to have a profound and lasting effect on English brickmaking and bricklaying crafts and promote a major 'Netherlandish' influence on much of its architecture. The term 'Netherlandish' (Percival, 1989, 15), rather than Dutch, is considered a more appropriate word to include not just present-day Holland, but all 17 provinces of the original (pre-1579) Netherlands or low countries. Considerable quantities of Flemish bricks were shipped into England for important works, such as 202,500 bricks from Ypres (Ipers) in 1278 for the Tower of London (Wight, 1972, 26). As native brickmaking techniques and production capacity proved capable, this trade declined. The town of Kingston-Upon-Hull for example established a corporation brickyard in 1303 (Brooks, 1939, 156).

Bricklayers and the Craft Guilds

The emergence of boroughs in the late twelfth century was associated with the establishment of merchant and craft guilds. Towns bought exemption from feudal exactions, and the guild secured the livelihood of member craftsmen by regulating craft practices, training apprentices and controlling the quality of products. A licence from the monarch could only create a guild, which every year paid a fixed annual payment to his exchequer.

There were two basic aspects of guild activities: the 'mistery' or 'mystery', craft knowledge and secrets, as well as the regulation and control of guild members, and also the 'fraternity', constituting a brotherhood which, encouraged by the Church, also helped relieve economic distress and encouraged a spirit of amity. The fraternity were dedicated to a saint, often the patron saint of that craft, and guild members would attend church on that saint's feast day; electing members to positions within the guild each year. Guilds were concerned with maintaining standards of craftsmanship, quality of materials, apprenticeships, continuity of work and a strict control of new craftsmen starting up in the defined area of guild search and control.

Learning to be a bricklayer meant becoming an apprentice (from the Old French 'aprentys' or 'aprendre' to learn, and the earliest records of apprenticeships in the building Industry in England date from the fourteenth century. The apprentice would be 'bound' by the payment of a premium to a master – meaning a teacher and not necessarily a master craftsman – for a defined period of seven years termed 'time serving', as laid down in an ordinance of 4th June 1518, that formalised a long-standing practice. The agreement and its dual responsibilities between the master and his apprentice were contained in an 'indenture', a binding contract executed in two or more copies; which were placed together so that their irregularly cut top edges were correspondingly 'indented' for identification. Guild officers called 'Searchers', ensured the apprentices were properly housed, cared for, not made to work on Sundays, received proper instruction in the craft, and did not divulge craft secrets, or 'mysteries'.

Though medieval guilds and chartered town corporations were in effect exclusive of women, the *d.*1562–3 Statute of Artificers, which regulated conditions of employment, did permit women to be taken on in all the building trades as parish apprentices (Clarke and Wall, 2006, 53–4). In 1568, in the city of London, the Worshipful Company of Tylers and Bricklayers received their royal charter of incorporation from Queen Elizabeth 1st (*r.*1558–1603) granting them an 'area of search' in a fifteen miles radius from the old city walls. Time-serving was not only a lengthy period of learning craft knowledge and skills, it was also linked from the journey from boyhood to manhood. Upon serving one's time, and demonstrating mastery of skills and knowledge through the production of a 'masterpiece', an apprentice would become qualified as a 'Journeyman'. The very best of these qualified bricklayers would, through natural talent and experience, go on to become those craftsmen capable of setting out and executing cut and rubbed work; and the elite of their ranks the 'Master Bricklayers'.

The use of brick during the Tudor period remained steady and was a relatively cheap building material by the end of the sixteenth century (Smith, 1987, 10) and from this time it became so highly regarded that rich courtiers and merchants chose it for their mansions. A number of the English nobility saw military service in France where they saw the French architectural use of brick, that stimulated them to use the same to build their own castles upon their return home, such as Ralph, Lord Cromwell (*c.*1403–54/5), who built

Tattershall Castle, 1434–46. He was in France through most of the reign of Henry V (1413–22), as Lloyd (1923, 7) states, Cromwell:

> …was present at the taking of Caen, Courtonne, Chambrays and other places in 1418. Sir Roger de Fynes, builder of Herstmonceaux, *c.*1446 fought at Agincourt and in subsequent engagements in the wars of Henry V.

It was in the early fifteenth century that a much higher standard of brickwork was introduced into England, due to an influx of Flemish and Dutch craftsmen, from around 1410 up to the late 1480s. These builders began constructing features previously seen in the Low Countries and Germany. Many rich English merchants, at this time, became familiar with the wonderful use of brick as a major constructional material in the prosperous 'Hanse' towns and cities of both the Low Country and Northern Germany, all trading within the powerful 'Hanseatic League'. This was an international corporation of influential and wealthy merchants responsible for transporting goods overland and overseas. England had trading links with the league through ports such as Kings Lynn and Kingston-Upon-Hull. Some of the late-medieval bishops also had a significant influence on the increasing popularity of brick in England as a decorative indeed prestigious, rather than a subsidiary building material. As Wight (1972, 142) states these bishops:

> …were great political forces, at least those who held the most important sees. They counted as part of the mediaeval nobility…Their power was thus ecclesiastical and secular. They controlled large estates.

Through their roles in the Church many were familiar with what was occurring spiritually, politically and commercially on the continent; and of European architectural fashions too. When they built their palaces and granges, or helped others to found schools and college buildings, they frequently chose brick. William of Waynflete (1395–1486), Bishop of Winchester, founded Eton College, Buckinghamshire, *c.*1442–51, Wainfleet School, Lincolnshire, *c.*1484, and built Mattingley Church, Hampshire. Cardinal John Morton (1420–1500) Bishop of Ely, built 'Old Palace' in the grounds of Hatfield House in a charming russet brick *c.*1480–90. Cardinal John Fisher (*c.*1469–1535) Bishop of Rochester, was Chancellor of Cambridge University and organised the building of Christ's (*c.*1505) and St. John's Colleges (*c.*1511), Cambridge generously financed by Lady Margaret Beaufort.

Cardinal Wolsey (1475–1530) also chose it when he commenced building Hampton Court Palace in 1515, on the site, and incorporating part of, an earlier moated brick-built mansion *c.*1495–50 (Thurley, 2003, 9–14) built by Lord Daubney (1451–1508). Wolsey, as Simon Thurley (2003, 41) so succinctly states,

> '…was, in fact, the last in a long line of English bishop-statesmen who had built on a scale rarely exceeded by their sovereigns'.

The ownership of Hampton Court Palace passed to King Henry VIII (1491–1547) in 1528, as a result of Wolsey's failure to secure the king's divorce from Queen Catherine of Aragon (1485–1536). Henry, in turn, carried on his own large programme of building works there during the years that followed up to his death in 1547.

Brickmaking in the Medieval and Tudor Periods

Brickmaking in the medieval and Tudor periods was essentially the same, although changes and developments inevitably took place; particularly as brickwork became highly desirable during the fifteenth century and a much higher standard of brickwork is seen. The bricks were made either from estuarine clay deposits on the banks of rivers and lakes, or shallow clay beds, often termed 'brickearth', or loam clay found especially in the Thames valley and eastern England.

Brick and tile making was a seasonal activity. Generally the clay was excavated in shallow digs close to or within the proposed site, but without pumps these could never be deep. Manual extraction of the clay, or being dug or 'won', was always completed before the onset of winter, generally the 1st of November. It was then 'stirred and turned' and left to 'sour' before the 1st of February and the last of the hard frosts that broke down the clay, which was then 'wrought' (beaten) before spring; after the 1st of March. The 'tempered' clay was then cast into a shallow pit to be trodden by people or oxen, ready for shaping or 'moulding'; stones, chalk or other foreign bodies were normally removed, where possible, at this stage. It was vital to get out the chalk, or other sources of calcium carbonate, as in firing these would become quicklime and blow the bricks due to expansion when in contact with moisture.

Utilising a timber mould box or 'forme' was well established in the thirteenth century. Various sizes of bricks are used during these years and sometimes these were stated within a building contract. As Wright (1972, 41), however, states:

> 'The advantages of some standardisation were soon realised, and it was the problem of building repairs that prompted the council of Colchester (Essex) from 1425 or 1426 to keep in the moot Hall a model "fourme" for the brickmakers to copy'.

Casting the 'clot' (from the Dutch 'klutto' meaning lump) of 'green' or unfired clay into the box resting directly on the grass or straw-covered ground. Early bricks were large and often referred to as 'great' bricks, such as those at

Waltham Abbey Gatehouse (Essex). These bricks are like the 'Klostermoppen' (Cloister bricks) of the Flemish Cistercian monastic sites at Ter Duinen in Koksijde (1214), at nearby Ter Bogaerte (1230), and at Ter Doest in Lisswege (1275), in present-day Belgium. These bricks measure 300–320 mm × 150–160 mm × 70–90 mm. They were rarely used in England after the late fourteenth century and by the mid-thirteenth century a size similar to our modern brick was increasingly common. Size was determined by the necessity to make it easy for the bricklayer to handle the brick, who prefers his trowel in one hand whilst laying, and is in relation to the span of the hand.

Sometimes the brickmaker might work at a bench and throw the 'warp' (Old English 'wearpen' meaning to cast or throw) of clay into the timber mould, dampened with water. Excess clay was smoothed off the top of the box using a flat wooden stick or 'strike', and the resultant bricks carried, still within the mould, to the adjacent drying area to be released out onto the ground. Initially the bricks were laid flat on bed to develop a 'leather' skin for handling and gain sufficient hardness to later be stood, and stacked, on edge, without the brick settling down on itself and bloating. This drying period of 8–12 weeks was very dependent on the prevailing weather. Obviously these bricks needed to be protected from the negative effects of the elements during this time, and 'Various accounts mention materials, sailcloth, "pakthred" and even needles used for this purpose' (Wright, 1972, 40).

The dried bricks were then 'fired', or burned, in a kiln or 'kylne' (from Old English 'cylene' and Latin 'culina' meaning a burning place or kitchen) of a simple up-draught type. Alternatively, and then most commonly, bricks were fired in a temporary kiln known as a 'clamp' ('clampe'); the terms can confuse in studying old documents, however, as they are frequently interchangeable.

A clamp was a skilfully erected outer shell or 'casing' of previously burnt bricks (or 'burnovers'), placed around the green, un-fired, bricks (usually a whole season's production). These were close-stacked in tight rows with 'battered' ends to prevent collapse and with layers of fuel of mainly wood faggots, as well as heather, furze, turf and sometimes coal. The top was closed with a layer of burnovers. Where no burnovers were available, then the outside faces of the green bricks were plastered over with mud, similar to how a temporary 'wicket' is bricked-up dry and plastered today (to seal a kiln entrance). The clamp, which could typically contain between 50,000 and 200,000 bricks, was then set alight from the 'fireholes' on the windward side. Clamps had the advantage of flexibility, were ideal for supplying a one-off demand for bricks, where the building of a permanent kiln would have been an unnecessary expense, or where huge quantities of bricks were needed on large-scale projects that were being built at a fast pace.

Essentially an uncontrollable firing, a clamp was simply allowed to burn itself out, which could be over several weeks (Rivington, 1901, 97); a good deal depending on the size of the clamp and the strength and direction of the wind etc. Such a clamp was generally used for firing only standard bricks; special shapes (and roof tiles) needed to be fired in permanent kilns where open-stacking and a more controlled burning was possible. Providing, of course, that the correct raw material was suitable for making rubbers in the first place, due to the lower overall firing temperatures, bricks capable of being cut and rubbed were naturally found within certain zones of the clamp, or kiln. Once the clamp was disassembled, or the kiln emptied, these were simply graded-out and reserved for cut and rubbed enrichments. It was possible to burn some particular shapes of green-moulded specials, such as plinths, in a clamp by interlocking them so their arrangement provided minimal voids with a flat upper surface for stacking above them; but this was not a common practice (R Ireland, 2003). A kiln, depending on type and size, could vary in capacity, typically from 8,000 to 30,000 open-stacked bricks; and, compared to a clamp, a kiln fired the bricks more quickly, five or six days rather than weeks.

Bricks, during this period and for several centuries afterwards, were fired longer and at much lower temperatures than their modern counterparts, from 750 to 950°C (1382 to 1742°F) being a typical range, as opposed to 1,000°C+ (1832°F+) common today. This is why, in contrast to other bricks, rubbing quality bricks are said to be 'baked' rather than burnt to a state short of complete vitrification. By baking the bricks, they are heated sufficiently to remove the plasticity from the material; hence when struck together they give a dull thud as opposed to the ring that is normal to well-fired bricks. The lower historical temperatures were due to primitive firing conditions and use of the above fuels, particularly wood. Wood, such as hornbeam, silver birch, willow, alder, sycamore, sweet chestnut and Scots pine, was the original fuel used for firing of bricks. The advantage of timber over other fuels was, and remains, that it burned slower with long even flames. This produced a gradual build-up of heat that penetrated the stack of bricks, across a broad burning zone and, as it burned away, gave an ash that was easily removed from the firing channels and thus did not choke-up, cutting-off the vital airflow.

In addition, steam was released during burning from the mainly green wood, as well as any remaining moisture within the bricks. This helped to lower the temperature necessary for a good overall firing and promoted a beneficial open-pored structure within all the bricks. This meant it was almost impossible to fire bricks too hard and that the lower overall ambient firing temperature achieved was ideal for the production of rubbing bricks. This is as opposed to the use of volatile fuels like coal, and particularly fuel-oil, and liquid petroleum gas (LPG) that are in common use by brickmakers today; that burn drier and reach higher overall temperatures more quickly.

All of the above factors involved in traditional brick burning led to a wide range of fired bricks, which, upon emptying the kiln or disassembling the clamp, would be graded by skilled and knowledgeable brickmakers; who might also be bricklayers. Grading would be based upon degree of hardness, colour, and dimensional accuracy, with the selected bricks being set aside for specific uses within a proposed structure. Sound, well-burnt and dimensionally stable bricks were reserved for facework. Over-burnt 'wasters', depending on distortion, could be used as hardcore or in the foundations. 'Flared' headers, produced adjacent to the fire channels, were frequently reserved for laying as headers to bond, producing decorative patterns in the face brickwork on the principal elevations of a building. It is thought that this surface reaction was the combination of the high temperature (in excess of 900ºC or 1652ºF) and release of potash from the wood fuel in that particular area of the clamp or kiln. This caused vitrification and discoloration of the brick face (Barksdale Maynard, 1999, 33).

Great judgement had to be exercised by the brickmaker or bricklayer to ensure the bricks set aside for cut and rubbed work were well baked and not underfired, as the use of the latter would result in them failing in the weather. Under-burnt bricks were termed 'semel', 'semeled', or 'samel', a combination of the Latin 'semi' meaning half, and Old English 'aelden' meaning to burn, hence 'half-burnt', as explained by Smith (1983, 5). Too soft and uneven of texture and colour, they would not be used for features where durability was required as with repeated wetting and the action of frost the 'semels' would eventually 'moulder', breaking down structurally and gradually falling to powder. Final brick colour was rarely an issue as colour washing, or 'ockering', of the brickwork (discussed on pages 40–42) was a relatively common practice on premier elevations, especially with high-status properties.

Hewen Bricks and Brickhewers

> Bricks sufficiently fired to be sound, yet soft enough to be easily cut, carved and abraded to suit particular angles, shapes and enrichments were then either termed 'hewentile' (Wight, 1972, 66), or 'hewen bryke' (Thompson, 1960, 88). The term 'hewen' is derived from the word 'hew', meaning 'to cut' or 'cleave'. At Tattershall Castle (Lincolnshire) in 1438, 2,200 'de tegulis operatis vocatis hewentile' or 'worked bricks called hewentile' were supplied for the chimneys and windows of the (now lost) great stable (Smith, 1999, 3; citing Simpson, 1925, 26). At Fox's Tower, Farnham Castle (Surrey), 3,000 'hewen bryke' were supplied in 1473 as the multiple concave and convex mouldings surmounted by trefoil corbelling for the fake machicolations (Thompson, 1960, 88; Moore, 1991, 227).

Some commentators on English brickwork find it difficult to accept that the majority of fifteenth- and sixteenth-century moulded brick enrichments, such as jambs, mullions, arches, cusped bricks, corbel-tables, chimneys, newels on ploughshare vaulting and handrails, etc, were of 'roubed [rubbed] bryck'. Some is from misunderstanding contemporary terminology, such as Jane Wight's interpretation (1972, 100) of the words, 'of roubed bryck all the shank of the chymnies', regarding the finishing of the chimneys shafts within a *d.*1525 contract with John Eastawe, the chief mason and master bricklayer, at Hengrave Hall (Suffolk). This phrase is incorrectly taken to mean that the shafts of these chimneys were first built from purpose-moulded bricks and that extra shaping and finishing was achieved by rubbing. Even today older craftsmen still refer to elements of gauged work as a 'rubbed arch', or 'rubbed cornice' etc, despite the fact that these would have been both cut and rubbed to their desired profiles. Later Wight (1972, 102) argues that from

> '…envisaged practicality and from the appearance of surviving Early Tudor chimneys that their ornament was usually, or mainly, moulded and not carved'.

Like many other non-practitioners, Wight shows difficulty in fully understanding the nature and working characteristics of rubbing bricks, and the reasons behind Tudor hewers cutting and rubbing them to various mouldings for their decorative chimney stacks, and incorrectly summarises that (1972, 102):

> The casual phrase 'cut and moulded brick chimneys' is, thus, misleading in its suggestion of parity. I would argue from envisaged practicality and from the appearance of surviving Early Tudor chimneys that their ornament was usually, or mainly, moulded and not carved.

As Smith (1999, 3) correctly points out, one must be careful not to cause confusion with the use of the term moulding in relation to describing a shaped brick. It can be misleading as it is used to describe an architectural moulding in a shaped stone or brick or, as is not the case with stone, being formed by casting in a mould. He quite correctly suggests using a possible alternative neutral term *shaped brick*, unless moulding or cutting is intended. An alternative way of avoiding this confusion is to state that a brick cut, or hewn, to a profile has been cut-moulded; which is to be preferred. Because a moulding is repeated in a building element was not necessarily a reason for casting the shape in the green clay. Tudor hewers were highly skilled and the relatively straightforward geometry of the fashionable shapes meant they could produce precise post-fired cut-moulded shapes at a reasonable speed and without the worry of those shapes shrinking and deforming during firing. As Moore (1991, 227) states:

> An important part of a skilled bricklayer's work was the preparation of moulded bricks; 15th- and 16th-century buildings often use them generously. The brick as

> a unit cast in a mould might seem ideally suited to the continuous repetition of a simple detail as a trefoil corbelling and window mouldings. Much of this was however hand-carved, as is apparent both from building-accounts and from the bricks themselves, the worked parts often revealing a core quite different from the fired face.

Firman (2003) takes the latter part of this passage as an indication that the medieval and Tudor bricks that were 'roubed and hewn' are unlike the rubbing bricks, of uniform texture and colour throughout, used for the more refined gauged work of the seventeenth century onwards. Although it is possible to show some examples to support this view, especially where a 'roubed' feature was to be stuccoed and appearance of the brick was of no importance, the majority of 'roubed and hewn' enrichments show consistent and uniform texture throughout. One need only study the cut and rubbed enrichments of England's fine medieval and Tudor brick buildings to see this quite clearly. It is unnecessarily difficult to cut and rub ornate mouldings on chimney stacks, tracery, labels, and voussoirs, with bricks that reveal dark cores to the face, as such harder bricks (practical experience has conclusively demonstrated) do not respond favourably to cutting and rubbing.

This point was discussed with the late Nicholas Moore, who emphasised that the majority of mouldings from these centuries were not cast from the 'green' clay, but 'cut and roubed' to shape (Moore, 1991, 4). The words '…the worked parts often revealing a core quite different from the fired face' simply indicate that one can visually determine that the face of the brick has been removed in the process of working, exposing to varying depths, textures and inclusions in its inner body. The photograph of a 'Finely finished' crocket at Wallington Hall (Norfolk) (*c.*1525), which Moore shows in his chapter, *Brick*, in English Medieval Industries (1991, 219), serves to illustrate that point (Fig. 2).

Figure 2
Finely finished crocketed finial brick, Wallington Hall (Norfolk) *c.*1525. (Courtesy of N.J. Moore)

It also supports his emphasis that these selected bricks were indeed capable of being cut and rubbed to a fine degree of accuracy, without detriment, and that those who executed this class of work were commonly called brekmasons (Moore, 1991, 233; citing Simpson, 1960, 60).

Some bricks used for medieval and Tudor cut and rubbed enrichments do reveal the presence of inclusions. This was inevitable with the cruder brickmaking techniques of these periods in comparison with the seventeenth century onwards, but rubbers of latter periods can also posses them; and to varying degrees. Cutting open salvaged bricks used for both cut and rubbed and later gauged enrichments from buildings of these periods has revealed their similarity in make-up and appearance.

Practical tests using salvaged bricks from the early sixteenth century through to the nineteenth century have clearly revealed how all were easily cut using the mason's drag as a saw (Fig. 3). It was noted that all freshly-cut surfaces showed similarly close-textured bodies, with or without inclusions, and when

Figure 3

Sections of historic rubbing bricks from the sixteenth to the nineteenth century.

these were rubbed smooth, on the rubbing stone, it was achieved with minimum effort and produced sharp arrises on each brick. This, despite the obvious fact that they came from different regions of the country and were made from various types of brickearths or clays worked within a reasonable distance from their host building.

One can conclude this point by bearing in mind the overriding pragmatic approach contemporary bricklayers would have taken whilst selecting bricks for hewing and rubbing. By experience of the feel and appearance of the brick, they would know instinctively the one suitable for that purpose. They would not have known, nor cared about the geological age of the raw material, whether clay or brickearth, or the levels of internal silica. Their only care would have been that the brick was well-baked, had a consistent body, could be easily abraded, and worked to shape as they desired, to reflect positively on their craftsmanship within the built enrichment.

Skilled bricklayers executing the cutting and rubbing of bricks were termed 'hewers' ('hewyers'). Like the masons this work would have been carried out in a temporary shelter, with a thatched roof termed a lodge, which later bricklayers came to call the 'cutting shed'. This would be erected to stand for the duration of building work to allow for setting out drawings, establishing templets and the necessary cut and rubbed work, and dismantled upon completion. Study of contemporary accounts shows that hewing bricks to the various shapes required was an activity frequently programmed for the winter months, when bricklaying operations ceased due to concerns for frost damage with slow-setting, moisture retentive, lime mortars. As Moore (1991, 235) states, 'Some brick-hewing was paid for during the winter months by weekly wage or by the week in gross'. Study of the Kirby Muxloe accounts indicate different rates were paid per thousand hewn bricks, such as 5s. per thousand in October 1482, yet only 1s. 6d. per thousand, when 26,000 bricks were hewn in March through April 1483. This was not only reflecting the difficulty of the mouldings to be cut and rubbed, but also whether a higher paid master craftsman was employed on the hewing work. According to Salzman (1967, 45), the Westminster accounts of 1530 record:

> …the hewyng of 50 tunnells (shafts) in bryke for chimnes and ventes for jaxys (jakes or latrines) which hath byn hewen this wynter by taske.

The accounts for Kirby Muxloe Castle (Leicestershire) for the week commencing Monday, 30th December 1482 (Hamilton-Thompson, 1920, 296) records the 'brekeleyers' working during the winter as:

> Breekehewers – Peter Corbell. Maligoo, Dalle, Mylner, Ruddicowrt, Bruston, 5 days at 2s 6d = 12s 6d.

The majority of these craftsmen, being 'aliens', some possibly from Germany, but also from the Netherlands sharing the same general description of 'Doche' (Deutsche or Dutch). The majority, however, were undoubtedly from the region of Flanders to the south of the Netherlands, who were internationally renowned masters in the art of post-fired working of bricks. They were much in demand in fifteenth-century England, particularly in the years from *c*.1410 to the 1480s, as stated above. From that time Moore (1991, 216–17) states:

> Brick emerged as a high-quality and decorative building material confidently handled by English designers and bricklayers… Imported details such as diapering and the spiral chimney were assimilated and developed…By about 1520 this impetus was largely exhausted, and the further development of brick decoration was mainly confined to East Anglia.

In essence Flemish and later English bricklayers were viewing and utilising the selected bricks capable of being worked in a post-fired state, as building stones. It is, therefore, incorrect to assert (Wight, 1972, 50) that:

> Brick was carved sometimes, perhaps in shallow relief…, but most shaping was done by moulding – as in Flanders,…

Also, in comparing dressed English Tudor brickwork to its Flemish counterpart, Wright (1972, 50) again incorrectly asserts that:

> 'Brick was carved sometimes, perhaps in shallow relief as at East Barsham (Norfolk), but most shaping was done by moulding – as in Flanders,…'

In many early features of 'cut and rubbed' brickwork, such as window tracery, the element might be given a coat of render to mimic the stone it substituted, as at Gifford's Hall, Stoke-By-Nayland (Suffolk) of *c*.1490–1520, and Layer Marney Gatehouse (Essex), of 1520 (Fig. 4). The use of rendered cut and rubbed and purpose-moulded detailing was quite a common practice; and one that was to continue in use on into the eighteenth century (Smith, 1987, 5–11).

The direct link with stone masonry at this time is very apparent. In Flanders a brick was, and still is, termed 'baksteen', which literally translated means 'baked stone'. In Calais at that time craftsmen termed 'maçons' (masons) worked and laid a material that was referred to, in Latin, as '*lapides vocati brykkes*' *or* '*stones called bricks*' (Moore, 1991, 233; citing King's Works I, 427, n. 4).

The Flemish Influence

It is in the early fifteenth century that decorative English brickwork begins to truly assert itself. This change is accompanied by an early flowering of the craft

Figure 4

Cut and rubbed window detailing to the gatehouse Layer Marney (Essex), 1520.

of the bricklayer in England, as it slowly but surely emerged from behind the influence of the powerful stonemasons who held almost reverential control over the design and construction of medieval masonry.

The catalyst for this change was foreign and due in large measure to 'alien' brickmakers and bricklayers from the Low Countries, who brought a high level of craft skills and technical knowledge. This influence began to make its presence felt in the improved quality of bricks, more consistent in shape and quality, as well as in their application in terms of structural bonding, decorative patterning and ornamental articulation, which raised English brickwork to unprecedented levels of sophistication. It is particularly in the skills of working bricks, post-fired, for structural and ornamental brickwork that these advanced levels of craftsmanship and the Flemish influence are truly witnessed.

The introduction of foreign craftsmen, and along with it high-quality brickwork, as Moore (1991, 214) suggests appears to date from:

> The introduction of high-quality work and foreign craftsmen appears to date …shortly after 1410, the earliest surviving building to combine them being the chapel tower at Stonor Park (Oxon.) with its diapering and moulded brick corbelling, under construction by Michael Warrewyk and his Flemings in 1416–17.

One can identify these as 'Flemynges' or 'Dochemen' (Dutchman or Deutchman) by their names. For example, 'Henry Sondergyltes, Brykeman', who was employed by the wardens of London Bridge in 1418; 'William Vesey', employed by the Crown in the 1430s (Wight, 1972, 22); and 'Baldwin

Docheman', who was the 'brekemaker' at Tattershall Castle (Lincolnshire) in 1440. Hamilton-Thompson (1920), reveals the numerous 'brekeleyers' and 'brekehewers' working at Kirby Muxloe Castle (Leicestershire) between 1480 and 1484, under the direction of leading English brick mason John Cowper, who also worked at Tattershall, were Flemish (confirmed by historians in Flanders) with names like John Hornne, William Wysoo, William Taillour, Marc Maligoo, and Turkyn Horwynde. The last, Anthony Yzebronde, is also referred to elsewhere in the accounts as 'Anthony Docheman', who also worked at Kirby Muxloe supervising brickmaking; believed by historians in Flanders to be a Flemish, rather than German name (Beernaert, 1997).

The different terms of address of the craftsmen is of interest as the 'cleric' (clerk) recording them was likely to alter spelling in the records, anglicise their names, or write them phonetically. A good example is in the above accounts for Kirby Muxloe Castle, where 'Wysoo' is also found as 'Wyso' and even 'Wysall'. Another practice was to record the craftsman's native country, as in 'Anthony Docheman'. Sometimes the name defines their craft, so that we read (Moore, 1991, 231–3), of Cornelius and Brian Brekemason at Farnham Castle between 1475 and 1477, and of John Prentes and Thomas Lernyng, clearly apprentice bricklayers at Kirby Muxloe in 1481. The name William Taillour, a Flemish hewer also at Kirby Muxloe Castle, is revealing, as 'Tailleur' is a Flemish mason's term for a skilled 'hand-dresser' or 'finisher' of stone or brick.

Moore (1991, 214–16) continues:

> …The extensive use of foreign detail on the finest buildings shows the domination of the industry by foreigners for a considerable period, tailing off only in the 1470s and 1480s…. Foreign brickmasons were still much in evidence in the building-accounts of Kirby Muxloe Castle (Leics.) 1481–84.

Preliminary discussion with architectural historians in England, the Netherlands and Belgium emphasised that West Flanders was the historic centre for the tradition of cut and rubbed and gauged brickwork. In spite of its turbulent history, Flanders had prospered through the cloth industries, banking, and transit trade through ports like Brugge, Ghent, and Antwerp, and the enormous mercantile benefit of several Flemish towns being part of the rich and powerful Hanseatic League. Brugge (Bruges) became not only the chief city of Flanders, monopolising the import of English wool, but also the leading mercantile centre for Europe, figuring significantly in the development of the Hansa (Hanseatic League). This offered a close federation of influential cities in the Netherlands and northern Germany, England and the Baltic region, formed in the thirteenth century to provide and protect mutual commercial interests.

The conditions that existed in the major towns and cities of Flanders were ideal for the erection of highly-decorative public and private buildings, financed by prosperous corporations, guilds, and merchants, utilising the very best materials and the finest of craftsmen as an outward display of their vast wealth. The erection of masonry in the Low Countries using stone pre-dated the re-introduction of brick in the late twelfth century, but was difficult because there was only a limited supply of natural stone in Flanders. Most was imported, with a limited supply of soft limonite from the south Flemish hills and sandstone from Artesia. This made stone available only for the very rich to build with. Even today, a person in Flanders with a large fortune is considered to be 'stone-rich'.

Much of Flanders forms part of a sand-loam area that is geographically highly morphous with a grey green, rather sandy clay, forming a subsoil over almost all the entire region to a depth of 120 m. Such clay was perfect for the exploitation and production of good quality bricks. It was only natural, therefore, that brick should become the ubiquitous material for structural and, later, ornamental masonry. The inland clays produce a pale orange/red brick whilst the wider deposits of the calcium-bearing coastal polder clay produces a pale buff-coloured brick, not unlike stone in hue that yielded a smaller contrast between brick and mortar joint which was deemed perfect for masonry enrichment. There are beautiful examples of cut and rubbed and early gauged work to be seen in several of the major towns and cities of the Flemish parts of modern-day Belgium such as Brugge, Poperinge and Veurne etc.

The buff-coloured bricks are harder than the rubbing bricks, and therefore the Flemish craftsmen also used, and still use, masons tools and techniques to cut and shape them. This raises concerns among some observers that they are too hard to hew and that one is removing the protective fireskin, leaving them open to decay through frost damage, despite hundreds of years of evidence of their successful use on cut and rubbed work to be seen across Flanders. Firstly these bricks, similar to rubbers, have no fireskin as they were not fired at a temperature sufficiently high enough (950°C, 1,742°F+) to form one and secondly the strength, or hardness of clay bricks are not indicators of their abilities to be frost resistant. As Mike Hammett (2004) states:

> Some low-fired bricks of modest strength (7–20 N/mm^2) and high water absorption (20%–30%) have excellent resistance to damage by frost action…There is no dependable correlation between strength and water absorption and frost resistance.

Brugge

The majority of brick buildings of Brugge are built in the Gothic architecture. There are, however, some examples of Renaissance-styled building, but it was never popular in Brugge, or Flanders, although a unique highly ornamental style of Flemish Renaissance developed gradually. Gothic was always fashionable in Flanders, especially 'decorated', and demanded great skill in the production of its enrichments of arches, tracery, columns, spiral staircases, and vaulting, so evident in the skilled work of European masons of the medieval period. The wealthy being able to finance well-patronised guilds of masons and bricklayers led them, in turn, to become prestigious repositories of knowledge and craftsmanship. The prolific use of brick for enrichments, normally executed by masons in stone, inevitably led to the unique development and refinement of skills in the post-fired working and laying of bricks. Putting bricklayers and masons together led to a cross-fertilisation of knowledge and skills from which the former was the major beneficiary.

The huge Cloth Hall, built between 1280 and 1350, is a mainly brick building of orange bricks laid in English bond with stone enrichments. Significantly there is clear evidence on the brick faces of post-fired working. The parallel comb-like marks, running vertically up the ashlared wall face, would have been made by a mason's tool such as a drag, which can also be seen on all the adjacent dressed stone enrichments. As these bridge the joints, the dressings was actioned as-laid or *in situ* by the bricklayer/masons.

Similar marks are also evident on the brickwork of the vaulted corridors at the rear of the Cloth Hall. This brickwork, of 1350, is of smaller, orange-red bricks set with standard-sized joints. The doorways have ordered moulded reveals, bridged by Tudor-styled depressed arches. The cutting of the voussoirs, particularly for the tight curves to either side of the arch with joints not exceeding 6 mm, planned so that they radiated through both orders, echo again the knowledge and skill founded on sound masonry practices. The *in situ* finishing, with comb-like marks, is worthy of note. On the reveals the marks run horizontally, but occasionally they are vertical as the craftsmen 'humoured' the shape of the profiles for a straight and plumb line to the eye. The brickwork of this building is, in all respects, a long way ahead of what was being achieved in England at this time. Certainly the practice of finishing the brick facework as a stonemason his stone was not common to English brickwork, although abrasive marks are often to be seen on cut and rubbed mouldings originally intended to be rendered to resemble stone (acting also as a key) up until the seventeenth century.

The Palace of the Gruuthuisse (1425) is constructed in the Gothic style, richly ornamented with beautiful brick tracery or, as the Flemish term it, 'maaswerk', across the façade with occasional use of stone as a corbel to support the enrichments or terminal features and to cope the gables. The post-fired shaping of the bricks to templets in the manner of a stonemason is known as 'bewerkte baksteenen' or 'worked-on bricks'. Some of this tracery was given a coat of lime and stone dust stucco to imitate the natural stone it was replacing.

The Hanse House (1478) is a wonderful example of neatly laid brickwork with mortar joints much thinner than contemporary English brickwork of this period. The large window reveals and pilasters are of purpose-moulded special shaped bricks, but the areas of 'maaswerk' are beautifully shaped cut-mouldings laid with thinner joints than for the general facework; they were intended to be seen and not disguised behind a coat of plaster. The same is true of Tribune Hereman van Outvelde (1516) which is a fine brick-built square-bayed window, constructed for the owner of that name (Fig. 5). He was a master silversmith who intended to impress customers and display the wealth created from the practice of his craft.

Figure 5
Tribune Hereman van Outvelde, Brugge, Belgium (1516).

The bay has many fine elements of brickwork laid as tracery and other forms of post-fired cut enrichments in a delightful orange-red brick set with fine joints of 2–4 mm. This has to be considered an example of early gauged work. There are specially cut-moulded bricks as terminal features for highly decorated cut and rubbed quoins containing flues, because in this room Outvelde smelted the ores and the flues were necessary to vent the resultant noxious fumes. The skills displayed on 'The House of the Elephant' (1564) are also a wonderful example of Flemish craftsmanship. The brick tracery and highly ornate circular finials, 'topstucks' form accurate geometrical shapes. It has been possible to determine, through archival research, the names of the most significant Flemish 'meester metselars' (master bricklayers) who worked as 'staad metselars' (town bricklayers), who worked primarily in Brugge (e.g. Jan van Oudernaerde, Govaert Cowwe, Ferry Aerts). Although it is felt that all of these master bricklayers remained in Flanders, it is quite possible that some could have worked in England at some point in their working life. Historians and archivists with the Flemish heritage authority, Monumentenzorg, however, do not think that their great masters, or indeed even their first-class Flemish bricklayers, ever came to England to work in the fifteenth century. This is because they were in very great demand at home, and extremely well paid and secure in their employment. It is the opinion of modern Flemish historians that only 'journeymen' bricklayers, still skilled in 'bewerkte baksteenen' (but not top masters), would have come to work in England. This is possibly why so much Flemish brickwork of this period is a long way ahead, in terms of style, finishing and overall quality, to that being achieved in England at that time.

Verschelde (1871, 5–21) provides the 51 detailed articles for the Brugge Guild of Bricklayers for the first half of the sixteenth century. It reveals that only fifteen-year-old middle-class boys, whose parents could finance their training over a four-year apprenticeship period, could be accepted. At the end of their apprenticeship they would have to produce their 'proefstucken' or masterpiece in front of two competent masters. The rules laid down the choice of three masterpieces – two difficult ornate styles of doorway or an ornate window, in the construction of which the apprentices would have to demonstrate skills in 'bewerkte baksteenen' or as termed in England, 'cut and rubbed brickwork'. The articles state that although a mason had to draw the design for his masterpiece, it was not compulsory for a bricklayer; yet it acknowledges that, the best bricklayers were also good draughtsmen.

Poperinge

Unlike nearby Ieper (Ypres), Poperinge, a former Hanse town, virtually escaped bomb damage in the First World War that destroyed numerous historic buildings in West Flanders, due to its position just in front of the conflict; hence the choice of 'Talbot House' as the original 'Toc H'. Although not fifteenth-century work, number 71, Gasthuisstraat (1579) is worthy of study as it helps to show the on-going influence and quality of Flemish post-fired worked brickwork (Fig. 6). The main building is constructed of buff-coloured coastal bricks, of a relatively fine calcareous body, laid in English Cross (or Dutch) bond with mortar joints of 5–10 mm. The large central brick doorway, designed in the regional Renaissance style, is a fine example of early gauged brickwork. The same bricks are used for the main walling, but the whole manner of the

Figure 6

A fine gauged brickwork doorway, built of stone-like buff-coloured coastal bricks, 71 Gasthuisstraat, Poperinge, Belgium (1579).

doorway treatment is completely different – cut and shaped with great care and then laid with joints of 1–2 mm and cross-joints varying from 1 to 5 mm.

It may also be noted that this gauged work had been finished *in situ*, similar to the dressing of stone with a drag by a stonemason (Fig. 7). This is known in Flanders as 'planing' due to the use of a stoneplane, or 'steenschaaf', as it is referred to in Flanders, discussed below. There is, however, a noticeable

Figure 7

A close-up of the brickwork to the gauged doorway, 71 Gasthuisstraat, Poperinge, Belgium (1579), showing the comb-like marks from *in situ* finishing, evident as the striations bridge both the bricks and joints.

difference in these striations to those on the Cloth Hall in Brugge. More care has been taken to work them parallel and vertical to the jambs, and then to follow the curve of the arch keeping with the coved horizontal rustications up the pilasters framing the doorway. This feature only deviates when the direction needs to follow the radiating voussoirs.

Viewed from a distance, especially with the tone of the brick, it is quite easy to mistake this doorway for stonework. This re-confirms the author's long-held belief that gauged work is the result of master bricklayers refining brickwork in the manner of the stonemason, resulting in brick being suitable for the enrichments of Gothic and subsequently Renaissance and classical styles, all primarily intended for the medium of stone. In the post-fired working of bricks and brickwork, therefore, there would have been both a desire and ultimately a need to work the bricks like the best carving stone.

Closely jointed masonry is symbolic of individual craft pride, demonstrating an accuracy of skill and resulting in stronger construction, and appears to reflect the sense of national pride and standards. When the Roman Empire was at its zenith of power and state discipline, the quality of its masonry was extremely accurate with refined joints between bricks or stones. As the Empire declined, so did the standards of its masonry and joints widened significantly. This was also true of Flanders.

Veurne

Die Nobele Rose (1572–75) in Veurne, another Hanse town, is another fine example of early gauged work, having similar-sized bricks, minor inaccuracies and finishing that echo the Poperinge doorway above. The arches and the large central window treatment with pilasters framing a scallop-shell hood within a cut-moulded arch are especially finely wrought.

The town hall of Veurne is a combination of late Gothic and Renaissance elements called 'Flemish Renaissance' style, and was constructed in two parts, in 1596 and 1612. Both display fine gauged brickwork enrichments, cut-moulded reveals, arches, pilasters, as well as *in situ* carved strapwork to aprons and tympana of arches; all laid in the buff coastal bricks. This work is superior in quality to that of the two doorways of Die Nobele Rose and 71, Gasthuisstraat, Poperinge, as the skills of post-fired working of bricks continued to be refined with knowledge and experience. A description of the work carried out on setting out, cutting, rubbing and constructing a new brick 'topstuck' to replace a seriously weathered 1612 original from this building, was the subject of an article written by Elie Degrande and Miek Gossens. It provides a valuable account of the methods employed by the Flemish craftsmen on post-fired working bricks for restoration purposes, as discussed below.

Clearly, by studying Flemish brickwork, and particularly the practice of treating bricks as stones for enrichments, one can see cutting, and rubbing, to have become a ubiquitous practice with signs of post-fired working very evident on the faces of the bricks. This was achieved by way of 'axing', and the use of either plain or combed-head chisels. The popular calcareous buff-coloured Flemish bricks would be slightly harder than, for example, the English orange/red rubbing quality bricks of the same period, so requiring more robust mason's cutting and carving tools and masonry techniques to work the face.

A Master Builder's Workshop

Modern Flemish bricklayers at the workshop of Master Builder Arthur Vandendorpe in Brugge, continue to set out and cut brick mouldings in the traditional manner, such as for the restoration of Gothic tracery or 'maaswerk'. Surprisingly the majority of bricks used on restoration work appear to be re-claimed; there are no brickmakers currently producing rubbing quality bricks. With the brick cut down to the basic size, the required shape is obtained from full-size templets, prepared from full-size geometrical drawings, with joint sizes to a maximum of 5 mm, as individual boxes. The brick is placed into this box, scribed and then removed for hand-cutting with the hammer and chisel, exactly as a stonemason cuts stone; working from drafts formed at either end of the brick that answer the templet and then the remaining surface is worked to shape between the drafts. After this sequence of cutting to shape the brick is then replaced into the mould to finish and check accuracy (Fig. 8). Today, disc-cutters are used to rough-out the shape but formerly all this cutting would have been done with a handsaw, brick axe, mason's tools like the hammer and chisel, and associated abrading tool(s).

Figure 8

Flemish templet box for scribing and checking a cut-moulded brick.

A foreman bricklayer demonstrating his skill as a 'tailleur' or 'finisher', by placing the re-claimed brick that had been cut roughly to shape using the bench-mounted disc-cutter. Placing the brick on its edge at an oblique angle in a timber box fitted on the side of a bench, using a narrower rather than his normal full-width stonemason's chisel, he produced a series of even, parallel stripes with a mason's mallet and sharp plain-edged chisel across the brick surface (Fig. 9). This is like a 'tooled or batted ashlar' dressing that is to be seen on mason's stonework in England. This finish is known in Flemish as 'frijnen' (freynen), meaning driven or striped. It basically involves 'walking' the chisel, or broad boaster, across the surface of the brick as it is rhythmically tapped with the stonemason's mallet. In some respects, these parallel lines are also faintly rem-iniscent of the herringbone tooling on the eleventh-century bricks in Sienna, described on page xxxvi.

Observing Flemish 'bewerkte baksteenen' from the late sixteenth century, most laid with tight joints so that it can almost be considered as early gauged brickwork, neat *in situ* finishing is present, similar to how a mason would 'drag-finish' a stone in dressing. This, it is concluded, could not have been 'Frijnen', as it is not suited to finishing *in situ* brickwork set in slow-setting lime mortar. The clue to the method being in how the Flemish refers, in English, to this finish as 'planing'. The parallel striations, running through bricks and joints, run plumb to vertical mouldings or following the curve of an arch are produced by a tool called a 'steenschaaf' (stoneplane). This is a wooden tool of various

Figure 9

Flemish 'Tailleur' producing a 'frijnen' finish, but using a narrower rather than the usual full-width chisel, on a cut-moulded brick.

lengths and shapes with integral handles, and having flat, convex, or concave shaped (smooth or combed) blades set into slots all along its underside, parallel or angled against the direction of 'push' (Fig. 10). In England, this tool is referred to as a 'French scraper' or 'French plane', only used on soft stones; and according to English masons it was never popular. In Flanders, the steenschaaf was, and is still used by the bricklayer/mason for running along a stone or brickwork dressing *in situ*, during the finishing process, in a similar manner to how a carpenter planes his wood, to both line up the work and clean the faces. In Saint Omer in French Flanders, the steenschaaf was observed in use by masons restoring an historic stone façade, both for shaping individual stones on the bench as well as for *in situ* planing of the built work. These French-speaking masons, however, called the plane a 'rabotin' (pronounced 'rabotan') rather than a steenschaaf.

In the Vrij Technisch Instituut (VTI) te Brugge, advanced-level craft students are given high-quality training in restoration skills necessary to maintain the architectural heritage of Brugges and the surrounding area of Flanders; including brick and stonework. Here, amongst the many Flemish methods of working bricks post-fired, it was particularly interesting to observe students using mechanical carborundum grinding stones to abrade shapes into the faces of bricks, where possible, for enriched mouldings. The bricks to be shaped could

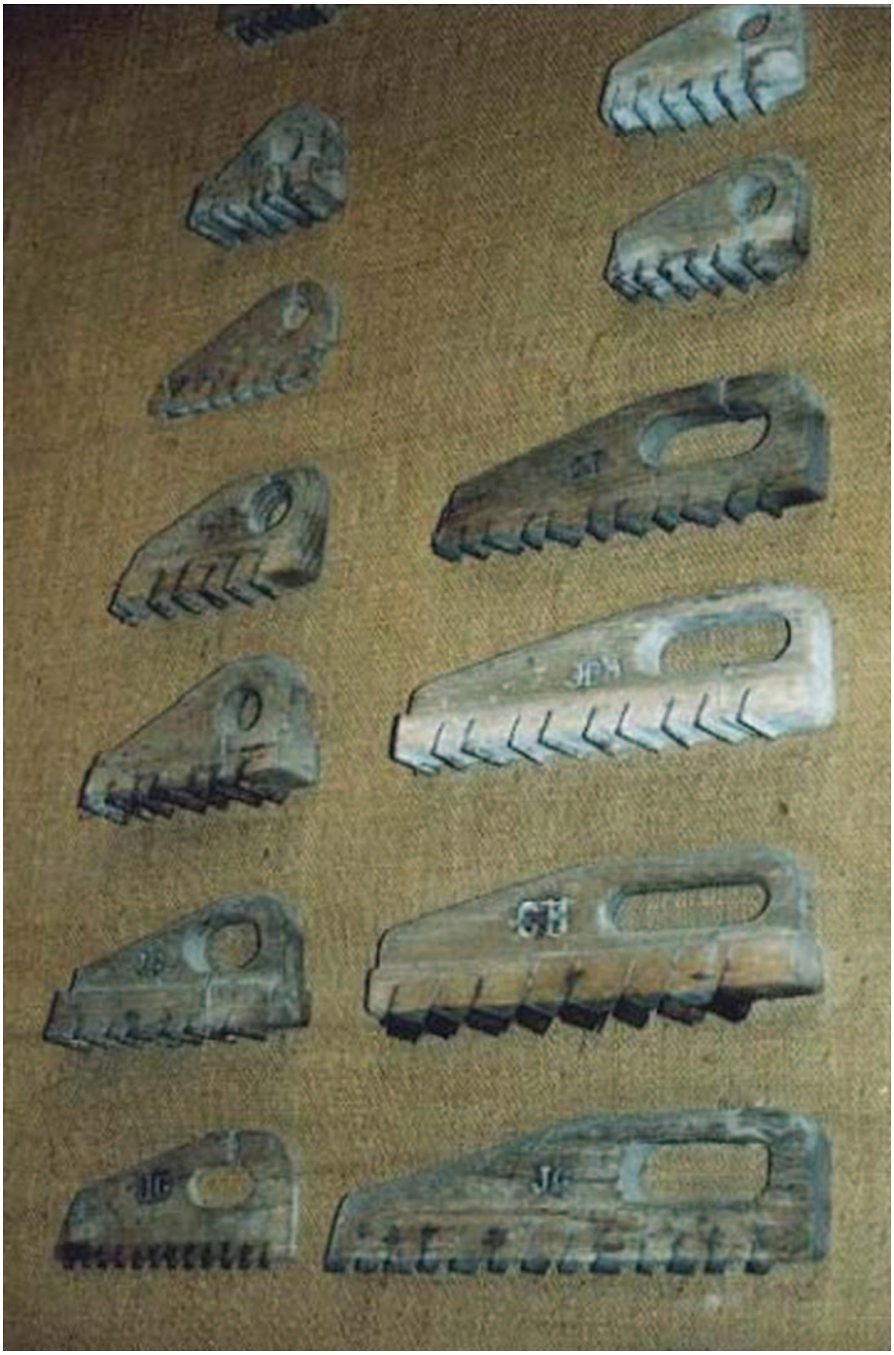

Figure 10
A selection of Flemish 'Steenschaafs'.

be either placed in a moulding box, as described above, for scribing, or alternatively, for an ornate spiralled brick chimney shaft or 'topstuk' (finial), by the use of what are termed in England, as timber 'clip moulds'. These are obtained from the plans of a full-size working drawing in which the differing upper and lower bed profiles are determined. The two opposing patterns, as 'clip moulds', are centrally placed on opposing beds and the shape scribed around the templets, which are then united at the middle during the rubbing process by manipulating the brick face against the spinning abrasive to achieve the desired finished profile. This adds weight to the long-held belief that the large circular grindstone, used in the cutting shed for hewers to sharpen their tools, was also utilised where possible to rub part, or all, of a moulding on the bricks.

The last quarter of the sixteenth century, despite all the innovative refinements of its brickwork, was the end of the 'Golden Period' for Flanders. The country was under the rule of King Phillip II of Spain (1527–93), determined to crush Protestantism in the Low Countries as the effects of the Reformation spread. The medieval cloth trade declined rapidly, resulting in calamitous and long-lasting social and economic consequences for the country. Architecturally, Flanders became trapped in the mannerism it helped to create.

As Kuyper (1980, 60) emphasises:

> Politically, Classicism meant the assertion of independence… but after the surrender of the Hapsburg monarchy, Flanders could not contribute to classicism.

Master craftsmen were not just very skilled, but also literate, numerate and highly respected freemen citizens of their guilds, enjoying high status and repute. The liberation and freedom to explore new possibilities that the Protestant faith appeared to offer attracted many, though not all, from Catholic Flanders. Whilst some migrated and settled in Protestant England, in such places as Sandwich (Kent), the majority of craftsmen and intellectuals simply moved north into the neighbouring Protestant provinces of the Netherlands, such as North and South Holland. This was a further economic blow to the confidence of Flanders, though an immense cultural and mercantile benefit to their new homeland and neighbour about to enter her own 'Golden Period'.

Later Examples of Fine Flemish Gauged Work

At 21, Northstraat, Veurne, in 1739 a new frontispiece of gauged brickwork was built onto a building of 1578. This is an exquisite example of gauged work, constructed of buff-coloured coastal bricks that are laid with joints of between 0.5 mm and 1 mm to both bed and perpend joints. The design, no longer the preserve of the master bricklayer, is an interpretation in brick of the French architectural examples in stone influenced by the Louis XVI styles that culminated in the eighteenth century. The entrance comprised 'blocked' reveals and arch with pediment and at either side exquisite spiralled volutes opening out from the base of pilasters. Above the doorway, there is a beautiful niche, with scallop-shelled hood. This is gauged work of the highest standard and is so easy to mistake for stonework.

The Huis Van Merris (House of Merris) in Poperinge also dates from the eighteenth century and is constructed in the same style of Louis XVI. Below the ground floor window cill height the brickwork below plinth level is of standard buff-coloured bricks laid with bed joints averaging 10 mm. Above this the entire façade is of fine gauged work with cut-moulded bases to the large ashlared pilasters, architraves to the openings and *in situ* carved swags to richly detailed aprons. This truly emphasises the success of constructing entire classical façades in refined gauged work, that becomes one homogenous mass instead of a series of busy individual bricks, allowing the architectural enrichments to be displayed without visual disturbance.

In studying post-fired worked brickwork across much of Flanders, there is a singular revealing aspect to almost all of the historic Flemish 'bewerkte baksteenen', and particularly where the quality is virtually gauged brickwork; that is seen from the early sixteenth century onwards. The overall bonding pattern is frequently treated more like ashlar stonework, rather than the disciplined and rule-abiding manner normally associated with good brickwork. This is almost certainly an indication of those taught as stonemasons being involved in its construction.

The skills of gauged work were very much brought to the fore in the years following the Great War and there are some wonderful examples to be seen on shell-damaged or entirely re-built properties, faithful to the original designs, in towns like Veurne and particularly in Ypres (Ipers). Today these skills are still formally taught to some bricklayer/masons for working on brick buildings needing repair or restoration.

Bricklayers and Brickmasons in England

During the late medieval period there was no distinction made between structure and decoration on masonry and authorship of the buildings was deemed unimportant. Although designing required a level of intellect and its decoration was seen as a subsidiary skill, designs were usually the collaborative effort of the patron, master mason and builder, though only the patron was truly recognised.

In England, during the fifteenth century, there was a period when stonework became unfashionable and numerous masons readily moved from stone to brickwork. That in fifteenth-century England some bricklayers worked also as masons is undisputed, being termed collectively 'Breekmasons' (Moore, 1991, 232–3):

> Building accounts including both brick and stone construction often show the interchangeability of brick and stone layers. At Eton, although there were 13 men in 1444–46 who were paid only as bricklayers, there were also 18 stonelayers of whom ten worked partly as bricklayers…at Kirby Muxloe some of the most skilled bricklayers were paid in May–July 1482 as 'roughmasons'.

At Hertford Castle, Hertford, Hertfordshire, the late medieval gatehouse was built for Edward IV in 1461–65 of bricks '… made locally by Cornelius Gyles – clearly of continental origin – for 1s. 9d. per thousand… laid by nine "breek-masons"' (Smith, 1983, 30). Harvey (1984, 73–4) indicates that at Kirby Muxloe Castle the master mason placed in charge of the bricklaying, and small elements of stonework, was John Cowper, who trained as a stonemason at Eton College. In the 1520s Robert Newby was employed as both the master brick-layer and chief mason at Lincoln Cathedral. Christopher Dickenson, who was in charge of eighty-seven bricklayers at Hampton Court Palace between 1537, rising to 113 in 1539, was master mason at Windsor Castle and Nonsuch Palace, yet the Nonsuch accounts record his role there as a Master Bricklayer (Harvey, 1984, 213). Piers Conway, stonemason/carver (Conway, 2002) states:

> It is my belief that when the craft of 'cut and rubbed' brickwork came to this country, the lack of craftsmen in this field would have provided an opportunity for out of work stonemasons to take up the mantle and apply their skills to the new fashion. This would have been viewed at that time as perfectly natural.

Despite this there would have been occasional tensions between the two crafts with the greater use of brick, and problems of craft demarcations too, as at York in 1491, when two masons murdered a 'tiler' [bricklayer] during a dispute on the construction of the Red Tower (Harvey, 1984, 144). Ordinary bricklayers, rather than hewers or brickmasons, would have been skilled only in 'setting' or laying standard bricks to bond, or stones, as Moore (1991, 233) indicates:

> At Tattershall Castle the accounts mention 'masons called brekmasons' and 'roughbrekmasons'; possibly only the first category laid the facing bricks and built the vaulting and corbelling.

Post-fired Cutting or Green Moulded

All the time and expense for 'cutting and rubbing' bricks may seem strange to many observers today. Why not make a mould to the desired shape and cast the shape before firing when so many repeats would be needed? There are several answers to this:

- The slight warping and twisting of the varying brickearth/clays in firing would be a problem for enrichments, especially where precision was vital (not so much though for those bricks hidden by stucco).
- The lack of skill of brickmakers in making sophisticated timber mould boxes to cast the clay in and mould the special shape before firing.
- The problem of moulding complex shapes that possess deep undercutting made their removal from the timber mould box, fixed with removable 'negatives', virtually impossible.

- The prolific use of 'clamps' to fire bricks, where the close-stacking arrangement of standard bricks and lack of firing control did not suit the production of 'specials', which, like roofing tiles, generally needed to be kiln-fired.
- The inherent quality of some brickearth/clays, when low-fired, to be easily cut to shape and abraded to a precise profile and smooth finish.
- The employment of masons and the continuing development of some of the highly-skilled brickmasons/bricklayers as 'hewers' able to expertly 'cut and rub' bricks quickly and accurately to the desired shape.

Cutting Mouldings from 'Green' Clay

There is evidence on some enrichments from the second quarter of the fifteenth century that, occasionally, mouldings were also cut from the 'green' (before firing) clay brick whilst semi-dry (Beswick, 2001, 24):

> The bricks for most buildings were made on the spot by an itinerant brickmaker employed for the purpose. Often he served as the bricklayer as well.

This important latter point is emphasised by Moore (1991, 233):

> Some bricklayers also made bricks. Antony Yzebronde, apprentice bricklayer at Kirby Muxloe, spent more time at the kiln than with his master…. At Camber Castle in 1539 Gilbert Drynkherst was successively head bricklayer at 7d. a day, brickmaker at 8d….

Peter Minter, proprietor of the Bulmer Brick & Tile Company in Suffolk and respected authority on traditional brickmaking and historic bricks suggests that:

> …this method could well have been carried out by the brickmaker under the guidance of the brick mason speeding production.… the identification of cut post-fired bricks as opposed to cut and green bricks, is as follows:
>
> Cut after firing. The material, even at low-fired state, is hard and abrasive, and requires the use of saw, scutch, rasp or any other tool capable of cutting down and rubbing to a finish. Marking out done even with a sharp instrument would only leave a shallow scratch in the surface of the brick, whilst a rasp tends to leave striations on the face. Poorly prepared clay and other inclusions become exposed when cutting into the core of the brick; these are then visible or in some cases fall out of the body of the brick during its lifetime.
>
> Cut green. Providing the clay is some three parts dry, it is possible to cut with a knife or chisel in the way a carpenter would work wood. The marking out is bolder due to the softness of the material and a more permanent mark is left, often becoming more pronounced due to weathering. When cutting semi-dry clay, the

> knife will tend to smear or smooth the surface of the cut, so giving a somewhat polished effect. Nodules of harder clay are cut, leaving evidence of their presence, but burnt into the brick once it is fired. Timing of the cutting varied, giving rise to a different size to the finished brick due to the amounts of shrinkage still to be experienced. This can be up to 8–10%. Again, a careful check, particularly of the marking out marks, will confirm the state of wetness of the brick.

These final remarks highlight the then particular problem of cutting mouldings with green clay. On-going drying and shrinkage of the clay would mean that, unless the hewer cut all the mouldings within a day or two of each other, there would be noticeable differences in the subsequent fired mouldings; as well as accompanying minor distortion in firing. Also, in the longer term, the resultant thin and smooth/polished surface of the green-cut face often has a tendency, with weathering, to peel away, leaving a rough core exposed, aesthetically disfiguring and opening the brick to decay; something that does not happen with post-fired cut work.

The rather intriguing ornate brick gateway in the garden of Stutton Hall (Suffolk) (*c.*1553) is illustrated in two photographic plates by Lloyd (1925, 312–13). The garden-side elevation is executed, from the cornice level down, with Renaissance detailing (as opposed to the Gothic parts) rendered to resemble stone. This stucco was carefully removed about 30 years ago exposing the Tudor brickwork, providing a valuable insight into how the above-mentioned methods (cut before or after firing) could be employed together on a decorative element (Fig. 11).

Study of the moulding to the voussoirs (not cut to radiate with the standard size mortar joints thus being 'v-shaped') of the semi-circular arch reveals how their ovolo profile was green-cut. The tell-tale signs of slight dragging of the surface inclusions and the smooth/polished appearance, with accompanying shrinkage cracks, that subsequently occurred during the remaining period of drying prior to firing are clearly evident. Many of these voussoirs also exhibit the characteristic signs of veneer de-lamination, as described above (Fig. 12).

The double-engaged fluted pilasters with entasis on either side of the arch are detailed with base and neck moulds, capitals, corona and drip, and a terminal cornice, again set with standard-sized joints. All have been both green or post-fired cut and rubbed to shape, or possibly a combination of both techniques. Clearly, the more intricate mouldings display the classic signs of cut and abraded inclusions. The pilasters are most revealing, as the evidence indicates that they were laid out to bond position and then cut to their correct entasis at the green-clay stage. The un-rubbed ends of each respective brick to the sides of the pilasters still have the original scribed numbers for the correct order of erection. Roman numerals were used because it is easier to scribe straight rather than curved lines and less likely to be misunderstood. These are consistent with having been executed on the green bricks.

Figure 11
Gateway to the garden of Stutton Hall (Suffolk), *c.*1553.

Figure 12
Green-cut moulded voussoirs to the garden gateway, Stutton Hall (Suffolk), *c.*1553.

Of particular interest is the use of, what is termed in the Netherlands, an 'accolade' – pronounced 'accolada' being scroll-shaped, green-scribed lines on the side of the pilaster bricks, along with Roman numerals, to ensure they were properly sequenced to maintain the correct entasis as laid to the capital (Fig. 13). The flutings, however, were cut and rubbed post-fired, as again one can clearly determine the cut and abraded inclusions. It is likely, though, that the positions of the flutings were scribed in outline on to the pilasters when they were laid out for cutting the entasis at the green-clay stage. These were then re-checked, scribed, and cut in properly after firing; hence also the need for the 'accolade' to help align the flutings.

Figure 13

A green-scribed 'accolade' to help align a fluted pilaster on the garden gateway, Stutton Hall (Suffolk), *c.*1553.

One can see, therefore, that although there was some use of cutting mouldings at the green-clay stage, there were greater advantages to cutting and rubbing them on to post-fired bricks to gain consistency in both size and shape.

Cutting Tools and Techniques

Hand tools may be categorised (Salaman, 1975, 605) as:

> …those used by craftsmen in the performance of a manual operation, such as chopping, chiselling, sawing, filing or forging, that directly shapes a piece of material into a desired form.

> …The common denomination of these tools is removal of material from a workpiece, usually by some form of cutting. The presence of a cutting-edge is therefore characteristic of most tools…

Close examination of many shaped and enriched bricks on fifteenth- and sixteenth-century buildings clearly reveals that the majority had been worked post-fired, as described above. Studying contemporary documentary evidence can substantiate this, which frequently records the tools used, as described above and indicated by Moore (1991, 227):

> Tools for this must have been among the dozens of axes, chisels and 'other' or 'small' tools frequently sharpened by the Smith. In 1533–34 a brick-axe at 8d. and three stone hammers at 6d. each were bought for the bricklayers at Windsor Castle. At Stonor Park there is corbelling with chamfers and simple mouldings on the chapel tower, cut with the aid of four hand-saws provided in 1416–17.

Hewers would undoubtedly avail of the cutting and finishing tools used by masons that would be suitable for bricks. These would be as used on soft calcareous stones, which was certainly the case with the Flemish craftsmen. It is important, however, to realise these highly skilled yet pragmatic craftsmen, having selected tools from the stonemason's wide range, would then adapt the tools and techniques as necessary to suit brick.

A generally larger mass of stone anchored on the floor, or banker, leaves the mason's hands free to use his tools on a rigidly fixed material. This would not be true of a small, lightweight post-fired brick to be cut and worked to shape. The hewer would be forced to either hold the brick down on the banker or rest it against something to prevent it sliding whilst cutting and abrading with the selected tools in his free hand. Alternatively, he might choose to rigidly secure the brick on the banker to leave both hands free.

The former method would have been the easiest and the most popular method for the hewer to cut and rub basic shapes and mouldings, the latter being sensible practice for the production of the more intricate cutting and abrading of detailed mouldings, requiring two hands to guide the tools. These methods are not documented (common every-day sights rarely were), but could have been as simple as a timber batten (or 'stop') nailed to the banker for the bricks to rest against. Alternatively, a 'sand-tray', which, as the name suggests, is a tray part-filled with sand for the brick to be bedded into, would serve to resist some movement.

Peter Hill, consultant stonemason, provides another possible method, which takes the form of a rudimentary clamp devised by resting a suitable-sized batten fixed with a twisted cord passed to a bar below through a slot on the banker. The upper batten rests upon the brick, or small stone, to be worked

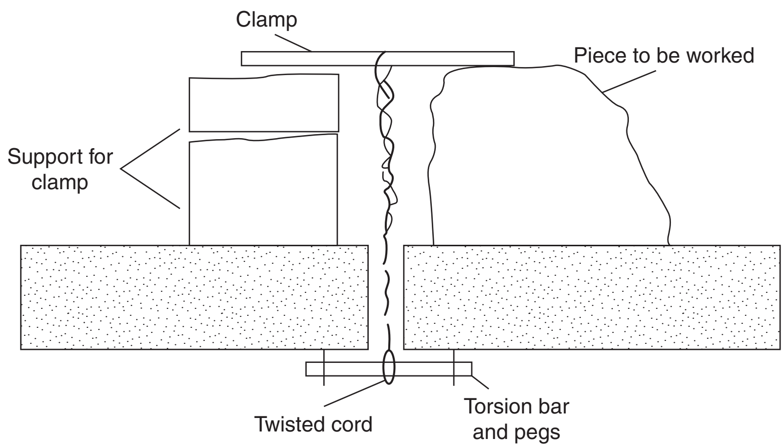

Figure 14

Rudimentary clamp to secure small stones or bricks whilst dressing them. (Courtesy of Dr. Peter Hill)

and the other, opposite, serving as a support (Fig. 14). As the lower torsion bar is turned, the tourniquet effect clamps the brick tight.

Yet another method that could have been adopted, as suggested by stonemason/carver Piers Conway (2002) was:

> Fixing down a small brick could have been achieved with small 'dabs' of Plaster of Paris to the base of it to hold it to the banker prior to being carved.

The author upholds all of these craft practices as sound and pragmatic alternatives to facilitate the post-fired working individual rubbing bricks.

Chisels

Chisels, in a variety of sizes, worked with a hammer or mallet, are among the most common tools used by the mason for cutting, shaping and finishing stone. They certainly would have been regularly used on some harder types of bricks selected for cut and rubbed work; and this was clearly evidenced on many of the calcareous bricks, similar in strength to soft stone, traditionally used in Flanders. They were neither necessary nor indeed desirable, however, on the softest of the rubbers. In tests carried out by Peter Hill, using his own mason's tools on rubbing bricks to produce some cut mouldings in the manner of a stonemason, concluded (P Hill, 2001):

> It was clear from our experience that working with masonry tools such as the mallet and chisel is not satisfactory for removing large amounts of material. This is owing to the nature of the material, which seems less cohesive than stone. There was a strong tendency for the brick to 'pluck' when removing more than two or three millimetres at once.

Hand-saws

The small hand-saws mentioned above would have been similar to what Moxon (1703, 245) displayed in *Mechanick Exercises: OR, The Doctrine of Handy-Works. Applied to the ART of Bricklayers Work* and described as:

> A saw made of Tinn, to saw the bricks where they cut

Later, this type of saw, most likely of tin-plate, became known to bricklayers as a 'grub-saw', used for marking around a templet prior to cutting to prevent spalling, or splintering, of the brick face around the new arris (edge) during cutting. It could be used for cutting away, to the established setting out lines, large parts of unwanted brick following the long-established masonry cutting sequence of 'chamfers, fillets, hollows and humps'. The saw being utilised to make a series of cuts down to the scribed lines, directly into the fillets and hollows to facilitate either chiselling-out or 'axing'. The hand-saw could be used to cut and shape certain sections too as on the cut-moulded finial brick from Wallington Hall *c.*1525 (see Fig. 2). This saw is very similar in size and shape to the mason's 'drag' and to a lesser degree the 'cock's comb'. In both the teeth would have no 'set' and the latter was used for cleaning-out small hollows, detailing, and the intersections of some mouldings.

Drags

With specific regard to the use of a mason's drag for finishing a moulding Peter Hill (2001) made the following observations, based on the trials noted above:

> The use of drags was clearly most satisfactory for removing up to 5–6 mm of material down to the finished surface. This was very quick and easy, and when used with care few if any marks were left on the surface. You get better control with one hand above and one below and that if you lay the drag almost flat the effect is much reduced. Keep working them in two directions or more, up at 45° to one side, slide it back, and up at 45° to the other side; it is a sort of figure-of-eight movement. If you don't go in two directions you will soon wear a hollow.

Brick Axe

The brick axe was clearly a very popular cutting tool amongst medieval and Tudor hewers that was small, relatively light and easy to carry with them from job to job and to care for. With some changes in style and skill in its use, it remained in a common tool in the cutting shed until well into the nineteenth century. The brick axe of this period, forged from a length of iron, resembles a double-bladed bolster with two wide blades at opposing ends with average dimensions of 5 ins (127 mm) in blade width. Typically 12 ins (306 mm) in overall axe length, a round central grip of 4½ ins (115 mm) and a weight around 3 lbs. (1.36 kg). The size and weight of the brick axe varies and Richard Filmer (2007) of the Tool and Trades History Society (TATHS), who has several in a private collection (Fig. 15), discusses this:

> Whilst most of the smaller brick axes are roughly a similar pattern, there does seem to be a significant variation in the size and weight, which is perhaps surprising, inasmuch as generally the size of the brick was reasonably standard. Perhaps it was the texture or composition of the brick that influenced the size?

This is possible, though given the nature of the soft textured bricks used for cut and rubbed work this might not have been the main influence size and weight. It is more likely that most brick axes were bespoke-made, by blacksmiths (and to varying standards of quality dependent on their materials and skills) so that the length, blade width and overall weight suited the individual craftsmen.

The brick axe appears to have come into England with the craftsmen from the Low Countries where it was termed a 'bikijzer' (brick iron/blade) (Janse, 1998, 41). The brick axe was used for roughing-out or chopping away waste brick and/or working a surface flat. Also, where necessary, it might be used for finishing, or dressing, the brick surface and in this respect the tool resembles a form of chisel as much an axe.

In his work on the significance of cut and rubbed brickwork on Tudor chimneys, Smith (1999, 3–8) describes evidence of post-fired working of the face of the brick using a brick axe. Gleaned from studying a salvaged original cut-moulded brick from an ornate chimney of a demolished Tudor Palace at Bridewell, London (1515–23), now in the Museum of London, he comments:

> The brick itself… shows tool marks which 'indicate that the brick was shaped by cutting rather than moulding'. These tool marks are somewhat coarse in their execution… suggesting the use of a brick-axe…. and from the dimensions that the shaped brick was cut from one of the standard bricks used for the palace….
>
> Even more significant are the scribe-lines on both bedfaces of the Bridewell brick. The cutting or carving of brick chimneys could have been done either by shaping the individual units and then laying them or by carving them in situ. It is likely, in fact, that a combination of both techniques was used….

Reference to the possibility of carving the intricate shaft mouldings *in situ* on Tudor chimney stacks is also sometimes touched on by other commentators as well as Wight (1992, 100). It is suggested it could never have occurred. The slow hardening and relatively weak set of a lime mortar, binding many small and essentially lightweight bricks into tall slender shafts, make it both impractical

Figure 15

Selection of iron brick axes to the Moxon specification. The curved ends to these blades, a result of misuse, would be unsuitable for axing bricks, which require straight blades. (Courtesy of Richard Filmer)

and dangerous. Also, there would be no practical sense in carving out the detail high up on a building when it all could be executed in the comfort of a cutting-shed, dry-assembled, and then taken up the scaffold in the correct order of laying. What was probably observed and misunderstood in the past was the practice of ‘humouring’; that is, adjusting lines and angles by abrading in the finishing phase to ensure all constructional elements swept neatly into one another.

With respect to this Smith (1999, 6) concludes:

> As noted, the tooling on the Bridewell brick is somewhat coarse…. It is not at all unlikely, therefore, that such bricks were given a finer finish, probably by rubbing with another brick or with a suitable stone.

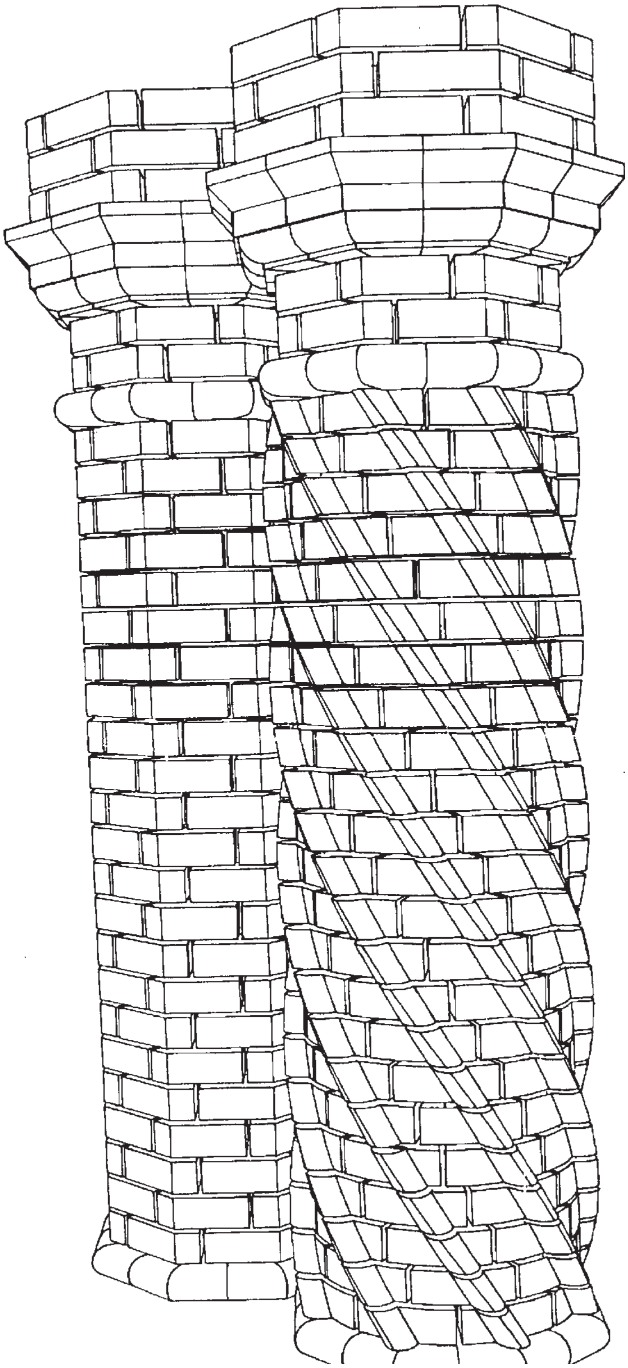

Figure 16

Drawing of an elevation of a chimney with a rope mould. (Drawing reproduced by kind permission of Robert Lamb, W.T. Lambs, Bricks and Arches Ltd)

Undoubtedly only the very best of craftsmen could be tasked with setting out, hewing and then building ornamental cut-moulded brick chimneys. Full-size plans and elevations of the appropriate parts of the bases, shafts and heads of the stacks would be drawn from which templets were obtained (Fig. 16). Plans provided individual templets for the many types of brick shapes as well as course templates, or moulds, to suit particular overall plan shapes, whereas elevational drawings provided templets for the profiled shapes of most vertical cut-mouldings. Shafts could be polygonal with canted bricks, some had continuous patterning with simple geometrical shapes like a square or more ornate with diamonds or hexagon detailing.

Where there was a vertical spiralling profile on the shaft, like the rope, or cable, moulding, as seen in the Bridewell brick above, the establishment of the templets was then altered to accommodate the change in profile through the height, or gauge, of a particular brick (Figs 17 and 18). On elevation the spiralling would be viewed as a regular stepping-off of measurements around the circumference of the shaft. Obtaining those templets was achieved from a plan view that established the offsets of both the lower and top beds of the individual brick. Working to a centre line, these two templets – sometimes fitted with corners to secure them to the brick as 'clip' moulds – would then be held to the bed and to the top of the brick, at the correct vertical distance apart, or gauge, and scribed. The brick could then be cut precisely by working between the two fixed points of reference and thus to the desired shape (Fig. 19).

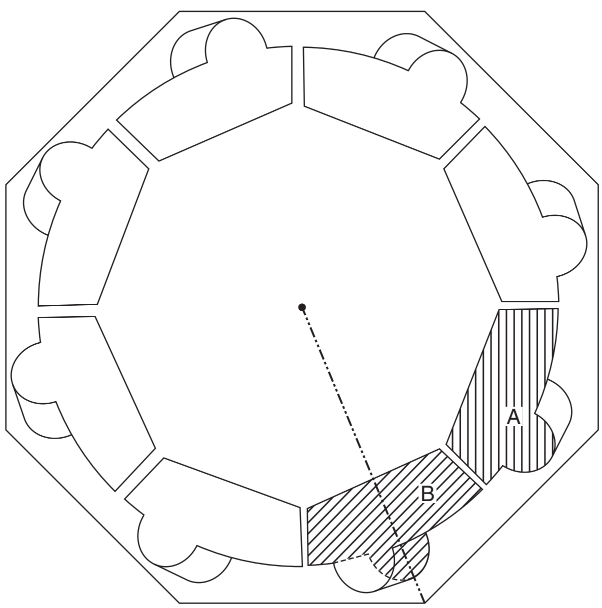

Figure 17

The positions of the two templets A and B, have been imposed by the author onto the plan to emphasise how they were obtained. (Drawing reproduced by kind permission of Robert Lamb, W T Lambs, Bricks and Arches Ltd)

Figure 18

Clip mould B – the top templet seen on the cut-moulded brick.

Figure 19

Clip mould A – the bottom templet seen on the cut-moulded brick.

Once all the bricks were cut to shape the building of the ornamental shafts commenced with the first course of bricks being orientated precisely to ensure that the bonding perfectly united, in a graceful manner, with the profiled bricks of the corbelled, or oversailed, heads. Each successive course, or layer, of bricks being maintained level, plumb and gauge; as well as checked for overall regular shape on plan by the use of a mould, or template. The heads or caps, single or joined on top of a stack of shafts, could also be wonderfully ornate, as Wight (1972, 413) indicates, sometimes furnished with, '…*star-tops* having one or two stars; *spur-tops* having blunted points with *scallops* between.'

Figure 20

Thornbury Castle (Gloucestershire), 1514, a testament to the skill and artistry of the Tudor brick hewers, and possibly one of the finest examples of cut and rubbed chimney stacks. (Courtesy of N.J. Moore)

Among the best surviving examples to be seen are those at Tattershall Castle (Lincolnshire), *c.*1440, St Oysyth's Priory (Essex), *c.*1475, and Thornbury Castle (Gloucestershire), 1514 (Fig. 20); which is perhaps the finest cut-moulded chimney in Britain. Other excellent examples of cut and rubbed chimney stacks from this period are those at Chenies (Buckinghamshire), *d.*1523–26 (Fig. 21), Plaish Hall, Longville (Shropshire), *c.*1540, Aston Bury, Stevenage (Hertfordshire), *c.*1545 and Stutton Hall (Suffolk), *c.*1553. Both Lloyd (1925, 81–2) and Wight (1972, 100) relate the tragic story of the construction of the ornamental chimneys at 'Plaish Hall' for Sir William Leighton, who was Judge of the Shrewsbury Assizes. Discovering he had sentenced to death, for sheep stealing, the only bricklayer that could be found in the locality to craft the patterned chimneys he desired, Judge Leighton had the death sentence suspended and the poor man taken from his cell to Plaish in order to build them. His craftwork done he was returned to his cell from whence he was hanged.

Figure 21

Cut and rubbed chimney stacks, Chenies Manor House (Buckinghamshire), 1523–26. (Reproduced by kind permission of Mrs MacLeod Matthews)

Some cut and rubbed chimneys would, like some other areas of face brickwork during this period, have been finished with a colour wash as Woodforde (1976, 48) records that at Collyweston, Lincolnshire, in 1504, a deficiency in redness was helped out with:

> vijlb [7 pounds] of red ocker [ochre] with 1oz. [Ounce] of the Glovers lether, vijd [7 pence]. Item to John Bradley wiff for xiiij [14] gallons of small ale for the said cheney of bryk, vjd [6 pence].

The technique used by the hewers to finish their axed work could vary in how they responded to the nature of the brick, their own style and standards of individual workmanship. Some might rub their axing marks smooth, whilst others liked to leave them visible. This decision might also make an allowance for the viewing distance so that if the feature was high up, it might be roughly axed, yet it would appear neat and to profile to the viewer at ground level.

Some hewers could be very disciplined and seek to always leave their axe strokes neat and parallel to one another, whereas another could leave cavalier axing marks with their particular hewing technique. Study of a number of cut and rubbed ashlared and moulded enrichments on several English medieval and Tudor brick buildings, has revealed a common and attractive finishing technique. For example, bricks axed for quoins and splayed reveals and not rubbed smooth, reveal how some hewers frequently dressed the faces of the brick diagonally; generally from top left to bottom right in a series of parallel strokes. These angles vary, presumably due to individual craftsmanship, from 45° and 60° (approximately) in a manner similar to what masons term 'boasted ashlar' work. This axing patterning can clearly be seen in Nathaniel Lloyd's photograph (1925, 334) of a gable detail to oversail an upper storey, on a late sixteenth-century property in Elham (Kent). The top two course of bricks, directly below a course of ovolo stretchers, are axed diagonally and laid with the axe strokes in opposing directions on each course for extra aesthetic effect.

This style of axing was also used for simple flat shapes, such as 'cants' used for reveals, or for voussoirs in arches; the diagonal axing marks providing evidence of the brick being dressed first before being cut to the wedge-shape of the arch voussoir in a two- or even three-stage cutting process. With more ornate mouldings, possessing concave or convex curves, the techniques were modified. If it was practical to use the brick axe throughout shaping, then it was worked so as to cut parallel to the run of the moulding, as in the Bridewell chimney brick, where the axe strokes follow the length of the roll or rope moulding (Fig. 22).

Where access with the brick axe was possible, though not to hew, or chop, with it, then it was used in a 'paring' manner similar to a carpenter's use of a wood chisel to gouge out the desired profile. The cut and rubbed work at Someries Castle, near Luton (Bedfordshire) and Kirby Muxloe Castle (Leicestershire) (see Case Studies Kirby Muxloe) are excellent examples of the use of these axing techniques. Someries Castle, or as the locals call it, 'Someries', is the ruins of a once sumptuous courtyard house, which as Smith (2005, 2–5) relates, '…was started by John Lord Wenlock (*c.*1390–1471), almost certainly in or about 1448'. Building work was, however, interrupted and then resumed again around 1460 but was left unfinished at Wenlock's death at the Battle of Tewkesbury, in 1471, during the 'Wars of the Roses'. The use of hewn brick for the moulded dressings on the handsome brickwork of this building is prolific. The hewers at Someries followed similar axing styles, in how they worked and finished their canted, convex and concave cut-moulded bricks, to those of the craftsmen working at Kirby Muxloe Castle; though the parallel axing marks at Someries are not maintained in quite such a disciplined fashion.

The question should be asked as to why the hewers work the plain face of a medieval or Tudor brick in the first place, when only needed for a quoin

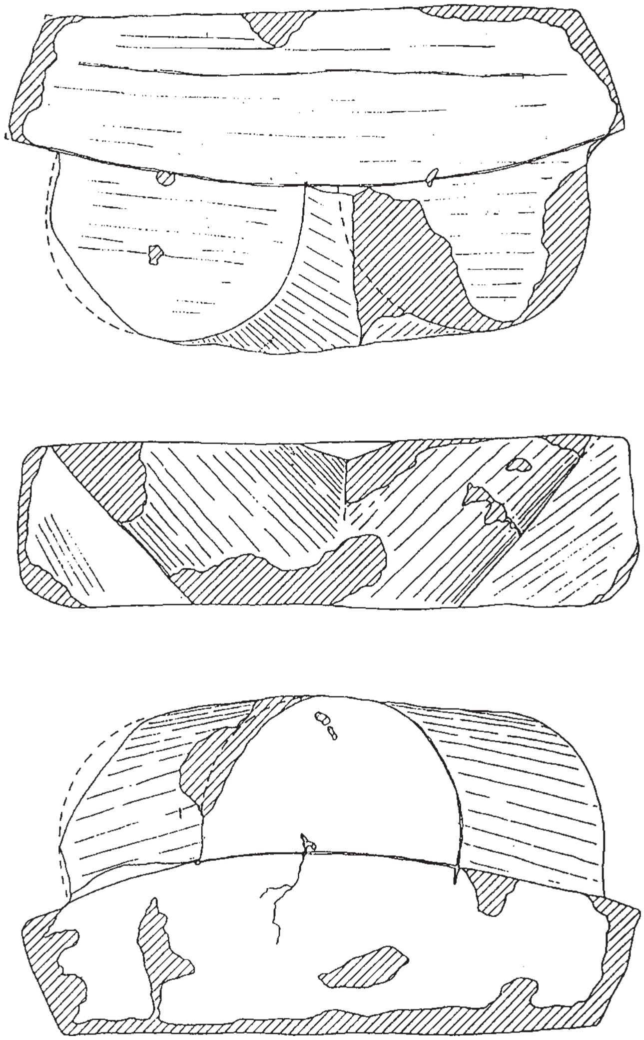

Figure 22

A drawing of views from above, in front and below, of the early Tudor chimney brick from Bridewell Palace, London, 1515–23. (Courtesy of Terence Paul Smith)

stretcher or the cut-splayed header? The answer may not be just one of aesthetics, it might also lie in how bricks of this period were moulded, as described above. The excessive moisture content in the 'slop-moulding' process meant once the green brick was de-moulded it could settle downwards into its bed, giving a slightly swollen or 'bloated' face. This, the hewer would have sought to dress to provide flat faces approximately square to each other. Wight (1972, 101) incorrectly states that 'Tudor brick was much harder than modern brick'. It is noticeable that most hewn bricks often tend towards orange in colour, simply because these would have been the selected baked bricks, sound in quality, yet possessing an easily worked body; ideal for cutting, carving, and abrading. It would, however, be a mistake to believe that only orange coloured bricks were, and are, capable of this work, the nature of the brickearth and clay can also produce red bricks that numerous examples show are eminently capable of being cut, carved and abraded too.

How the brick axe developed is lost in the passage of unrecorded history, yet it is possible to put forward a plausible theory based on practical experience of working post-fired brickwork and of re-examining craft tools and techniques no longer used but historically associated with such work. As stated above, masons/hewers would have adapted their tools for suitability of purpose and the varying types of wooden-handled stone axes in use during these periods would have been unwieldy. They generally require two hands to use them and would have produced too heavy an impact on the brick. 'Hafting' does, however, endow a tool with better control.

A series of tests carried out using a blacksmith-made facsimile of a fifteenth-century brick axe provided evidence on axing both ashlar and moulded enrichments. This work was undertaken to assess the true practicality of using a brick axe, in order to help develop a better understanding of the reasons for the development of this unique, and once highly-prized, hewer's tool (see case study, p. 52). Also to gain a better understanding of why the bricks were being worked in the manner described above.

Using one hand to hold the brick was, and remains the preferred craft technique for cutting and shaping, so there would be a desire to work with a small cutting tool that would facilitate this practice (Fig. 23). It is quite reasonable to imagine the craftsman ignoring the hammer, yet picking up a wide-bladed 'bolster' by clasping the shaft, so the blade emerges beneath the hand, and

Figure 23

Author axing a cut-moulded brick for a Hampton Court Palace chimney.

proceed to chip away at the brick, removing waste and developing the desired profile and finish.

Testing this process revealed that, although it works to some degree, it is not practical, because bolsters are percussive tools to be struck by a hammer. It also proves uncomfortable, poorly balanced, and requires much effort to make up for the lack of tool-weight over the cutting-edge; negative factors that would have been apparent to the medieval craftsmen. The development of a sharp double-bladed bolster, thus creating the brick axe, is both a logical and practical outcome of such a situation (Fig. 24).

Figure 24

The finished axed moulding against its templets with the brick axe.

Nathaniel Lloyd (1925, 73) remarks that experiments undertaken with a brick axe in the hands of a bricklayer expert in the use of a 'scutch' (see pp. 274–5) revealed it to be 'far inferior to the latter in handiness'. Tests on the use of the brick axe also invited comment from several skilled bricklayers and two stonemasons, who were all previously unfamiliar with the tool. After initial tuition with the author, its use was highly praised by all parties; somewhat surprised and impressed by how it performed. Hill (2001) stated that the brick axe was:

> …awkward to use at first, but with a little practice became easier. In particular, working in an arc so as to use only about half the blade width at once proved very satisfactory, and removed material more accurately and more easily. There was also much less tendency to pluck.

The overall opinion, therefore, was of a well-balanced and comfortable tool with good control and very effective in executing tasks for which it was designed. The double-blade, it was agreed, served several purposes. Firstly, as described above, it gives balance either side of the handgrip. Secondly, forging two blades saves metal for a given weight of material. Thirdly, it gives weight above the lower cutting-edge and behind the blow being delivered. The final advantage is the benefit of an extra blade, sharp and ready for immediate use as the other blade dulls, requiring the attention of the blacksmith only half as often.

This latter point is of importance, as even though the bricks selected for cut and rubbed work were relatively soft, they still caused the edge of the brick axe to dull rapidly. This accounts for the large number of brick axes being used by the hewers and frequently sharpened by the blacksmiths. Contemporary accounts for Kirby Muxloe Castle (Leicestershire), reveal sharpening every two or three weeks in the winter of 1482 (Hamilton-Thompson, 1920, 293–4):

> Monday 18 November…
> Smyth, …For sharpyng 10 dosen axes with Chesell and other
> Tooles, at 2d [a dosen]…20d
>
> Monday 9 Dec[ember]
> Smyth, …for sharping 12 dosen axes with Chesells and other
> Tooles, at 2d…2s 0d.

The sharpening of brick-axe blades and other cutting tools was not just a simple matter of grinding on a grindstone, as at York in 1499 where Salzman (1967, 337), says the blacksmith was paid:

> Pro les gryndyng les axes et tules", or for the grinding of axes and tools.
>
> This type of sharpening would be executed on what Salzman says was "a great round stone…." Called a 'gressour' or a 'gryndelston'.

It was generally accepted that it took one blacksmith to keep three masons continually provided with tool care (Coppack, 2002), including re-working the edges of cutting tools, by what was then termed 'bateracione', or 'battering'. (Salzman, 1967, 337) quotes a payment:

> …to Katherine the smith-wife for steeling and battering of the masons tools.

The forging and sharpening of a hewer's brick axe would clearly have been the skilled work of a blacksmith. It is a complex, yet very interesting subject and one that is worth exploring if we are to gain a deeper understanding of the brick axe (see case study, p. 60).

Axing Technique in Practice

Why hewers axed their bricks in the manner they did becomes apparent when testing the brick axe in use. On a brick face the diagonal axing strokes would appear to be based on achieving flat faces, square to one another in the simplest, swiftest and most effective manner. In preparing stone, a mason looks first to work the surface flat, the accuracy of which is vital so that the other planes and angles related to it will not be thrown out. Due to the normally large size of stone this typically involves using a mallet and chisel to work down, about 25 mm, two flat draughts, or drafts, at opposite sides. Once formed and checked, the mason will then work across the face of the stone, one side to the other, using the original draughts as guides. The surface is then cleaned with the boaster and drag and the flat surface checked by using a straightedge diagonally from corner to corner.

Hewers working a narrow face on a brick (in comparison to stone) simply followed an older stonemason practice from the eleventh and twelfth centuries when working with a stone-axe, evident in studying the stonework of this period (Colvin, 1982, 333–4):

> With their unmistakable axe-tooling, diagonal on flat surfaces…

They worked the face of the brick down using the brick axe diagonally between two prepared adjacent arrises (edges) cut to answer to the templet, therefore flattening, checking, and presenting a textured, or 'axed', finish across the full width of the face of the brick, all in the one action. It is important to remember that with the normally large width of the bed joints on brickwork of this period, it was not absolutely vital that the worked face was exactly 90° to the bed face. This could be 'taken up' by altering the bedding of the brick into the mortar during the laying process, tilting it backwards or forwards to achieve 'face-plane' to the surrounding facework. Where it was necessary to have the face at 90° to the bed, this could be achieved by marking up from the bed on to the header face at either end with the 'try-square'. One could then scribe the two lines across to meet one another along the top of the brick, and then 'work' the brick face 'true' to those marks.

Practical tests, as discussed above, appear to indicate that the brick being axed to finish would sit flat on a sturdy workbench, historically termed the 'chopping-block'. It would be positioned face up and resting on what is traditionally termed a 'softing', usually some thick hessian sacking that helps to take the jarring action of the blows, thus preventing the brick being damaged.

The brick is positioned and held at the desired angle, rather than turning the blade of the axe, so that the brick axe is used with its blades parallel to the hewer rather like an adze, thus producing the diagonal axing marks on the face of the brick. The brick axe, used in a chopping-action, is worked from the top to bottom corner towards the hewer, which allows the cutting surface to be seen and position of the blade to be judged to maintain parallel lines. Care needs to be exercised when starting and finishing to prevent dislodging the corners, where it is found best to utilise the side edge of the axe blade, gradually utilising the centre of the blade as one crosses the full width of the brick face.

Tests on working mouldings also served to confirm the two methods proposed above. For 'squints', 'cants' and 'shouldered-bullnose' brick shapes, the axing method would remain diagonal to the stretcher and header faces; but like all individual craft techniques, however, they could vary and be worked vertical, and occasionally some bricks studied show a very random cavalier use of the brick axe. For more ornate profiles, such as curved and projecting enrichments, the axe strokes would either be horizontal, vertical or parallel to the shape produced (Fig. 25). This would be achieved by working the outline of the desired profile at either end of the brick, having first cut out waste shapes with the hand saw, and then axing the profile required at either end, treating them as draughts. Once exact, the whole brick face is axed and abraded to shape from one side to the other.

Figure 25

Cut-moulded voussoirs displaying various styled axing strokes at Kirby Muxloe Castle (Leicestershire), 1483.

With the rope mould for the chimney brick, described above, the first stage is to remove all the waist brick above the scribe lines and either roughly axe the straight sections, or simply cut them off with the small hand-saw. The saw is then used to cut a series of parallel vertical slots finishing each just above the scribe lines, allowing these slender sections of waste to be easily snapped off. The brick axe is then used to hew out the general shape, using increasing care as it gradually works the surface close and true to its templet shape. The final sequence being the dressing or finishing of the face with the axe strokes running parallel to the angle of the rope mould, as shown in Fig. 22.

The aesthetic choice as to whether to leave axe, saw, or drag, strokes visible on the brick face or rub smooth (more easy with low-fired historic bricks than their modern counterparts) is (as it was in the past) down to time, finance, the final viewing position and level of craftsmanship.

The significance of the brick axe to the Tudor city bricklayer is evident by studying the design of the coat of arms of the Worshipful Company of Tylers and Bricklayers; granted the first of their four Royal Charters by Queen Elizabeth I on the 3rd August 1568 (Bell, 1938, 18). Though as Smith (2003, 5) states the company: '…traced its ancestry back to the time of Richard II (1367–1400), although at first it was a guild of tilers only.' The extended arm above the armorial shield shows a hand clasping a brick axe, as opposed to the brick trowel one might expect to see. Company rules excluded 'aliens', emphasising that, by then, the best native craftsmen (and not just the Flemish) were very capable of working bricks post-fired. English craftsmen must always have had the opportunity, even in the earliest times, to learn from Flemish 'hewers'. This fact is clearly shown in a letter of *c.*1440 concerning the preparation and cutting of an ornate chimney at Havering-atte-Bower (Essex), as reproduced by Ryan (1996, 57):

> Ye well ordeyne me a Mason that ys a ducher or flemyng that canne make a dowbell chemeney of ye brykke … and yf ye may no fflemyng have then I wold have an engelesche man and he were a yong man for a yonger man ys sharpest of wittes and of cunnynge [skill],

Abrasives

The rubbing of both individual bricks and completed enrichments, to achieve shape or finish on cut and rubbed brickwork, is a practice again steeped in the traditions of stone masonry; particularly of working soft stone. For abrading bricks on the banker, depending on the relative hardness of the individual bricks and the detail the craftsman was shaping, the hewer might use an appropriately sized metal file, rasp, 'riffler', or even timber.

Files

The many tiny chisel-like teeth of the metal file all point in the direction in which it must be pushed in order to be effective. According to Salaman (1975, 619):

> A treatise of 1100AD mentions files of square, round, triangular and other shapes. At this time files were made of carburized steel that could be hardened after completion of the cutting, which was done with either a sharp, chisel-like hammer or chisel and hammer.

Files would have been used for finishing, as little material is removed with each stroke. They are also suited to smoothing a rough workpiece or altering its shape in substantial detail.

Rasps

Rasps, or more correctly rasp-cut files, have a series of individual teeth produced on the abrading surface of the metal by a sharp, narrow punch-like chisel. The resultant rough-cut is suited to soft substances, such as wood, soft stone, and brick, and allows the fast removal of waste material and cleaning of small areas.

Rifflers

Rifflers are simply small rasps, of varying degrees of fineness, on a stem shaped to a variety of configurations used for cleaning and smoothing small and difficult parts of a worked soft stone or a cut-brick moulding.

Alternatively he might use suitably shaped hand-held stones, or a suitable piece of wood as an abrasive.

Hand Stones

These various abrading tools would only have been used within the cutting shed to prepare the cut brick prior to setting. The hand-held stones could, however, be used in the workshop and where desired, finish the brick surface *in situ*. Generally sandstone would be preferred and the stones could be square, oblong, flat or curved, or cut to the reverse profile of a moulding by the mason or brick hewer, to suit the purpose. Clearly for most medieval and Tudor post-fired brick dressings, hewers were happy to leave the axing strokes visible. When necessary, as on the inner window voussoirs to the north circular stairwell of the guardroom at Kirby Muxloe Castle (Leicestershire, 1483), the brickwork was clearly rubbed to follow the inner curve of the walling, so leaving a smooth-abraded finish.

It has been frequently suggested that bricklayers may have substituted part of a brick for hand-held stone to rub over the finished brickwork. Occasionally this may have taken place, but experience dictates it was not common, as a brick abrasive wears away relatively quickly, reducing its effect, and creates double the hazardous dust, all avoided with a proper hand-stone.

Timber

The use of a suitably sized and shaped timber batten may appear to be a strange abrasive, but practical experience has demonstrated that it can serve to abrade a surface providing the brick is relatively soft textured and the wood is sufficiently hard and has a pronounced grain. As the timber is rubbed across and along the surface of the brick, the resultant dust sits between the timber and the brick serving as an additional abrasive too.

Summary

The Medieval and Tudor periods witnessed brickwork firmly establishing itself as a rival to stonework for the masonry of properties belonging to aristocrats and wealthy landed gentry. Through foreign influence, and primarily that of the highly skilled immigrant Flemish bricklayers, the best of these men established post-fired working of bricks (primarily using brick axes, hand-saws, appropriate mason's tools and abrasives), began to rival the work of the stonemason on late Gothic enrichments. The craft practices that developed subsequently were the culmination of vernacular traditions dictated by available materials, budget, and time constraints imposed on the project, and the all-important levels of skill, knowledge, and ingenuity that individual craftsmen imparted to their work.

Case Study: Repairs to Axed Work at Kirby Muxloe Castle (1480–84), Leicestershire, England

Background to Project

By Nick Hill, Project Director, English Heritage

Constructed in the closing years of the Middle Ages, Kirby Muxloe Castle is one of the finest brick buildings of its period. It was built for Lord Hastings, a prominent supporter of Edward IV, in 1480–84. However, the castle was never completed, as Hastings was executed on the accession of Richard III in June 1483, and building work stopped soon afterwards.

The castle was planned as a rectangle, with square towers at the four angles and a gatehouse in the middle of the north-west side. Only the west tower and the gatehouse survive, together with the main moat walls. The west tower still stands to its full height, an impressive crenellated structure. An oak bridge over the wide moat approaches the massive gatehouse, its drawbridge protected by gunports to give flanking fire; some of the earliest in the country (Fig. 26).

Almost the whole of the structure is built of brick, with stone used only for the surrounds to principal doorways and windows, together with stringcourses and copings. Brick was used only for buildings of the highest status at this date, and Kirby Muxloe is Leicestershire's earliest surviving brick building. The brickwork craftsmanship is of superb quality, with shaped bricks used in a wide variety of ways, for angled corners, splayed and moulded openings, chimneys and – most impressively – vaulting to spiral stairways. Complex patterns

Figure 26

Kirby Muxloe Castle (Leicestershire), 1480–84.

are formed with blue brick headers, mainly of diaper type, but Lord Hastings' initials 'WH' can also be seen on the front of the gatehouse.

Kirby Muxloe's historical importance is given further significance because an exceptionally detailed set of accounts survives, giving fascinating insights into the original construction process. The master mason is named as John Cowper, who came from Tattershall in Lincolnshire, the location of another slightly earlier major brick-built tower, Tattershall Castle. Bricks were made near to the site, under the supervision of Antony 'Dotcheman', probably a Fleming. Antony is later found in the accounts working as a bricklayer, presumably again in a supervisory role. The accounts specifically mention 'brick-hewers', who must have been cutting bricks to the necessary special shapes. This is a rare glimpse of how the skills to create the new style of brick architecture were transferred from the Continent to English craftsmen.

After the abrupt abandonment of work in 1484, the castle was left untouched for over four centuries, a rare instance of the survival of original early work without later alteration. In 1911 the owner placed the property in the guardianship of the Office of Works. A major programme of repair was carried out in 1911–13 under the direction of Sir Charles Peers and Sir Frank Baines. This was one of the first such programmes of work carried out on a national monument, and it played an important part in the development of conservation in the early twentieth century. Extensive repairs were made to the brickwork and the moat was recreated.

These thoroughgoing repairs lasted well, but by the 1980s the need for further repairs was becoming evident. A number of minor programmes of repair were carried out in the 1980s and 1990s, which helped secure various parts of the fabric. However, deterioration continued to escalate, particularly to the areas that were most difficult to access, at high level and over the moat. Condition surveys in the late 1990s showed that the west face of the gatehouse and the upper parts of the west tower were now in a serious state. Lamination of the brick faces was starting to escalate, and structural cracks were developing to the top of the west tower. Erosion of brickwork at the waterline of the moat was also severe.

It was clear that a major, co-ordinated programme of work was needed. In order to erect scaffolding for the west face of the gatehouse and the west tower, it would be necessary to drain sections of the moat, a considerable undertaking. A three-phase programme of work was organised, tackling first the gatehouse, then the west tower and finally replacement of the decaying oak bridge. The overall project budget was £0.5 m.

The English Heritage team, consisting principally of Senior Architectural Assistant Gurdev Singh and Inspector Glyn Coppack, had considerable experience of the repair of ruined brick monuments. The Inspector made inspections of the previous programmes of repair, alongside the preparation of a conservation plan. It was quickly recognised that the exceptional importance of the early brickwork demanded a very careful and considered repair approach. Close inspection showed that none of the various twentieth-century repairs had matched the high quality of the original brickwork. In particular, the shaped bricks had been dressed rather crudely with a brick hammer, rather than matching the original fifteenth-century finish.

It was agreed that expert advice was needed on this specialised aspect of the repairs. A site meeting was arranged with Gerard Lynch, well known for his expertise in the field. He was able to firmly identify the precise techniques used and to explain how to replicate the original finish, with use of the traditional brick axe. Supply of special matching bricks was also considered at this early stage, and a visit arranged with Peter Minter of Bulmer Brick & Tile Ltd. An early order was placed to ensure bricks would be supplied in good time. A total of 15,000 bricks were used during the whole works programme.

The specification for the first phase of work could now be drawn together with confidence. Detailed drawings were prepared to show the exact extent of the brick repairs on each elevation. Wherever new shaped bricks were to be used, it was specified that these would be cut and hand-dressed with the brick axe on site, not supplied as ready moulded specials, or dressed with modern tools. Shaped bricks were needed principally for the cut-moulded surrounds to openings, angled corners, plinths, and repairs to brick vaulting. It was agreed that the specification should include for training sessions of the workforce with Gerard of the appointed contractor so that the brick-axing technique could be properly learned and applied on site (Fig. 27). Competitive tenders were sought for the work from a shortlist of selected contractors, and Midland Masonry Ltd were duly appointed in 2004 to undertake repairs on the gatehouse, and afterwards the other two phases of work on the west tower and bridge.

Figure 27

The author introducing one of the masons to the brick axe and training him in its correct use to help re-create the same tooling marks on the remedial work as are on the original fifteenth-century cut-moulded bricks, at Kirby Muxloe Castle (Leicestershire), 1480–84.

Background of the Contractors

By Pam Oakden, Area Manager, Midland Masonry Limited

Midland Masonry Limited is a leading conservation specialist who have restored and conserved cathedrals, churches, castles, estates, public and private buildings. It can mix the traditional skills of bricklayers, stonemasons, carpenters and joiners, roofing specialists and lead workers with today's technology. It uses, wherever possible, authentic materials and works closely with its clients throughout the project to ensure satisfaction.

The experience and expertise within Midland Masonry Limited enables it to undertake the most intricate and demanding projects, each individually assessed and teams assembled to meet the particular skills and expertise required.

In 2005 Midland Masonry was commissioned to restore and consolidate the South Tower, which required extensive structural work to safeguard it. The high parts of the tower were secured with stainless steel ties to prevent collapse. Large sections of the chimney had to be re-built using a mix of the original bricks and new hand-shaped and tooled squint bricks. The company's skilled craftsmen, under lead mason Roy Harvey, could then begin to repair and where necessary renew the patterned and specialised shaped bricks to the spiral staircase and large sections of the brick newel post and vaulted ceiling. Also the doorways to the South Tower had extensive erosion to the moulded jambs; many shaped and tooled bricks were cut and rubbed by hand to restore these important features.

The Practical Work

By Roy Harvey, Site Manager and Lead Fixer Mason, Midland Masonry Limited

As stated above, the remedial work to the cut and rubbed brickwork to the West Tower centred on:

- Two entrance doorways at the bottom, one leading to the base and the other to the spiral staircase, which had widespread spalling of the cut-moulded bricks. This was to the full height up to the springing position of the right-hand jamb on one opening, and the cut-moulded voussoirs of the two-ring, 'ordered' arch on the other doorway.
- Spalled cut-moulded voussoirs of the segmental arch of the entrance, from the spiral staircase, onto the 2nd floor of the tower.
- Spalled and fractured area/s of the cut-moulded brick newel and section/s of some of the brick 'ploughshare' vaulting of the spiral staircase where it mitred into it, in the tower.
- The repairs and replacement brickwork to the large cut-moulded chimney shaft at the top of the tower.

This work was deliberately scheduled for the months between April and September, when there is no fear of frost, good drying weather and length to the daylight. To undertake these remedial actions, depending on the size of the particular element of brickwork and the intricacy of the work involved, we might assign up to four or five craftsmen. Their varied tasks would involve recording the work, creating templets, taking down, cleaning, numbering, storing and salvaging bricks, as well as one or two masons to cut and rub the bricks and others to re-build the brickwork being repaired or restored.

All of the above enrichments to be worked on had already been identified and indicated on working drawings from English Heritage. My team then carefully recorded these individually before any brickwork was disturbed. In the case of the arches, our joiners accurately made timber centres to support them during work by being propped and wedged into position and upon them all voussoir positions carefully marked before dismantling. For the remedial works to the newel and the vault brickwork mitring into it was necessary to provide support whilst decayed bricks were cut out and new cut-moulded newel bricks and vault bricks were carefully inserted. For the newel bricks this was done by looking at the bond and determining what could be carefully cut out and what bricks could be left to provide support, perhaps 10 out of 20 bricks. The vault brickwork need planning and depended on whether individual bricks or a small patch of bricks needed to be repaired. With the latter laths bent to shape and fixed to the surrounding brickwork provided sufficient support.

Recording took several forms. We would take several photographs of the brickwork to be repaired or restored. Sketch drawings would also be made and on them all relevant measurements such as lengths, widths, heights, angles etc, would be written and individual bricks given a fixed number to its position. Templets of card were then made from the cut-moulded bricks needing new replacements. This was best achieved on a removed original by both measurement and by tracing around it onto the card. This tracing would then be carefully lined-in using a pencil and ruler etc, then the shape would be cut out and labelled for its identification related to the drawing.

With recording complete the brickwork was carefully dismantled. Where necessary a tungsten-tipped hand-saw was used to cut through the mortar beds to aid release of the bricks, cut out to follow bonding. All the bricks being removed were carefully cleaned of old mortar, by gentle scraping, scribed with a number linked to the drawing; and where possible salvaged to be re-laid back to its original position within that element of brickwork being repaired or restored. The remaining brickwork was then carefully cleaned of old mortar with hammer and tungsten-tipped masonry chisel and dusted clean in readiness for re-building.

The soft rubbing bricks necessary for the cut and rubbed work were selected out of the general delivery stock for this contract of 15,000 low-fired bricks, of two different sizes, chosen by English Heritage to match the original fifteenth-century bricks. We set up a cutting bench as near to the brickwork to be repaired or restored as practicable. The first process was to square all the bricks by rubbing bed and face on the large rubbing stone and checking with the try square prior to scribing and cutting to shape. We had the choice of three large slabs of 'grit stone', coarse, medium down to a fine grade; all of which would be placed on the bench to do this. Each squared brick was then scribed to its templet and cut using the saw to remove straight lengths of material. Next the brick would be cut to shape, by holding the brick with one hand as it rested on an old carpet to prevent the brick being damaged, and carefully hewn to the approximate scribed shape using the scutch hammer in the other hand. The final shape was then achieved by careful abrading by the skilful use of the mason's drag, held with both hands in a side-to-side fashion, just as is sometimes done on some soft limestone.

The final finish, which was particularly important to achieve and match precisely the aesthetics of the original fifteenth-century cut and rubbed brickwork, was achieved by the use of the Brick axe. Pam Oakden, our area Manager, had several of these made by a traditional Blacksmith in Derbyshire, 320 mm in overall length with 100 mm long sharp blades. Though these followed the pattern we obtained from Gerard, they were made with octagonal faceted rather than smooth handles to improve grip. Having had training with the use of the Brick axe we could have used them to cut-mould the bricks, but we were more familiar, and therefore faster, with our scutch hammers. We therefore used the Brick axes to carefully dress the brick faces to the specified finish by carefully chopping across and along the brick faces to create a series of parallel blade marks that were diagonal across the plain or flat faces, and straight on the convex or concave curved profiles (Fig. 28). These axes held-up pretty well but occasionally needed to be re-sharpened so that they had the keen cutting edge necessary to create the 'axing' marks; and this was done by us using the fine grit stone.

Figure 28

Finished remedial work at Kirby Muxloe Castle showing the axing marks on the cut-moulded jamb bricks to match the original.

Re-building all of our cut-moulded work into the various elements involved careful setting out. For the work on the arches the cut-moulded voussoirs had to be laid back to the positions marked out on the centre. For the jambs of the openings it was vital to re-establish the first few courses of bricks to line, level and gauge and then strain lines up to the springing position to ensure the work was built plumb. The work to the newel and vault brickwork required a differing treatment. For the newel it was a matter of carefully laying the cut-moulded bricks into the prepared pockets on full beds of mortar but no cross-joint against the other decayed bricks needing to be removed. These were allowed to set so that these adjacent decayed bricks could then be carefully removed and their new replacements laid. On the vaulted brickwork the manner of replacing bricks varied with whether it was an individual or several bricks. With individual bricks it was simply a matter of placing the brick into a prepared pocket, with plenty of mortar to the rear and sides, and then wedging it in the bed and cross-joints with slate tapped back to allow for full and flush pointing. Where a number of bricks required laying these were laid with full flush joints over the lath formwork. For the chimney it was a simple matter of laying the bricks to bond so that they were set level line, and plumb, and laying the corbelled course accurately for the terminal capping.

Figure 29

Finished remedial work at Kirby Muxloe Castle showing the axing marks on the cut-moulded newel bricks and ploughshare vaulting to match the original.

All the brickwork was re-built using a specified NHL 3.5 moderately hydraulic lime binder from Castle Cement, mixed with a blend of two units of soft building sand and one of grit sand. There was no fixed ratio as we were very much governed by the need to aesthetically match the varying historical mortars of the brickwork surrounding our remedial works on the different parts of the building. All existing brickwork to be built on or against was brushed clean of dust and well dampened, using a sprayer. The bricks to be laid were also dampened the same way to reduce porosity, allow it to be bedded and adjusted and improve bonding characteristics. Each brick was laid to line, level, gauge and to neatly run on from the previous moulding, on a full bed of mortar with fully filled cross-joints. The specified joint finish was for the mortar to be cut back from the arris and then stippled with the 'Churn Brush' to create an exposed aggregate and pleasantly weathered appearance. Timing is essential with this joint, so that the brickwork was not stained by lime, and was dependent on the weather. On a warm sunny day one would finish the joints later in the afternoon, once the mortar had 'hazelled off' or stiffened, while with dull, damp and cool weather this would be done the next day. The brickwork was protected from drying out too quickly and aid curing of the lime mortar by covering with damp hessian sacking, and polythene sheeting was used if the weather became inclement.

As someone who spent many years working as both a bricklayer and a fixer-mason, I am in no doubt we need to ensure that the future craftsmen and women come out of their period of training fully-equipped with the knowledge and skills of traditional and modern building practices. Sadly the recent trend for modular college-based training to provide for modern site needs rather than time-served fully rounded apprenticeships, on-site with additional college education, is not helping this situation. Neither is the move away from companies and organisations directly employing a well-trained and qualified workforce, who are given the time to do their work properly, for the increasing use of sub-contracted labour. All old buildings, not necessarily a listed building like Kirby Muxloe Castle, that require repair or restoration, demand that those working on them possess knowledge of the historic materials, tools and equipment, and the skills of how to use them, so that work can be executed sympathetically to the original. We not only should pass on these old buildings to future generations in a good state of repair, but also our historic crafts; for both are part of our nation's heritage.

Case Study: Traditional Forging and Sharpening of Brick Axes

By Jay T. Close, Professor of Architectural Metal, American College of the Building Arts, Charleston, South Carolina, USA

Overall, I think the world of reproducing period tools with period materials and techniques and then putting the products to use 'in the field' is wide open. I know from experience that modern woodworker's may stress their tools beyond what would have been possible in the pre-industrial past. Modern materials used in tools even of traditional form often lead to modern work habits that do not reflect period practice. If we are interested in how the old tradesmen worked, the experimentation must be done with period appropriate tools of period appropriate materials. We may find it makes no difference and that the old tool works just like the modern one; but that is knowledge, too.

Nothing I state should be construed to suggest that historical tools were inferior. Yes, the materials were relatively unsophisticated, but the finest edge tools in the world, the exquisite Japanese temple carpenter chisels and plane blades, are still made of the same basic materials: wrought iron bodies with forge welded simple carbon steel edges. It is possible to abuse a tool and stress it beyond its limits; any tool used unskilfully is vulnerable. Presumably, the time-served tradesman of the past was sensitive to the limitations of his tools and adapted his work practice to accommodate them. Bear in mind that the cost of hand tools, even within the past century, was a much greater percentage of wages than today. A careful tradesman husbands the tools that provide his living.

I have examined at some length two period brick axes from the collection of Richard Filmer. I have even attempted my own reproduction using wrought iron and a relatively simple, high carbon steel. Being in the employ of the Colonial Williamsburg Foundation for over 13 years, I focused on eighteenth century work, primarily woodworking tools of English or Anglo-American manufacture. I have made bench chisels, mortising chisels, plane blades, carving tools, carpenters' claw hammers, hatchets, felling axes, broad axes, draw knives, center bits and probably a host of other stuff I no longer recall. All were put to use, so I have had good opportunity to observe how they held up, how they wore, how they endured use both skilful and otherwise. The degree to which my speculations apply to prior centuries and the technology of mason work is an open question. I suspect that the technology between 1500 and 1700 was little altered. I may be sticking my neck out, but I am pretty confident in the broad accuracy of my observations.

There is much misinformation about the nature of ferrous metals in an historical context. It would be good to sort some of this out at the beginning.

By the time period you are interested in, there were three iron-based, or 'ferrous' metals: (1) what was commonly called 'bar iron' or 'wrought iron'; (2) steel; and (3) cast iron. By way of definition, cast iron, is iron with between 2% and 6% carbon in it. The carbon makes the material brittle, easily cast but unforgeable. It is of little interest to us.

Cast iron came into it's own with the development of artillery. It was the availability of cast iron that enabled England to lead the way in the production of cast iron canon for a century from the time of Henry VIII.

'Bar iron' or 'wrought iron' was of greatest importance. This was an almost pure iron bar stock that had significant silica content. That silica was not chemically allied to the iron but ran as long, thread-like inclusions through the bar giving it a linear grain similar to a piece of wood. Also like a piece of wood, the bar was relatively strong when stressed in one direction relative to the grain and weak when stressed in the other. In the better grades of bar iron, the silica content was minimized by working the material at white heats to squeeze out as much of the liquefied silica as possible and reduce what remained to finer and finer threads evenly distributed through the bar.

This was the basic bar stock of the smith from the beginning of the Iron Age until the 1870s. It was tough material when well refined, soft under the hammer when hot and it welded at the forge beautifully. The best grades are a dream to work. As wonderful as this material is, it makes poor quality edge tools. There is, however, an ancient ferrous material called 'steel' that can be manipulated to produce long-wearing and effective cutting tools. Make no mistake, steel is nearly as ancient as iron in human history.

Technically speaking, steel is iron plus a relatively small amount of carbon. Even trace amounts of carbon can strengthen a bar a little, harden a bar some and lower its melting or burning temperature by a couple of hundred degrees. Yet, material with such low carbon content would not have been thought of as steel in the pre-industrial age.

Steel, in the historical context, is a ferrous material that was capable of hardening by quick cooling from a red heat – an effect imparted by carbon content in excess of about .35% (that is thirty-five one hundredths of one percent by weight) and to perhaps as high as 1.25% carbon. To a point, the more carbon in the steel, the harder it will become. Also, up to a point, the quicker you can cool it, the harder it will be rendered: cool in the air and leave the bar soft; cool in water and make it quite hard; cool in oil and achieve a mid-range hardness.

In the period, no one knew with scientific certainty what it was that made steel harden in this way. Modern experiments have shown that the ancient 'bloomery' furnaces that smelted iron in the Middle Ages were perfectly capable of making steel, too, when operated in an appropriate manner. Yet, why some bar was soft to hammer and others resisted the hammer blow, why some bar burned at a lower temperature than others and why some would get brittle hard when quenched in water from a red heat was little understood. To add to the mystery, smiths found that once a bar of steel was made hard through quenching, the effect was completely reversible – just heat the bar red-hot again and let it slow cool. It will be soft once more.

Yet, lack of sophisticated metallurgical science did not inhibit smiths from practical knowledge. Moxon, writing at the end of the seventeenth century [*Mechanick Exercises: or, The Doctrine of Handy-Works, of Smithing in General, d.*1678], was well aware of the characteristics of steels from different regions, how to identify each and the sorts of work each was best for. Theophilus, writing in the twelfth century, describes small tools made entirely of steel and provides guidance for hardening larger files without scaling or decarburizing their fine cutting surfaces (always a danger in the oxygen rich forge fire).

This wondrous material, steel, was a boon to the smith, the consumer and to the tool user. Bar iron will simply make poor edge tools. Like most metals, iron will stiffen from cold hammering, but it will never take an effective cutting edge. Steel, on the other hand, can be forged to shape, slow cooled to leave it soft and then filed, polished, engraved or otherwise dressed and improved. Then – as a final step – it can be re-heated and fast-cooled to produce the desired hardness for a given application: from glass-hard, through springy, to soft but tough.

As in all things, there is no free lunch. The harder the steel the more brittle it becomes. While the same steel might make a 'burin' ['graver'] for copper-plate engraving (very hard) or a spring (soft but elastic), each use demands a different degree of hardness, each has a different tolerance for brittleness. Well before the eighteenth century smiths discovered that they had great control over the final hardness of steel if they first made it as hard as possible by quick quenching from red heat and then carefully re-heated the steel to a lower temperature in the 300 to 600 degree F range (149 to 316°C). This pulls away the excess hardness that weakens the tool and leaves behind just the needed hardness for the tool to function well. To quote Moxon concerning newly hardened steel: '….you must *let it down* (as Smiths say) that is, make it softer by *tempering* it' (Moxon, 1678, 61).

This second heating, 'tempering', in Moxon's terminology, modern smiths also call 'drawing' or 'drawing the temper'. The higher this second tempering heat, the softer the steel was left. The smith judges forging temperature by the incandescent colour of the heated iron; tempering heats are judged by the development of oxide colours on polished steel: yellow or straw, bronze or brown, purple, peacock blue, pale blue and then grey as the temperature increases. Smiths could also selectively temper different parts of a tool leaving some areas relatively soft and tough, other parts harder.

While I mentioned that the early bloomery furnaces could make steel by direct reduction of iron ore, a more readily controlled process called 'cementation' developed as well. I think this accounts for most large-scale steel production by the Renaissance. In this process a piece of quality iron was surrounded by a carbonaceous material – often charcoal – and packed inside a heat resistant, closed container to exclude oxygen. The container and its contents were brought to glowing red temperature in a furnace and held at temperature for a lengthy time, perhaps days. Heated in the absence of free oxygen the iron absorbs carbon from the materials packed around it. Heated long enough, the iron will absorb carbon into its core. The result is a low grade of steel with uneven carbon content. The British referred to this in the eighteenth century as 'blister steel'.

The distribution of carbon in blister steel can be improved by both mechanical and chemical means. On the one hand, the bar was cut into pieces and then those pieces redistributed. The rearranged bar would then be re-consolidated by welding at the forge and anvil. This cutting, rearranging and welding might be repeated two or three times to the improvement of the material. Chemically, however, there is another process occurring called 'carbon migration'. The carbon in a rudimentary piece of steel will naturally seek an even distribution, moving from areas of high carbon content to areas of low carbon content. So, just heating and forging a piece of blister steel will improve it. Moxon, writing about 1680, writes of steel, its use, shaping and heat treating in terms that any modern blacksmith will easily understand. This is ancient, traditional knowledge that by Moxon's time was centuries old.

Steel is desirable and available but expensive. It is unusual to find an historical tool of any size like a brick axe that is composed entirely of steel. Instead, the common strategy was to make the bulk of the tool from bar iron and weld a piece of steel only where it was needed, typically along a cutting edge. The advantage was reduced cost with little or no loss of utility. The alternatives do not seem nearly as likely on any tool that needed a long lasting edge.

The first alternative would simply be a tool like a brick axe of bar iron – an inferior tool in constant need of sharpening. Even hammer-hardened iron, a process also recognized by Moxon, is pretty worthless as a cutting tool. If a joiner could have a steeled or 'lined' (as it came to be called) chisel, if a charcoal burner working on the edges of society could have a felling axe with a steel bit, why would not a journeyman mason or brick hewer enjoy a similar advantage?

The second alternative would be a case hardened edge. Case-hardening is described by Moxon and even in the twelfth century by Theophilus. Briefly, case-hardening is a superficial application of the cementation process that made thoroughly carburized steel. Iron is baked in a carbon rich environment (often surrounded by ground charcoal or pieces of leather, bone or horn) from which oxygen is excluded. The surface of the iron absorbs carbon, turns to high carbon steel and will harden upon quenching. Theophilus describes case-hardening for making smaller sized files (Chapter 19), but in general it is fairly worthless for an edge tool that must be sharpened. On the first or second significant edge touch up, the hard steel will be ground away. This is particularly true for a tool like the brick axe that is sharpened to a symmetrical, knife-edge.

With the steeled edge, the tradesman gets the best of two worlds. The bulk of the tool is made of a tough, relatively inexpensive bar iron, but where the work is done a hardened and tempered piece of steel provides a wear resistant edge. Yet, even the best steel most carefully heat-treated needs eventual sharpening. Your [Gerard Lynch] account of 1482 that records brick axes being sharpened every two to three weeks on the work done for Kirby Muxloe Castle does seem odd. I suspect that a brick axe does not need the keen edge of a carving gouge, but waiting two weeks to renew an edge implies either a low tolerance for a dull edge or a miraculously long lasting cutting edge. This is an area where experimentation with a period appropriate tool might provide some insight. I imagine that the brick hewers may have done daily, on the job edge touch up themselves, but when the blades needed extensive regrinding they may have been packed off to the local smith.

The account of 'Katherine the smith-wife' being paid for 'steeling and battering' of the masons tools is most intriguing. The bimetallic construction I suppose for a brick axe means that there is a finite amount of steel available to sharpen, and with each grinding material is inevitably lost. Eventually new steel needs to be added.

In blacksmith's accounts of Colonial America this is referred to as 'laying' or 'steeling'. I have seen 'laying' applied to hoes, 'To laying a broad hoe… so many pence'. In this case it is probably welding new iron to an all iron farm tool. Axes, on the other hand, are sometimes laid and sometimes 'steeled' – 'To steeling an axe…' I am certain that the reference here is to adding a new piece of steel to a worn out edge and I have seen period tools to which this was clearly done.

On the other hand, before a tool was so far gone as to need new steel, after repeated sharpening the shape of the tool might become thick and awkward to use. The tool might appear in a smith's shop for another operation called by the smith (both ancient and modern) 'drawing out' or 'drawing down' (cf. Moxon, 1678, 9). The available steel is heated and hammered longer and thinner thereby re-establishing the working geometry of the edge. Again, colonial accounts sometimes record this operation on the woodsman's axe. 'Battering' is, I think, the reference to this process that you have found in the Kirby Muxloe Castle account of Katherine the smith-wife. This battering might be done many times before a tool needed to be 'steeled' once more.

Regardless of how they appear in accounts, from the smith's point of view, these are distinct operations: grinding, drawing out (battering) and steeling. As the steeling involves the application of new and expensive material and is technically most demanding, that would be the most expensive operation, and I imagine grinding the least expensive.

Another point is that steeling inevitably entails all three operations. The steel is welded in place as a relatively thick piece. Then it is hammered out longer and thinner to get the proper taper to the blade. The steel would be heat-treated and the final edge ground on. 'Battering' avoids the addition of new material but does entail hot shaping of the blade, heat treating and final grinding. Remember that in heating the blade to thin it, all hardness is removed and must be re-established by quenching and tempering. Grinding is done cold. Unless the edge is over heated through careless grinding there is no need to re-heat treat the edge if it only needs grinding/sharpening.

I had a good look at two period brick axes from the private collection spread over several days. They are illustrated in Fig. 30. For ease of reference, I will call the first tool **Brick Axe A** and the second one **Brick Axe B** viewed left to the right.

Figure 30
Brick Axe A and Brick Axe B. (Courtesy of Jay Close)

Brick Axe A

Barring a scientific analysis of the metal's carbon content I cannot speak with absolute certainty. I can state with confidence that both blades **of Brick Axe A** have pieces welded across the cutting edges just as one would expect from a period edge tool. I have tried to note that weld line with a white chalk pencil (Fig. 31). The blades on this brick axe are remarkably thin: about 3/16 inch (4 mm) thick in the middle and thinning toward the edges. The edge pieces – presumablya medium to high carbon steel – were likely added while the blade stock was heaviest then drawn out thinner with the rest of the blade.

Figure 31

Close up of the edge of Brick Axe A showing the welded pieces across the cutting edge. (Courtesy of Jay Close)

The steeling or lining of the opposite blade is much less evident. The carbon content of the steel does, however, cause it to oxidize a bit differently than wrought iron. It often looks a little darker in colour and frequently is more heavily pitted with rust. There is something about the carbon in the steel that makes molecular chinks in the armour where oxidation can begin. I think there is some of both indications on this blade.

An interesting construction detail of this brick axe is that the grip seems to have been forged from a different piece of iron than that of the two blades. This is indicated by a clear, nearly circular weld line at the base of one of the blades: it seems that the handle material was lapped, or perhaps slit and pinched onto the blade stock and forged in place.

The other blade also shows evidence of this construction. Here the lap is clearer because the weld was less thorough – although certainly good enough to withstand use in the field. There is also a flaw in the material (perhaps a slag pocket) that has cracked and peeled-up in use. That flaw may even have been evident at the time of manufacture. (I can almost hear the smith swearing under his breath about the poor quality of iron 'nowadays'.)

The strategy of creating a dramatic shape change by welding a smaller size bar to a larger one is common in traditional smiths' work. The alternative is to start with one bar having sufficient mass for the larger component and then draw or work down the smaller section from it. With forge welding ability an expected part of the trade, with a selection of bar stock available, using one size bar for the grip and second for the blade makes sense in terms of production efficiency.

Overall **Brick Axe A** is a sweet, veteran tool, skilfully forged and neatly finished. Except for the heavy rust pitting, I think it exists in largely its original form. When new, I would expect that the surface was left 'as forged' with a black oxide coating from the fire and a careful hammered texture. The junction of blade to grip may have had some clean up with the file, as these transitions are often difficult to forge with the expected level of finesse. The blade profiles where likely filed to refine them before heat treating the cutting edge and the edge ground to final form after hardening and tempering. To quote Moxon (1678, 62): 'He that will a good Edge win, Must forge thick and Grind thin'.

Brick Axe B

This is a more robust tool that shows considerable reworking of the blades. The hammered texture of both is what I associate with in-use repair rather than original manufacture. We have discussed the need to have a blade hammered out thinner as material loss in grinding begins to make a thick and clumsy cutting edge. Likewise if the cutting edge is steeled, there comes a time when the tool will no longer hold a good edge. All of the steel has been sharpened away. The tool then gets sent to the local blacksmith for a functional, if not aesthetically pleasing repair: welding on a new piece of steel and then hardening and tempering the edge.

Weld lines show the added material on **Brick Axe B** on both sides of each blade (Fig. 32). This suggests that the additional material was pinched onto what remained of the original blade, rather than being lapped on.

Given the historical expense of steel, it does not make sense that these additions be entirely of steel. In fact, when viewed at an acute angle, it is possible to see a colour change as a band across the cutting edge. This suggests an added edge of heat-treated steel. So the obvious weld lines I would argue show additional iron added to compensate for material loss due to repeated grinding and drawing out of an edge. Eventually there was no longer much mass to work with. Yet there was still significant value in what remained, value enough to retain it and weld additional blade stock to it and then finally steel the reconfigured shape.

All in all, this tool has been reworked enough that it is hard to draw conclusions about its original form. The grip is nicely forged and may even have been filed to further smooth the surface. Such additional attention to areas of a tool

Figure 32

Welded edges on Brick Axe B. (Courtesy of Jay Close)

that were to be held in use is not unusual in period ironwork. The repairs or renewals to the blades are done in a competent and functional manner without apparent concern for the quality of the hammered texture left behind. This is a good example of what would have been called 'country work' in the eighteenth century American colonial context – the level of work that local clients would accept that likely provided the bulk of the income of a practising provincial smith.

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2

Jacobean and Pre-Restoration Period (1603–1660)

Introduction

As Colvin (1982, 37–8) says of the Jacobean period and its brickwork:

> Building materials and techniques underwent no conspicuous change in the early years of James I…. Brick remained, of course, the basic structural material, whether stone-faced, rendered, painted or exposed….Inigo Jones seems to have encouraged the interpretation of classical features in brick…at the Prince's Lodging at Newmarket (1619–21) the chimney-shafts had Tuscan heads of 'hewn bricks'. At James I's banqueting house at Theobalds (1625) the brickwork was 'hewed with an axe' and rendered; but at the repository for the king's clocks at Whitehall (1635–6) the brickwork was 'neately axed and joynted' and evidently exposed. An early appearance of gauged, [or fine cut and rubbed], brickwork seems to be recorded at Greenwich (1623–4) where rustic piers were formed with bricks 'rubbed and polished'.

Clearly the gradual movement in architecture away from the late gothic detailing of the Tudor period to that of the classical, and the use of brick instead of stone, was leading to an ever-refined use of cut and rubbed brickwork; not intended to be covered by stucco. The desire was to set the brickwork with ever-tighter joints to reduce their distracting impact on the enrichment or overall façade.

The Jacobean Period (1603–25) was a time of immense architectural change. The Renaissance, or 'Re-birth', began in Italy during the fifteenth century. There, influential designers and artists were the first to be influenced by an intellectual movement reviving the learning and artistic styles of classical Greece and Rome; the central emphasis being on symmetry, proportion, and space.

Andrea Palladio (1508–80) published *'Quattro Libri dell' Architetura* in 1570, setting out his theories and illustrating his works, which was to be hugely influential on Inigo Jones (1573–1652). Jones was the first English architect to be truly conversant with the rules of classical architecture; whose architectural style was later to become associated with Palladianism.

Sir Henry Wotton (1568–1639), English traveller, scholar and diplomat had been appointed as Special Envoy to The Hague in 1624. He was long acquainted with Inigo Jones at the Royal Court, as well as the Dutch architect Huygens, and by way of introduction to the works of Vitruvius, Lord Wotton published *Elements of Architecture* in the same year. This book reveals the classical influences that coloured much of the work of influential Jones (who visited Holland in 1613 and who was very popular there) (Kuyper, 1980, 228) relates that this:

> …is an indication of the impact of the ideas in Inigo Jones' environment on Dutch learned circles.

The effects of the Renaissance moved northwards from Italy into France in the sixteenth century, through the Netherlands and on into England. In each, local vernacular traditions influenced and altered the new style, giving each country its own unique interpretations and characteristic craft practice, as Stoesser-Johnston (2000, 121) records:

> Decorational elements derived from classicism had arrived in England from Antwerp via Hans Vredeman de Vries, [1526–1609], Architectura (1563) and Compertimenta (1566).

Penoyre and Ryan (1958, 111–14) give a brief, yet sufficiently detailed, overview of this transitional phase in England at the close of the Elizabethan period (1558–1603) and the following, overlapping Jacobean period. This helps one to understand the early effects of the Renaissance on domestic architecture, and by necessity its craftsmen:

> It is by the mixture of Gothic ideas, like the hood mould over a window, with classical detail such as columns, broken pediments, and so forth, that Elizabethan work is most easily distinguished…. It was not till Inigo Jones came home from Italy that the Italian style began to influence the basic shape of buildings…. As the 17th century progressed, so the quality of the decorative work became more correct.

It is important to realise, however, that Gothic architecture was not entirely supplanted by the influence of the Renaissance. The handsome brick-built Caroline tower to St. Mary's Church, Winkfield (Berkshire) (1629) built in the reign of Charles I (1625–49) is a good example of this. The church is set in the Thames Valley (Clifton-Taylor, 1978, 1–3) which nature has endowed with an abundance of soft plastic clays admirably suited to brickmaking; and ideal for rubbers too. The pleasantly textured orange-red bricks, typically measuring 230 mm × 110 mm × 50 mm, are set within a well-proportioned tower delineated into three distinct stages, with clasped buttresses at the quoins.

The original shaped bricks for the mullions, voussoirs, labels of the window openings, and the reveals and ordered arch and label of the entrance doorway are clearly of cut-moulded bricks. The visual signs of axing and abrading, and the regularity and accuracy of post-fired working on the faces of the cut-moulded bricks, are readily evident and some, removed during recent restoration of the tower brickwork carried out by St. Blaise under instruction from Caroe and Partners, Architects, have been closely examined by the author in his consultative role. Clifton-Taylor (1978, 3) is therefore incorrect writing:

> Purpose-made bricks are also much in evidence at the windows, which are of various types and shapes. Some are mullioned: some have tracery: some hood moulds above.

Brickmaking

The seventeenth century saw a considerable development in the quality of bricks, largely influenced by the practices of brickmakers from the Netherlands. Brick sizes altered during the period and some Jacobean bricks are noticeably larger than their Tudor counterparts (Lloyd, 1925, 12; citing a Proclamation of Charles I, 1625). Government law or statute regulated these, although usually reserved for London only, enforced by the powerful Tylers and Bricklayers Company. By 1622, to regulate the brick supply the Tylers and Bricklayers Company were entrusted with overall supervision of the City brickmaking industry.

The gradual effects of deforestation gradually led to the increased use of coal, delivered into various national ports by ships, or 'sea-coal' as an alternative fuel. This in turn necessitated modifications in clamp and kiln firing, and in placement of the green bricks, to produce rubbing bricks of a quality broadly similar to those burned by wood, such as the control of draught and humidity within the burning zone.

Master Bricklayer and the Architect

Several factors combined to make gauged brickwork emerge and consolidate its position in the seventeenth century.

- The increasing native assimilation of the Renaissance of classical architecture by a new class of designers – architects.
- The shift of importance in the development of architectural inspiration and innovation from Italy to northern European models; proliferated through builders 'pattern books', and combined with the movement to England of influential continental architects and master craftsmen.
- The on-going refinement of the skills and knowledge of post-fired cutting and rubbing of bricks by city bricklayers for classical architectural enrichments.

- The continuing use of brick for the building of influential houses in and around London.

Until the middle of the seventeenth century, the design and control of a building, as it had from the Middle Ages, lay largely with the master mason or bricklayer. This manifested itself during the early Stuart period in the so-called Artisan Mannerist style of architecture, so called because of the licence the builders (artisans) took with the rules of classical architecture.

The word architect (from the Greek architekton, meaning 'builder-in chief') begins to be encountered during the latter part of the sixteenth century, but Airs (1995, 31, 34) suggests:

> …it is used in a vague and imprecise way…. However, even though the term 'architect' was loosely used in the sixteenth century, with a meaning that was not synonymous with that which is has now, many of the men to whom it was applied were clearly able to make designs. But most of them remained 'mechanics', employed as wage earners and servants of the builder.

In England, the client's wishes had a crucial influence on the overall layout of a building, but the master craftsmen had a continuing tradition of deciding the nature of mouldings and architectural detailing (Airs, 1995, 35):

> …innovations, perhaps initiated by a few master craftsmen, were quickly absorbed into that tradition and spread by example from their place of origin throughout the rest of the country.

The foundation of Renaissance architecture was intellectual and to understand its rules required at least dedicated book learning and, if possible, travel abroad to witness first-hand its effects.

During the late sixteenth and seventeenth centuries, wealthy noblemen, patrons with a keen interest in classical European architecture, were travelling abroad and amassing libraries of foreign architectural books. This served to advance the arrival of the architect. This, however, caused much resentment from the master craftsmen, most of whom lacked a full formal education, complete access to Renaissance designs and the opportunity to travel abroad. As Airs (1995, 49) states:

> The well-known dispute between Inigo Jones and Ben Jonson was partly a reflection of this battle for the status of the architect.

Ben Jonson (*c.*1572–1637), soldier, actor and playwright, was also a time-served city bricklayer. Bell (1938, 21) states legend had it that Jonson worked, '…as a bricklayer upon the great turret gateway in Chancery Lane of Lincoln's Inn, bearing a trowel in one hand and a Horace in the other.' Jonson was certainly a freeman of the Tylers and Bricklayers Company; who had spent time as a soldier in Flanders fighting the Spanish. His love of the English language and Drama (Smith, 2003, 12–14) meant he did not ultimately pursue his craft. Nevertheless his experience working with the trowel, and military time in the Low Countries, where he would have observed Flemish buildings and brickwork, must have been of interest and value to Inigo Jones too; and it seems inconceivable that they would not have discussed the use of brick in buildings.

This was a radical change in the control of design and execution of English architecture. From this point onwards the influence of the architect as opposed to the master builder on the design and control of a new building, was becoming more significant. It was important that someone with understanding and knowledge of the subject was in charge, although the client in consultation with his skilled craftsman traditionally decided details as the building progressed.

The Artisan Mannerist Movement

Master craftsmen were not going to release easily the privileged status that they had historically enjoyed and were determined to acquaint themselves with the pattern books arriving into seventeenth-century England 'via the free interpretations of the Low Countries' (Airs, 1995, 35).

Mowl and Earnshaw (1995, 8) suggest:

> This problem of the iconography of a style had arisen partly from the wider use of brick as a building medium and partly from the innovations of Inigo Jones. In 1623 the London church of St. Giles, Cripplegate had been re-built in rubbed brick but to the design of…an Perpendicular gothic church….

Dutch influence was especially strong, in the 'Artisan Mannerist' style, with skilful handling of brick to shape and build columns, pilasters, moulded openings, architraves, and pediments, following mainly classical profiles. These displayed a wealth of finer brickwork advancing the skills previously required for the preparation of Gothic-styled Tudor tracery, arch labels, and ornate chimney stacks. The Dutch House, Kew Gardens (London) (*c.*1631), is an influential example of the style. Others are Cromwell House in Highgate (London) (*c.*1637–40), Broome Park (Kent) (1635–38), Swakeleys (Middlesex) (1638), Balls Park (Hertfordshire) (*c.*1640), and Tyttenhanger Park (Hertfordshire) (*c.*1655).

The 'Dutch House' in London, as it was called for over a century after it was built, is known today as 'Kew Palace'. It was built for a wealthy merchant of Dutch origin called Samuel Fortrey, and is frequently given as the earliest example of English gauged brickwork (Lloyd, 1925, 15; Brunskill and Clifton

Taylor, 1977, 26). It is perhaps better described as a good example of the transition of the Artisan Mannerist style, employing post-fired brickwork for enrichments, from the earlier Tudor Gothic 'cut and rubbed' work, prior to the later, and more refined, classical use of the true Dutch style of employing gauged brickwork.

The 13 Building Articles for the properties in the parish of St Paul, Convent Garden, in London, emphasise this fashion for post-fired worked brickwork of the second quarter of the seventeenth century. 'The revised articles required the house fronts to be built of 'hewed or well rub'd brickes…' (Sheppard, 1970, 30).

Cromwell House in Highgate, London (1637) (despite poorly applied and inappropriate modern re-pointing) has a delightful central first-floor window opening, set with a lugged architrave, with volutes and scrolled consoles (Fig. 33). This would appear to indicate some degree of *in situ* carving. At Tyttenhanger Park in St Albans (Hertfordshire) (1655) (another victim of modern re-pointing) is a later and more finely executed example of the same cut and rubbed central detailing to the first-floor window (Fig. 34). The bricks for this enrichment are of a better quality for cutting and rubbing than those employed at Cromwell House, 18 years earlier. It is not impossible that the detailing for both windows was designed and executed by the same craftsmen. Colvin (1995, 656) suggests that the author of Tyttenhanger might be the master bricklayer and artisan architect, Peter Mills, discussed below, stating:

> Tyttenhanger is a brick house which Mills may well have built, and the resemblance's between Wisbech Castle and Thorpe Hall are so striking as to suggest that he was Thurloe's architect.

Figure 33

Cut and rubbed 'lugged' window detailing at Cromwell House, London, 1637.

Figure 34
Similar, but later 'lugged' window detailing at Tyttenhanger Park, Hertfordshire, 1655.

Through the popular use of brick for properties designed in the classical or Mannerist fashions, the use of cut and rubbed ashlared and moulded brick was increased. At the Queen's House at Greenwich in London (1635–36), Colvin (1982, 119; citing National Archive Reference E351/3269) records the moved and re-built gate piers as '…two rustique Peeres with brickes rubbed and polished'.

The term 'rustic' indicates the practice of chamfering the horizontal or vertical (or both) arrises of selected bricks, or indenting, to create a 'blocked' effect to emphasise the masonry and create an impression of massiveness, impregnability and strength. This is seen with the 'noble piers' at Lincoln's Inn Fields, London (Fig. 35), discussed below.

Peacock's (sometimes referred to as Pocock's) School at Rye (Sussex) (*c.*1638) shows adaptation of the Tuscan order to brick, which Lloyd (1925, 76–7), quotes the architect Sir Reginald Blomfield, who says the designer:

> …made no attempt to adhere exactly to the orthodox rules of the Tuscan order…. Yet the work is by no means ignorant…The arches over the window are straight brick arches, channelled [rusticated] to form voussoirs and key-blocks. These are rubbed brick, but coarsely jointed.

It must be remembered that the 'coarse jointed' description may not have originally appeared as severe, due to the practice of colour washing some principal elevations with ochres ('ockering' or 'ruddeling'). This was done to regularise the various tones of brick colour, the joints being then picked-out, to a reduced size, with white or black coloured distemper applied by the bricklayers using

Figure 35

Gauged 'blocked' or 'rusticated' piers at Lincoln's Inn Fields, London, date unknown, but now believed to have been removed and re-built in the mid-eighteenth century. (Courtesy: City of London, 'The London Metropolitan Archives')

a thin brush. This practice is referred to in accounts as 'pencylling'. Certain cut and rubbed brickwork might still be stuccoed during this period, but was not required when the rubbers were colour matched and the façade was intended to be rubbed smooth.

In terms of finishing exposed cut and rubbed work, one finds references not only to it being 'rubbed' or 'polished', but also, as at Somerset House, London (1609–13) to the chimney stacks undergoing 'polishing and rauncering'. This as Colvin (1982, 257) suggests 'presumably gave the appearance of polished rance'. The term 'rance' is according to Colvin (1982, 33) 'a veined, dingy-red marble, from Tournai in France'. Some historic, un-washed, rubbers, when their faces are cut and rubbed, do indeed present a slightly marbled effect, due to a less-refined mixing of a sometimes varying raw material. It has also been suggested that in the Netherlands this clay blending might have been a deliberate practice, for aesthetic effect, by some native brickmakers. Dirk De Vries (2006, 3262) states:

> …a special effect could be given to the surface of a brick by mixing little balls of yellow and red clay to a certain extent, since the aim was not to obtain a homogenous mixture but rather a kind of flaming pattern.

The tools and cutting techniques used by the craftsmen preparing post-fired worked bricks were largely as in the previous periods. We therefore read of 'hewen chamfrette', at Theobalds (Hertfordshire) in 1607–10 (Colvin, 1982, 275). For Inigo Jones at Whitehall, London in 1625, we read of 'the brick woorke being hewed with the axe' and in Whitehall Palace, London in 1635 we read of brickwork 'neately axed and joynted [jointed]' (Colvin, 1982, 337).

Jigginstown House, in Naas, County Kildare, Ireland (*c.*1635–37) was built in brick in a sophisticated Mannerist fashion by Thomas Wentworth, 1st Earl of Strafford (1593–1641), whilst Lord Lieutenant of Ireland; during the reign of King Charles I (1625–49). In the conserved ruins of the once magnificent brick property, one can still observe the decorative cut and rubbed enrichments. Linear emphasis is achieved through cut and rubbed moulded plinth, platt band and cornice picked-out in very small (180 × 83 × 38 mm) pale yellow, possibly Flemish, bricks. These bricks have been rubbed perfectly flat on their beds and are in contrast with the standard size of red bricks used for main colour washed elevations; for polychromatic effect. An annotated drawing of 1726 by Edward Lovett-Pearce, artist and draughtsman, for his client Richard Boyle, 3rd Earl of Cork, shows architectural detail of post-fired worked bricks incorrectly described in contemporary language as 'rub'd and gadged' (see case study, p. 99).

Prominent Artisan Architects and Master Craftsmen

The name of a significant master bricklayer who had both a strong connection with the Artisan Mannerist movement and the transition from accurate 'cut and rubbed' work to precise gauged brickwork is Peter Mills (1597–1670). He was the son of John Mills, a tailor in East Dean (West Sussex), he became apprenticed to John Williams, Tyler and Bricklayer of London, on 30th November 1613 (Colvin, 1995, 390–91). Mills himself took his first apprentice in 1629 and during this period he was to work professionally with Inigo Jones and his influential architect pupil, John Webb (1621–67).

On 17th October 1643, Mills was appointed 'Bricklayer to the City of London'. As a sign of his regard, both within his livery company and the craft itself, he was also made 'Master of the Tylers and Bricklayers' Company' in 1649–50 and again in 1659–60 (Bell, 1938, 68). Mills was highly regarded and, as he moved upwards in his craft, gained prominent architectural work in the city, as well as after the Restoration on the re-building of the centre of Cobham Hall (Kent) 1661–63. He was appointed as one of four surveyors, or 'measurers', as they were then termed (Colvin, 1995, 655), to supervise the re-building of London after the Great Fire of 1666; working alongside Wren, May, Hooke and Sir Roger Pratt.

Peter Mills was a highly qualified, prominent individual who played a not insignificant role in taking English domestic architecture out of the Tudor/Elizabethan models. He must surely have used his craftsmanship and influence to help advance the skill base of his craft to a new level of use and quality. This would have served as a springboard for the highly capable city bricklayers of the post-Restoration Period, to be readily able to absorb and use the advanced Dutch skills of refined gauged brickwork.

Godfrey (1946, 168) emphasises the contribution that Mills made to architecture:

> In 1639 a scheme of building in the new Italian style was started in Great Queen Street and Lincoln's Inn Fields. The houses in the former have unfortunately been pulled down. They appear to have been built by Peter Mills who in his early career was bricklayer to the City of London, but rapidly acquired reputation as surveyor and architect.

Of the Great Queen Street houses and Lincoln's Inn Fields, Summerson (1947, 18–19) states:

> The Great Queen Street houses were reputed, in the 18th century, to constitute 'the first regular street in London'. They laid down the canon of street design which put an end to gabled individualism, and provided a discipline for London's streets, which was accepted for more than two hundred years….
>
> In Lincoln's Inn Fields… (Nos. 59–60) under the name of Lindsay House…is one of the many buildings of the kind which is attributed (on the evidence of Colin Campbell) to Inigo Jones himself. Its brickwork is covered with stucco, though the fine brickwork of the original fore-court piers is still exposed.

Summerson (1953, 102) suggests the architect for this property may not have been Jones, but rather the influential master mason, Nicholas Stone. Stone is discussed below in possible connection with the introduction of early English gauged brickwork. Peter Mills and Nicholas Stone, both of whom had worked with Inigo Jones, were familiar with brick and stone at the highest level of preparation and application; so it is not surprising that either man's name may be placed against early English gauged brickwork.

The aforementioned forecourt brick piers are themselves of importance and are mentioned by Gomme and Norman (1932, 97) as 'Two noble piers of brick, surmounted by lofty carved stone terminals, stand in the courtyard and were justly praised by Hatton in 1708'.

These 'noble piers', shown in Fig. 35 (restored by Nimbus Conservation Limited), are of rusticated brickwork, which, if original, are an early example of quality gauged work. It is most probable that the brickwork is later – 'It may therefore be suggested that these piers were removed to their present position when the premises were divided in 1751–52' (Gomme and Norman, 1932, 98).

With regard to the early introduction of gauged brickwork into England, a good example may be seen in the remains of the classical entrance porch to the north elevation of Houghton House in Ampthill (Bedfordshire) (a conserved ruin in the care of English Heritage) (Fig. 36). The ashlared gauged work of orange fine-textured rubbers is, as yet, undated, but possibly *c.*1617–18 and thought to be to the designs of Inigo Jones (1573–1652), commissioned after the house was completed in 1615. Of Houghton House Harris and Higgott (1990, 84–5), record:

> The most tantalising and grand commission of these year is Houghton… possibly begun just before Jones returned from Italy… It is possible that in the building process she [Mary, Dowager Countess of Pembroke] was persuaded to provide modernity to the house by inserting classical frontispieces into the north and west fronts. These could only be by Jones, so classical are they in Jacobean England. As such, they are precious relics of his designing skills in this early period, probably in mid-1615 and certainly before 1621 when the Countess died.

This is very significant, as the brickwork, though with varying joint sizes and lacking the highly disciplined nature of the post-Restoration work, is of a much

Figure 36
An eighteenth-century print of the entrance loggia on the north elevation of Houghton House, Ampthill (Bedfordshire), 1615. Note the artist has mistakenly depicted the left-hand loggia as built entirely of stone work when it is of gauged work with stone dressings. (Courtesy: Society for the Protection of Ancient Buildings Archives)

higher standard than Kew Palace; yet clearly pre-dates it by a decade or more. It would now surely be correct to recognise Houghton House as the first building on which gauged brickwork was introduced into England (Fig. 37).

Figure 37
Early gauged brickwork detailing on the entrance loggia on the north elevation of Houghton House, Ampthill (Bedfordshire), 1615.

It is important to note, however, that some authorities think the design of this once large loggia, with its early gauged work, is too 'mannered' for Jones in which case a strong candidate is master mason and sculptor, Nicholas Stone the Elder (1586–1647). (Harris and Higgott, 1990, 155) record:

> One architect in Jones's entourage whose work is both distinguished and singular is Nicholas Stone, the mason of the Banqueting House and master mason to the Crown from 1632, deeply read in continental treatises… Stone created a Mannerist style that is not 'artisan', but stems directly from the northern Italian Renaissance.

One cannot but be struck by certain aspects of the similarity in the overall design of the drawing for the original north-facing classical entrance porch at Houghton House and the principal façade of 'Huis Bartolotti' in Herengracht, Amsterdam (1617) (designed by De Keyser) (Fig. 38). De Keyser single-handedly created what is known today in Holland, as the 'Amsterdam Renaissance style'. Kuyper (1980, 29) emphasises his influence on Nicholas Stone by saying '… his manner is stylistically so close to his master's….'

Figure 38
Huis Bartolotti, Herengracht, Amsterdam, Netherlands, by Hendrick de Keyser, 1617. (Courtesy of Joop Hofmiejer)

Nicholas Stone the Elder (1586–1647) was born at Woodbury Exeter. He served his apprenticeship with an unknown mason in London before being transferred, or 'turned over' for at least two years of his apprenticeship, and a further year as a journeyman, with a Flemish monumental mason and refugee called Isaac James. He caught the eye of Master sculptor/mason, Hendrick de Keyser (1515–1621) when he was working with Inigo Jones. De Keyser had become architect to the city of Amsterdam in 1595, and along with the city's Master Bricklayer, Cornellis Dankertz, were in England between April and June 1607. This was a working trip paid for by the city administrators to both meet Inigo Jones and investigate the construction of the new Commodity Exchange in London being built by Hendrick Van Passe. They took Stone back with them when they returned to Amsterdam where he worked on the new Commodity Exchange and, under De Keyser's tutelage, he advanced to the highest levels of skill and architectural knowledge. He remained in Amsterdam until 1613; when in the April of that year, he married De Keyser's eldest daughter, Maria, her dowry being a large amount of Portland Stone from a quarry De Keyser partly owned. Stone returned to London, taking premises at Long Acre, at the behest of Jones who later appointed him Master mason on the Banqueting House in Whitehall, London; on the building of which Stone used this dowry.

Stone had three sons – Nicholas (also a sculptor/mason), John (who was educated for the church) and Henry who trained as a painter. After his death, John and Henry, with Nicholas running the on-site activities inherited his premises. A diary entry by Nicholas emphasises the on-going commercial, as well as social, architectural and cultural connections with the Netherlands. On 13 November 1646, he writes that Mr Henry Wilson of Petticoat Lane had shipped 30 tons of Portland Stone to Amsterdam, to his uncle Hendrick de Keyser, and that he was to have a third part profit (Knoop and Jones, 1937, 27). The Stone's yard employed the finest masons, including Caius Gabriel Cibber (1630–1700). After studying in Italy, Cibber travelled to Holland where he came into contact with Pieter de Keyser, sculptor/architect and brother-in-law of John Stone, and commenced working for him, first as a journeyman and then as a foreman sometime before the Restoration. He later became one of Wren's favourite mason carvers (Knoop and Jones, 1937, 26).

Nicholas Stone the Elder could not have been immune to, or unaware of, the great craftsmanship of early seventeenth-century post-fired cut-moulded brick-work that had been blossoming in the hugely influential city of Amsterdam during his several years living and working there with Hendrick de Keyser. He would naturally have sought to use brick in a similar high-class fashion as a façade masonry material, whether to his own designs or that of another, such as Jones.

An important and high-quality gauged brick construction with strong links to the Stone family is the impressive rusticated, pedimented and arched brick gateway at Chesterton (Warwickshire) (Fig. 39). The author advised on the restoration of the gauged work for the late architect Eric Davies, and the works were carried out by Messrs Linford-Bridgeman in 1991, using rubbing bricks from Bulmer Brick and Tile, Sudbury (Suffolk) (Fig. 40).

Figure 39
The Chesterton gateway (Warwickshire), *c.*1662, before restoration in 1987. (Courtesy of Eric Davis)

Figure 40
The Chesterton gateway (Warwickshire), *c.*1662, after restoration in 1991. (Courtesy of Eric Davis)

Set into the north wall of the nearby churchyard, it was originally the private entrance to the church from neighbouring Chesterton House (demolished in 1802), owned by the Peyto family. The gateway, as yet undated, is undoubtedly a fine example of ornamental gauged brickwork. The design has been traditionally accorded to Jones (Lloyd, 1925, 83, 317, 412), but as Wise (2000, 155–6) counters '…most authorities place the date of the Peyto Gateway rather later in the seventeenth century'.

Wise continues:

> The surviving accounts for the House, however, record its construction between 1657 and 1662 and, given that Jones died in 1652 he cannot have been the architect…. surviving documentary evidence suggests that Chesterton House is the work of John Stone (1620–67), the son of Nicholas Stone.
>
> John Stone was certainly employed by the Peyto family at this period…in October 1659 Elizabeth Peyto gave £1 to 'Mr Stone for drawing the draught of the head of the pillars for Chesterton'. In the following year she paid John Stone £2 'for the 2 capitalls of the arch at the staires'….
>
> …but the continuous patronage of the Stones, father and son, by the Peyto family over some twenty years strongly supports the identification of John Stone as the architect in this case.

There are some doubts as to John's practical skills (most likely due to his original education towards a religious life), but he was acknowledged as a good designer/architect. He employed a regular small staff, including his Dutch cousins (De Keysers) and several other craftsmen from the Low Countries, as well as the Danish master sculptor Caius Gabriel Cibber (1630–1700).

Payments to John Stone by the Peyto family for his work, as described above, in 1659 and early 1660 and of Cibber's work there later in 1660, are explained by Spiers (1919, 28):

> …that he [John Stone] went over to Breda [Netherlands] with the intention of petitioning the King for the grant of the office of Master Mason of Windsor held by his father; whilst there, however, he had a violent attack of the palsy, which deprived him of the use of his limbs, and incidentally we also learn from Vertue's own MSS [Brit. Mus. Add. MS. 23069, f.4.], that Caius Gabriel Cibber, who was then his foreman, went over to Holland to bring his master home…

Stone was awarded the position for which he had petitioned the King in August 1660, but later sold it to a competitor, Joshua Marshall, due to continuing ill health. He died in September 1667.

The construction of the Chesterton gateway is now widely believed to be contemporary with that of the house. Certainly the quality of craftsmanship is at the higher level which one begins to be seen developing out of the earlier cut and rubbed work and which immediately precedes the very precise gauged brickwork, seen in the post-Restoration period. That stonemasons, or indeed the best master bricklayers, who could work, when required as masons, may have erected this gateway is not surprising given the history of these two branches of masonry. The nature of the construction, particularly of the rusticated arch, is highly suggestive of craftsmen very familiar with stonemasonry skills.

Close examination of the soffit to the rusticated arch, which provided shelter from the weather, reveals the 'blinding-out' of the mortar joints to match the colour of the bricks; creating an homogeneous appearance to the overall masonry. This could have been achieved by several different methods. Rubbing-up the wall whilst it still retained some moisture in the bricks forced part of the resultant dust to adhere on the faces of the mortar joints. Alternatively, the joints could have been pointed and a colour wash applied as at Jigginstown House, or 'stopped-up' with an ochred pointing mortar to also achieve the same result. The visual evidence further suggests that these ochred or 'blinded' joints were lightly 'struck' then 'ruled', and possibly 'pencylled' to finish.

The remarkable changes in the first half of the seventeenth century in domestic architecture produced ever-improving standards of brickwork, manifesting itself in a higher level of skill in working post-fired enrichments. The influence of key personnel, like Nicholas Stone and Peter Mills, cannot be over emphasised in how they enabled English post-Restoration architects and craftsmen to absorb, design, and deliver classical gauged brickwork. It is in the fine work of the century from the 1670s that we truly witness the finest expression of English brickwork and, again, this influence was from the Netherlands and, in particular, the provinces of North and South Holland.

The Dutch Influence on English Classical Gauged Work

By 1609 the seven united provinces in the Netherlands, of which North and South Holland were pre-eminent, became independent of Spanish rule. Within only a few decades they experienced a 'Golden Age' of culture, prosperity, and influence, with the Netherlands emerging as a major world power. The united provinces benefited from the thousands of Flemish refugee craftsmen and designers who had moved north to escape Spanish and religious persecution. From the early seventeenth century, one begins to witness Flemish craft skills of 'Berwekte Baksteenen', or 'worked-on bricks', appearing on Dutch buildings, serving as a prelude to their gauged brickwork.

This arrival of Flemish craftsmen in Holland was coincidentally at the dawn of a Renaissance style (called 'Dutch Mannerism') of architecture that followed the close of their Gothic period. By 1600 the style was referred to as 'Dutch Renaissance' and, by 1615, 'Amsterdam Renaissance'. 'Dutch classicism' began to appear in 1625, inspired by such architects as Jacob van Campen (1595–1657), Constantine Huygens (1595–1687), Pieter Post (1608–69), Arent Van's-Gravensande (1599–1662), Philip Vingboons (1607–78), and his brother Justus (1620–98). It enjoyed its heyday between 1640 and 1665, and it was this style, strictly following the rules of Italian treatises, that was to become popular in post-Restoration London, and to bring with it the prolific use of gauged brickwork.

Dutch meester metselaar (master bricklayer) and highly-respected craft teacher, Joop Hofmeijer reveals that Dutch gauged work is concentrated mainly in the west and south of the Netherlands running on into Flanders; no examples of note being extant in the east or north of the country (Hofmeijer, 1997).

The skill of gauged brickwork is referred to in the Netherlands by the term 'geslepen metselwerk', which literally translated means 'sharpened brickwork'; a term that is beautifully descriptive of the practice of grinding, cutting and shaping the selected bricks to precise arrisses for accurate setting. It was used mainly in the seventeenth and eighteenth centuries, but to nothing approaching the extent of its proliferation in Flanders.

Leiden

The late Johanna Hollstelle states that, by the seventeenth and eighteenth centuries, the brickmaking region of Leiden (Leyden) along the old Rhine (Rijn) had become important, where there were at least 30 kilns, some holding 600,000 bricks fired three to five times a year (Hollstelle, 1976, 276). This stated capacity for such huge volumes of bricks, however, is indicative of clamps rather than kilns. A particularly popular source of bricks was the Leiden (Leyden) region, where the downwash alluvial clay was very clean and refined, and therefore perfect for a rubbing brick or 'Leide Steen' or 'Leiden brick'. Traditionally the best of top-grade bricks selected for facework, those that were perfectly baked, rather than burned, were reserved for gauged work; though (Hofmeijer, 1997) there was no brick called a rubbing brick or an equivalent Dutch term.

The gauged work in Leiden dates from the early seventeenth century through to the nineteenth century, although a different type of clay was used for the latter period. A large-span semi-circular arch leading into the courtyard of the Burgerweeshys (1607) is accurately cut and gauged, with the bedding faces only rubbed and edged and laid with fine joints. The voussoir faces are not dressed nor finished *in situ*, the clay folds being clearly visible on the brick faces. Study of some early sixteenth-century Dutch gauged work is highly suggestive of the immigrant Flemish craftsmanship using both 'freynen' to dress individual bricks and the steenschaaf to *in situ* finish enrichment in their native manner. A good example of the latter is Pieter's Kirk Gracht (1620) which displays gauged work for ashlar, as well as handsome segmental arches finished *in situ* with the steenschaaf. The large-span semi-circular arch to the church at 64, Breestraats (1635), has also been neatly finished *in situ* with a steenschaaf and following neatly the curve of the arch (Fig. 41).

Figure 41
A radial 'Steenschaafed' finish to a splayed arch face, 64, Breestraats, Leiden, Netherlands, 1635.

The accurate cutting for an impressive hearth vault at Jean Postign's Hofge, 21, Kloksteeg (1685) displays again the inevitable interchange of skills between bricklayers and stonemasons. Particularly noticeable is the finishing by rubbing the brick smooth, with no signs of the use of the steenschaaf.

Observations in the regions of the Netherlands where gauged brickwork is present, it is not executed in the buff-coloured brick, favoured by the Flemish, but in orange/red fine textured bricks. It is noticeable that during the seventeenth century, a rubbed-smooth finish to the work largely replaces the earlier Steenschaafed finish. This can be seen as a part of the overall development of classical gauged work evolving from earlier Flemish practices as a direct result of using clean-bodied Leiden, or similar, bricks and realising the greater potential for easier post-fired shaping and rubbing a smooth finish. This is in comparison to their harder Flemish counterparts, minimising the need for the abrasive action of the steenschaaf. Hollstelle (1976, 58), however, appears to be in conflict with the author's research when she states:

> When specially shaped bricks with chamfered corners or mouldings were required they were moulded in their final form in northern districts and in

> Flanders, probably under the influence of the brick workers of the abbeys there; but in Holland, ordinary rectangular bricks were cut and carved to shape.

This statement is not upheld by the author, as findings show that the historical Dutch practice had been to make green-moulded, special-shaped bricks to order, whereas in Flanders they were usually fired before being cut and shaped, as described earlier in Chapter 1.

Hollstelle also considers the firing of moulded bricks in the desired form as a characteristic expression of a fully developed brickmaker's art and sees post-fired mouldings as a fundamental misuse of the material. This is simply not so, and wholly misunderstands the difference and nature of utilising a baked brick for cut and rubbed or gauged brickwork, as opposed to mistakenly using a fully-fired brick (needing its all-important protective fireskin). Once this is understood, one can then see that gauged brickwork is in fact characteristic of a fully understood and highly developed art.

Bricklayer's Guilds and 'Gildeproeven'

The guild system of the seventeenth-century bricklayers/masons in the Netherlands followed rules and practices similar to Flanders; particularly in the wealthy provinces of North and South Holland, that established very high standards. The master bricklayers, despite the advent of professional architects during the seventeenth century, were still designing and erecting buildings with reference to pattern books published in the Netherlands at that time. This style was referred to in Amsterdam as 'Contractors Classicism'. The very best of final-year apprentices wishing to advance to the status of a master had to demonstrate their ability by constructing a 'gildeproeven' (masterpiece) to be assessed and passed by the 'proefmeesters' (proof-masters). 'Geslepen metselwerk', or gauged brickwork was considered the supreme test for the bricklayers, requiring knowledge of measurement, setting-out, geometry, fine skills in cutting and shaping bricks, and in setting and finishing the brickwork (Kurpershoek, 1997, 18–29). This is remarkably similar to the earlier, sixteenth-century, 'Proefstucken' models demanded by the Flemish guilds (Van der Horst, 1998). As in Flanders these were for the final-year apprentices demonstrating mastery to their mentors. Although it was not customary for all bricklayers' guilds in the Dutch towns to demand this high level of proof, especially in the earlier periods when there was no clear separation between the brickmasons and the stonecutter. Following the guild rules of 1579, a bricklayer/mason could only join the guild if he had practised his craft, as an apprentice, for four years, followed by working for two more years with the same master. Amazingly, there are two places in the Netherlands where examples of 'gildeproeven' from the seventeenth century still survive; the best, not surprisingly, is in the wealthy city of Amsterdam.

De Waag – Amsterdam

The 'Onze Liewe Vrouwgilde van der Metselaars', or 'Our Lady's Guild of the Bricklayers', in Amsterdam, dates from the fifteenth century and continued until the abolishment of the craft guilds 'in the Netherlands in 1808, by virtue of the constitution of 1798 (Batavian Republic)' (De Vries, 2006, 3247). In 1617, the guild took residence in one of the former old city wall gateways (Saint Anthonispoort) *d.*1488, situated in the Nieuwmarkt. This medieval brick building, with round towers at each of its four corners was later called De Waag, as it also functioned as a 'weighhouse' for goods as they went in and out of Amsterdam. There is a seventeenth-century classical styled 'Bentheim Sandstone' surround to an entrance doorway of the north-east tower, in the pediment of which is a carved bust of Hendrick de Keyser, the master sculptor/mason, holding aloft a crowned trowel. The tools of the crafts of the bricklayer, mason, slater and 'pumpmaker' [plumber] surround him. These represent their four guilds, bricklayers being foremost, with three masters, one as Dean and two as surveyors, compared to one master for the masons and a single person serving as master for the other two crafts. These people met from three to five every Monday at De Waag (De Vries, 2006, 3250).

This particular doorway to the tower was once the entrance leading to a spiral stairway rising up to the first floor where the bricklayers/masons had two rooms. The first, and smaller, anteroom, where all income and payments were made, led directly into the main bricklayer's guild room, or 'metselaargilderkamer'. It was in the hallowed latter room, that the finest of the city's master bricklayers and masons would meet to discuss the mysteries of their craft and teach their finest apprentices advanced studies. One master, Simon Bosboom (1614–62), an artisan architect, translated and elaborated the popular Renaissance treatise, 'L'idea della architettura universale', by the Venetian architect Vincenzo Scamozzi (1548–1616), which originally appeared in 1615. A copy of the translation of this book was kept in the guild room and on the front page in reference to the apprentices who were encouraged to read it, Bosboom had written, 'Very easy for young pupils and useful for all young lovers of architecture' (Kurpershoek, 1997, 28).

From 1681 the city municipality, in order to maintain De Waag, had given the bricklayer's guild the authority to work on the fabric. This formalised what in fact had been a long-standing practice, for inside their guild rooms the bricklayers had decorated and improved the rooms by placing apprentice's masterpieces of gauged brickwork around the walls. These are part of the classical and more theoretical approach that was sweeping Dutch architecture at that time, deriving its heritage from the Renaissance and the classical proportions of the orders. Almost all of the original medieval wall surfaces of the guild rooms and spiral staircase, where the work follows the angle of rake (incline), are decorated with more than eighty masterpieces of very accurate and artistic seventeenth-century gauged brickwork around several walls, including the spiralled entrance (Fig. 42).

Figure 42

Early seventeenth-century gauged work following the spiralled staircase to the former 'Metselaarsgilderkamer', De Waag, St Anthonispoort, Amsterdam, Netherlands.

Amongst these masterpieces are niches (Fig. 43), oblique elliptical bullseye windows, semi-circular arched windows and several shapes of ornate blind ashlared panels; a number of which can also be seen on the outside of the building. In respect of the importance of these masterpieces, no one could join the guild as De Vries (2006, 3250) states:

> …unless he was a citizen and had prepared a masterpiece, for which he paid 13 guilders plus additional costs, among other things for inspection of the masterpiece and a 'certificate' in the form of the accompanying medallion and the testimonial, 63.13 guilders in all.

Kupershoek (1997, 28) describes the brickwork masterpieces so eloquently:

> The walls of the small room are full of proofs of very handsome bricklayer's work, every brick is sharpened and polished. Nothing was too difficult for these bricklayers; the brickwork frames, blind niches and niches are either broadened or narrowed, all made to different angles. Besides their craftsmanship, they showed their knowledge about perspective. All the brick frames form a depth that doesn't' really exist.

By 1691, due to misunderstandings and dispute, strict times were laid down for the execution of the masterpieces which varied from fourteen days for the plumbers up to a maximum of six weeks which was for the bricklayers (De Vries, 2006, 3250).

The work in De Waag is a consummate expression of classical gauged brickwork. The rubbed smooth brickwork of orange/red rubbing bricks are laid in regular Flemish or English bond with putty lime: silver sand joints of 1–2 mm in thickness. The majority of the masterpieces date mainly from the second quarter of the seventeenth century up to the early eighteenth century (Van der Horst, 1998), and are very similar to the best of post-Restoration English gauged brickwork in all respects. Bonded perfectly, these masterpieces are undoubtedly the work of bricklayers rather than masons and the influence on English gauged work is without dispute.

Figure 43

Hood of a seventeenth-century gauged niche masterpiece, De Waag, Amsterdam, Netherlands.

The premier example to all of this brick craftsmanship is just inside the door of the payment room of the guild. A beautiful niche, with a carved scallop-shelled boss, and framed with a cut-moulded architrave, is surmounted by a richly decorated pediment carried at either end by two turned, or 'Solomonic', columns on the capitals of which is carved the inscription 'Anno 1660' (Fig. 44). Thus confirming the high level of perfection that such fine gauged work had already reached in the Netherlands before the Great Fire of London of 1666. Originally above the niche was a poem, signed by guild brother, Hendrick Wourtesz, which began:

> Here is the tough [hard work] and proof of the laudable art of building… (Kupershoek, 1997, 28).

Kupershoek (1997, 28) continues that at the entrance to the guild room, off of the spiral staircase, was once another poem that read:

> But only by diligence and judgement, a pupil goes the stairs, of the seeked mastership, to his own honour and benefit.

The apprentices, providing evidence of self-consciousness, pride and encouragement, it would appear, liked the use of poems.

Figure 44

A 1660 masterpiece, De Waag, Amsterdam, which reveals the high quality of gauged work in the Netherlands from the second quarter of the seventeenth century.

These masterpieces were all worked from full-size orange/red bricks that had been deliberately worked to a much smaller scale laid with a mortar of lime putty with some silver sand. Measurements taken from some of the masterpieces averaged:

Stretcher – 148 mm
Header – 74 mm
Gauge – 25 mm
Bed joints – 1 mm
6 course gauge – 216 mm

On many of these gauged masterpieces the bed joints that average 1 mm with perpends averaging 0.5 mm, many of the latter were seen to have been achieved by the use of a 'dummy', or false, joint scored on the face of an appropriate full, or three-quarter, stretcher. All of the gauged brickwork masterpieces have been built and then finished by being rubbed to a smooth surface, though in some inaccessible parts of some brickwork, grooved striations, of varying depths, are occasionally visible. De Vries (2006, 3256–9) discusses the origin of these grooves, or 'hatches' in both the brickwork of De Waag and on other buildings, and discusses whether they were for aesthetic or technical effect. Quite rightly he emphasises that, 'In a number of other situations vertical grooves occur, which do not run on across the entire wall surface but were connected to individual bricks…' This is to eliminate the possible use of the steenschaaf as being responsible for the grooves. He theorises that they may have been placed onto the 'green-clay' brick from the mould, or 'with a piece of wood, a comb with teeth…' (De Vries, 2006, 3257). This reasoning is influenced by the belief that the darker red bricks, as opposed to the orange-red colour of other bricks used on the masterpieces, are therefore harder and not easy or indeed made to rub. Experience and research demonstrates that colour cannot be used as an indicator of hardness, the noted TLB rubbers, from the mid-nineteenth century onwards, were once available in both 'Cherry Red' and 'Orange' tones, and the famed Fareham rubbers were red. The presence of grooves, De Vries (2006, 3255) continues:

> …had a number of advantages for the construction: once the brickwork had been completed fewer bricks needed to be rubbed away, a possible 'post-firing surface' can be broken more easily, it is easier to remove the grindings through the grooves and a smooth surface develops, because the grooves serves as an indication for the measure of the layer to be rubbed away.

It is correct that those grooves would have helped in this respect, but it is doubtful that they were placed onto the brick in the green-clay moulding stage. Discussion with several experienced traditional brickmakers reveals that to create bricks with these grooves by throwing the clay into a mould with narrow flutings to its inside would be impracticable; given the nature of the clay and the addition of moulding sand to dust the box before casting the clot. Of course it is not impossible the grooves were 'combed' onto the surface of the green brick before firing, however, it is more likely that these were applied onto the surface of the brick post-fired, as part of its overall final preparation for gauged. The grooves are certainly not indicative of 'axing' nor the use of the steenschaaf, rather it is the author's opinion that they are the signs of 'freynen', the tooling of brick faces in the manner of the Flemish craftsmen, as discussed in Chapter 1. Some craftsmen were content leaving these grooves on their finished work, as the masons their 'tooled', 'furrowed', or 'boasted' faces on stone. Other craftsmen bricklayers, however, would see this as only the first stage in the overall post-fired working of bricks for rubbing to a smooth finish once the entire brick enrichment was constructed, as on the De Waag masterpieces. This is entirely consistent with other historic cut and rubbed and gauged work researched and surveyed by the author in Flanders and the Netherlands.

The author concluded that the reason the bricks had been worked so small on the masterpieces were so apprentices could prove mastery of the skill of geometry, fine cutting and setting skills on a scaled model, facilitating intricate detail but without using precious space within the guildrooms. Drawings for nine guild masterpieces are depicted, six of which are for the bricklayers and their relevant geometry and mathematics discussed, within 'Architectura of Bouw-Konst' (Architecture of Building Construction), *d.*1777 by Adrianus Erzy. He was an Amsterdam teacher of mathematics and architecture, who particularly emphasises the design, setting out and obtaining the templets; which in turn were made by carpenters. Four of the designs show three styles of square framed panels, plates LXII, LXIII and LXX, and the more difficult elliptical bullseye with mop-staff moulded oblique reveals, plate LXVI, are repeated several times over in De Waag (Fig. 45). The latter due to its complexity and being visible on both the outside and inside of the building, Erzy (1777, 10) is, '…often assigned to two persons as a masterpiece'.

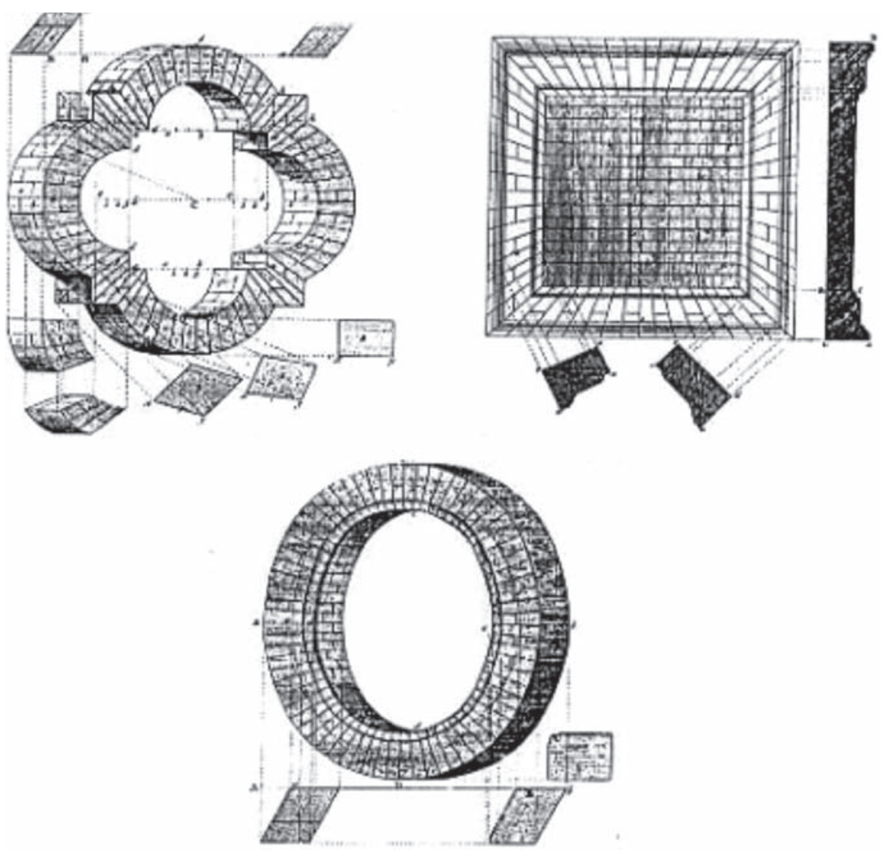


Figure 45

Three examples of drawings for Dutch bricklayer's masterpieces dated 1777, to be constructed in gauged brickwork and taken from 'Architectura of Bouw-Konst' by Adrianus Erzy 1777.

Two of these designs were reproduced several times in De Waag, St Anthienspoort, Amsterdam, Netherlands, over a century earlier.

Amersfoort

In the church tower of Onze Liewe Vrouwetoren in Amersfoort (1440–1500) there are three apprentices gildeproeven of gauged brickwork contemporary with those of De Waag. An arched niche, a splayed elliptical blind bullseye with cut-moulded reveals, and a double hearth vault (joining to form a shelf), broadly similar to the one in Leiden as mentioned above. This is also delightful gauged brickwork and executed to a high standard, but is rather more provincial in quality than the Amsterdam masterpieces.

Surprisingly, the use of this exquisite level of gauged brickwork for enrichments on Dutch properties, with some exceptions, appears largely restricted to use on half-bonded flat arches, and one is disappointed not to see anything matching the work of De Waag. Clearly even in the wealthy city of Amsterdam where they had perfected the skill, gauged work did not establish itself as a popular fashion. Perhaps this is due to the legendary puritanical austerity of the Protestant Dutch, compared to flamboyant Catholic Flanders, or simply that the high degree of accuracy and quality of their standard face brickwork was deemed sufficient for a premier elevation. Of course there are exceptions, and although not a seventeenth building, the very fine gauged work to the façade of 8, Hofplein, or 'Van der Perrehuis' (1765) in Middleburg, is particularly worthy of study.

Built as a grand home for a wealthy merchant of that name, the design encompasses two huge curved wing walls on either end, incorporating large gateways to the rear coach houses and stables, that lead gracefully to the central straight section, containing the main entrance. The entire façade is of gauged work, with ashlared orange-red rubbing bricks laid in English bond, and incorporating segmental arches and large semi-elliptical bullseye arches for the window openings with large semi-elliptical arches bridging the two carriageways. The jambs to the openings on the section of the curved walls, and therefore the 'springing' of those arches are by necessity splayed and the arch faces curved on plan as well as on elevation; what is termed in the craft 'circle-on-circle' work. The bricks, laid with joints of 1.5 mm, with perpends strictly maintained and to an eight course gauge of 324 mm, have been rubbed smooth to finish, revealing slight inclusions in their body. In a few areas joints are still coloured as a result of rubbing the brick dust into the fresh mortar during finishing.

Dutch Bricklayers in Post-Restoration London

Taking into account the dramatic improvement in the character and quality of post-fired worked brickwork that results in the production of Dutch-styled classical gauged work, one has to consider the possibility that bricklayers from the Netherlands were working in England, especially alongside the influential and highly-skilled city craftsmen.

It is not impossible that Dutch bricklayers, possibly from Leiden or Amsterdam, did come to London to ply their craft. The collapse of the 'tulip mania' commodities in 1637 could have been one economic reason and later, in the post-Restoration period, they may have come for the extensive re-building work in the city following the Great Fire of 1666. A Royal Proclamation to consolidate the Building Act of 1667 allowed 'foreigners' (native craftsmen living outside the old city boundaries and in the surrounding shires) as well as 'aliens' (craftsmen from abroad) liberty to work as freemen on the re-building. Working alone, or as a 'gang', Dutch bricklayers would have found much work specialising in producing elements of gauged brickwork. To date, however, extensive research in England and in the Netherlands has failed to find evidence to support this theory.

The names of these bricklayers may, of course, be anonymous within building accounts listed under an English Master Craftsman, or they may have anglicised their names; a common practice for immigrants. Certainly the city master bricklayer, Edward Helder (Holder) who was used by Wren on the Temple, has a Dutch surname, and his skills in gauged brickwork were undoubted (see Chapter 3.

Discussion with various architectural historians in the Netherlands suggests that the idea of a proliferation of Dutch bricklayers working in London to be negligible and unlikely. Dirk De Vries (De Vries, 1998), a respected senior historian with the Dutch Monumentonzorg who discussed the possibility with his colleague and noted historical architect, Wouter Kuyper (Kuyper, 1998), upholds this view:

> He (Kuyper) does not think that Dutch bricklayers came over to England, except two of four sons of Hendrick de Keyser, Willem (1613–74) and Hendrick the younger (1613–65).

It is of interest to note that Kuyper refers to these craftsmen as bricklayers, when we would term them stonemasons. The same terminological confusion does arise in Dutch transcripts, translated by a Dutch architectural historian, where many of the seventeenth-century master bricklayers, working out of Amsterdam, are sometimes referred to as stonemasons. One can see this as again, reinforcing the fact that when called upon these craftsmen could, and certainly did, cross from stonework to high-quality refined brickwork with consummate ease if called upon to do so.

Research has indicated that Willem and Hendrick de Keyser trained in England under their uncle, Nicholas Stone. By 1640, Willem was back in Amsterdam working as city mason from 1647–53. He then returned to England after he went bankrupt in 1658. Hendrick returned to London when Stone died in 1647.

If we are to accept that, in the main, Dutch bricklayers did not directly teach their fine skills in gauged work to the city bricklayers, then most clearly they learnt from them by several indirect means. From the Tudor and Jacobean bricklayer's work of hewing and rubbing brick mouldings, the Stuart craftsmen had simply continued to refine these skills, working with ever-improving bricks and demands for smaller mortar joints, through the architectural designs of the Artisan Mannerist movement, as influenced from the Netherlands. Craftsmen eagerly learning these new skills and techniques further reinforced this movement, made strong by the proliferation of pattern-books out of Antwerp.

Summary

The brickwork of the Jacobean and pre-Restoration periods was influenced by a combination of factors, including architectural writings from the Continent with designs based on the Renaissance. The rise of the Artisan Mannerist movement saw the continued refinement of the skills of master bricklayers and masons. These men, post-fired working an ever-improving quality of bricks, were able to achieve a much higher degree of accuracy, essential for classical detailing. This movement was largely led by respected artisan designers and was the key link to the full acceptance and development of Dutch-styled gauged brickwork that flowered in the post-Restoration period.

Case Study: Jigginstown House, 1635–37, Naas, County Kildare, Republic of Ireland

The Principal Architect's Perspective

By Ana Dolan, Senior Conservation Architect, The Office of Public Works, Ireland.

Jigginstown *d.*1635–37 is the earliest building in Ireland constructed mainly in brick and was built by Thomas Wentworth, Earl of Strafford. Wentworth was appointed Lord Lieutenant of Ireland in 1631 but he did not come over until July 1633. He was an ardent royalist and was eager to persuade Charles I to visit Ireland. He declared that there was no building suitable to lodge the royal household and decided to build a large palace in Naas, 21 miles south east of Dublin. The lands were acquired in 1635 and the main building was completed in 1637 at a cost of six thousand pounds. Jigginstown House, which Wentworth himself described as, *'built not only to excess but even to folly'* never received its Royal visitor. In 1640 Wentworth was recalled to England and impeached for treason. He was executed on Tower Hill in 1641, aged 48 declaring *'put not your trust in princes'*.

Jigginstown House is a unique construction in the history of Irish Architecture in terms of its scale and building material. The building is almost 400 feet long with the terrace range 315 feet in length. The main building consists of a two storey brick building supported on a stone plinth, which contains the basement level. On each end of the main building, there is a large pavilion positioned to the front of the central block connected by a single doorway. The brick vaulted basement level is not continuous and consists of three separate compartments with individual entrances. The style of the building cannot be linked to any particular architect, but, like many English nobles at that time, Strafford had travelled abroad and had a keen interest in Renaissance architecture and, indeed, he may have supervised the building programme and the artisan's work himself.

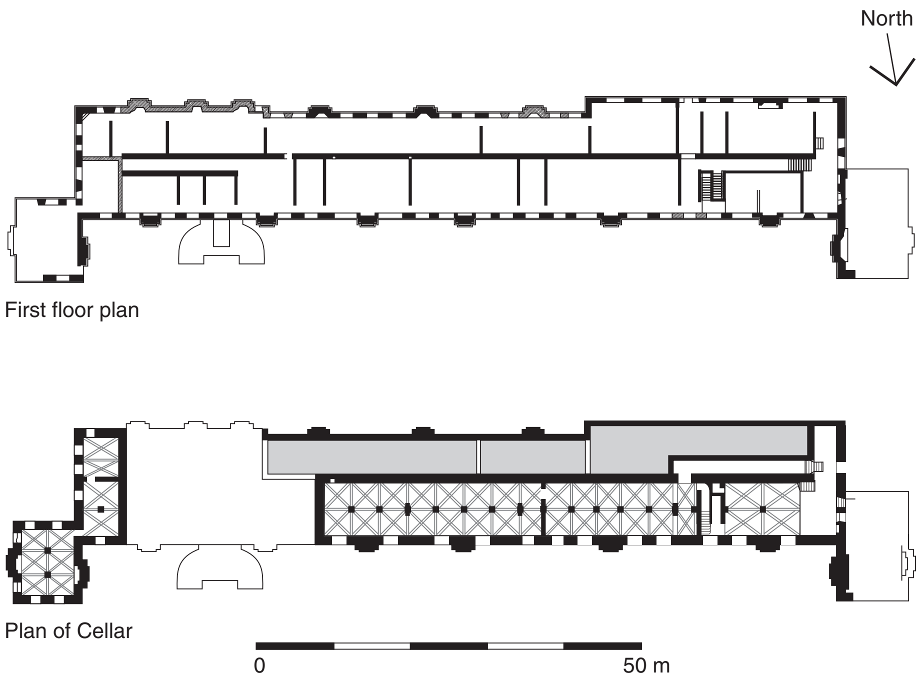


Figure 46

Plan of Jigginstown House, Naas, Co. Kildare, Ireland, *c.*1635–37, drawn by Kevin O'Brien. (Courtesy of Ana Dolan)

The layout of the interior and the elevations of the building are irregular and lack the restrained symmetry and simplicity of the buildings designed by Inigo Jones (Fig. 46). In terms of the plan and scale, the closest comparison that can be made is with the terrace range at Bolsover Castle, completed in the 1630s for William Cavendish, Duke of Newcastle, by John Smythson. At Jigginstown, the central rectangular block is divided longitudinally by spine wall running east-west. The larger rooms face the north or entrance side of the building with the smaller rooms facing onto the garden on the south side. There are no corridors in the internal layout with doors arranged *en filade* with large fireplaces on the external walls. The long gallery at Jigginstown is 90 feet in length and 15 feet in width and opens directly onto the upper part of the terraced garden.

The exterior of the building was decorated with elaborate polychromatic brickwork of two colours. The principal structural walls are made with red hand made bricks laid in Flemish bond with pointed ruled joints that had been colour washed, with decorative brick features in a tasteful combination of smaller buff-coloured bricks that link gracefully to the red brickwork. The external walls of the building have a continuous ornamental plinth course at ground floor level and a Platt band at first floor level. The external chimney-breasts have a slightly different ornamentation with a more complicated plinth detailing and Platt band. The very large window openings, that once had timber frames, externally had 'ordered' flat-arch heads with ornamental brick detailing, including a 'Cupids-Bow' design.

After the execution of the Earl of Strafford and the following years of the English Civil War, Jigginstown House was neglected and began to structurally deteriorate (Fig. 47). By the time of the Civil Survey of 1654–56, less than twenty years after it was completed, Jigginstown House was already beginning

Figure 47

Photograph of the ruins of Jigginstown House, Naas, Co. Kildare, Ireland. (Courtesy of Ana Dolan) to fall into ruins; which indicates the roof had been lost soon after completion. The first pictorial evidence of the house dates from 1726 when Edward Lovett Pearce was commissioned by Lord Burlington to investigate the ruin to see if Inigo Jones had designed it. Pearce studied and drew the building but concluded that due to its eccentricities Jones did not design it. Pearce's illustrations of 1726 show a building in ruins; the roof, the second floor and all decorative stonework are missing. Less than eighty years following completion, the building known as 'Strafford's folly' had become a picturesque ruin. Pearce recorded the brick enrichments, including the decorative polychromatic, carved, large span window heads of bonded blocks of red and buff bricks, which one precious single example survives as well as a single example of the first floor platt band level detail directly above it (Fig. 48).

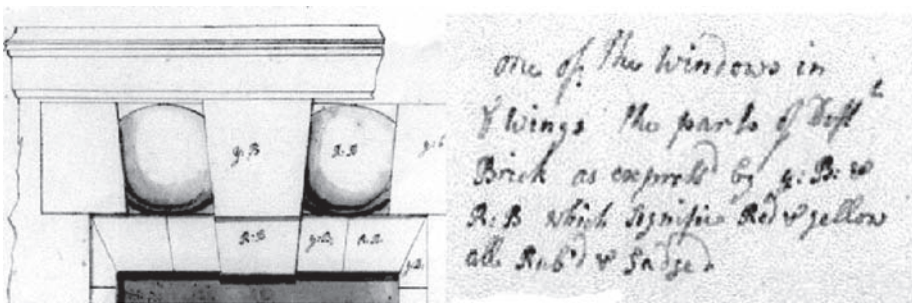


Figure 48

A detail from a drawing (1726) of Rub'd & Gadged brick enrichments, Jigginstown House, Naas, Co. Kildare, Ireland, *c.*1635–37 (Drawing number 4, Devonshire Collections, Chatsworth, Derbyshire, England). (Courtesy: Devonshire Collections, Chatsworth, Reproduced by permission of the Chatsworth Settlement Trustees)

Since 1971, Jigginstown House has been in the care of the National Monuments Service of the Office of Public Works (OPW). The Office of Public Works was founded in 1831 as a Government Department with responsibility for large infrastructural projects funded by the Exchequer. In 1871, following the Irish Church Act, a number of churches of antiquarian interest were transferred into the care of the OPW and the National Monument Service came into existence. Over the years, many different types of monuments were given over to the Department and a large portfolio of properties has been assembled. The National Monuments Service carries out maintenance and repairs to its properties using a direct labour force under the direction of the District Senior Architect. The direct labour force consists of qualified craftsmen such as masons, stonecutters, bricklayers and carpenters as well as apprentices and general operatives. The use of the direct labour force allows a wide range of in-house skills to be built up as well as specialist skills. Projects range from simple maintenance work to large, complex conservation projects such as Jigginstown House.

In 2002, a programme of conservation work was begun at Jigginstown. The principal objective is to stabilise and consolidate the original early seventeeth-century physical fabric of the building as far as possible and using traditional materials and techniques that is in harmony with the original construction. As part of this project we will be recording the existing physical remains and researching the original client, builders, materials, craft practices and other valuable sources of information. In the long term, when Jigginstown is conserved and structurally safe, we will be facilitating public access and interpretation. In the process we hope to learn and replicate the skills and materials used by the craftsmen who originally built the building and to publish the research and the remedial works carried out at Jigginstown.

The initial phase involved two seasons of archaeological excavations at the site as well as the immense task of surveying and recording of the building itself. The ruins of the building are extensive and, despite the fact they have been ruined for over three hundred and fifty years, in remarkably good condition. The brickwork, including the cut and rubbed dressings, had all been laid in hard lime mortar and then pointed with a separate and finer lime mortar that was 'ruled' to finish. An analysis of the mortars at Jigginstown carried out by Dr. Sara Pavia at Trinity College, Dublin, showed that the core bedding mortar for the three bricks-thick walls was a hot-mixed eminently hydraulic mix with 1:2 proportions of binder:aggregate. The pointing mortar was a feebly hydraulic mix containing fine sharp sand in a mix with 1:2 proportions of binder:aggregate. The strength of the bedding and pointing mortars are the principal reason that the building has survived so well. Indeed it has proved difficult to salvage any original bricks for re-use as the mortar is harder than the bricks. Any attempt to salvage bricks for re-use by cleaning off the mortar results in a pile of brick dust and fragments of near perfect mortar remains.

It became apparent that we would need specialist advice before tackling any brick repair work at Jigginstown. In March 2003, I travelled to England to the Weald and Downland Open Air Museum in Sussex to take part in a training course on the conservation and repair of historic brickwork by Gerard Lynch, Historic Brickwork Consultant, Master bricklayer and Author. I spoke to him about Jigginstown House and invited him over to Ireland to consult with us on the nature of the brickwork, the causes of its failure, how best to consolidate the ruin.

His first trip over was in September 2004 and we spent two days together on site examining the brickwork, and seeing it through his expert eyes. He was very quickly able to determine that all the buff-coloured bricks, originally selected for the dressings, had all been 'cut and rubbed' to shape. The tooling and abrading marks were readily apparent once shown to us. He also noted that these bricks were remarkably like Flemish bricks that he had seen and used during his time studying in Flanders. Dr Jane Fenlon, Architectural

Historian for the project, was able to inform him that this observation tied-in with an aspect of her findings, revealed in a letter written by Pearce stating that:

> *…the whole is better brick worke than ever I saw out of Holland and I believe both bricks and workmen came from thence, the best of their kinds* (Letter in Chatsworth Library from E.L. Pearce to Lord Burlington dated 24th October 1726)

Later, whilst examining for the first time copies of the Pearce drawings Gerard pointed out the hand-written account of the post-fired worked enrichments that described them as '*Rub'd and Gadged*' (see Fig. 48). He emphasised that Pearce was using later eighteenth-century terminology to describe the cut and rubbed work. Also, though the quality of this early seventeenth brickwork on Jigginstown House was very good, Pearce was being over generous in his praise, as it does not correspond to the high-quality work achieved by bricklayers in the Netherlands at that time. He, therefore, doubted Pearce's assertion that craftsmen from the Low Countries had been employed in its erection, believing it to be the work of English bricklayers who would have been well versed in such cutting and rubbing skills. Research into the origins of the clay used for the bricks carried out by Dr. Sara Pavia of Trinity College indicates that a local clay was used. Pearce's drawings show, though they have been ruined for over three hundred and fifty years, how all the chimney stacks were also detailed with 'cut and rubbed' buff bricks for the plinthed bases as well as the linked, projecting, heads above their slender red-brick shafts. There can be little doubt when this building was finished, the face brickwork would have been an impressive sight. Having read all the research material and discussed with all the timescale for the erection of this house, our historic brickwork consultant was of the opinion that it was built with a strong mortar to facilitate the rapid speed of its erection and survive the notoriously damp climate of Ireland. The grey appearance of the hard original vault mortar being indicative of the addition of a 'pozzolana' called 'trass' that was processed and sold by the Dutch. This again tied up with Dr. Fenlon's research that had revealed that a John Allen had acted as a 'factor' for the Dutch to sell their various building materials during the construction of Jigginstown House.

There are many different conservation and consolidation issues to be resolved at Jigginstown but initially, under our Historic Brickwork Consultant's guidance, we decided to concentrate on supporting the external brick facing on the front of the building. The external red brick sections between openings, which still showed widespread traces of the original colour washing, were literally hanging on to the front of the building without any visible means of support other than the strength of the mortar beds and collar joints (Fig. 49).

Figure 49

Colour washed face brickwork not tied-in to the backing masonry hanging unsupported as a result of a collapse of brickwork at the lower supporting plinth detailing. (Courtesy of Ana Dolan)

He informed us that this was an example of 'facadism', a seventeenth-century bricklaying practice of snapping headers from best face bricks to make two half-bats, gaining another aesthetic face brick rather than a full header. So essentially our wall was a deceit, of a quarter-bonded half-brick veneer with occasional headers tying to the inner brickwork. In order to support and ultimately save these suspended elements of original face brickwork and tie them back to the building it was decided to build up from the base stonework underneath, replicating the several courses of cut and rubbed moulded brickwork of the plinth where it was missing or badly damaged (Fig. 50). Kevin O'Brien, who is the Building Surveyor on the project, took copious measurements and made an overall drawing of the plinth detail for Gerard to examine. Upon his arrival back in England he re-worked everything from the first principles of geometry to make the overall template of the feature as well as the individual brick templets; just as the original seventeenth-century bricklayers would have drawn it. He also took with him several recorded examples of loosened bricks from this enrichment to assess the brick sizes and how they were rubbed to a polish finish on bed and hand-cut and abraded. Another task was to assess the colour, hardness and texture of the bricks with a view to sourcing a possible match for replacements.

In May 2005, Tom Speers, the District Works Manager and I travelled to the UK and spent a full and informative day with our Historic Brickwork Consultant in his workshop at his home. As there is no matching handmade

Figure 50

An area of failed plinth detailing to the right prior to replacement, alongside existing sound cut and rubbed plinth supporting the colour washed red face brickwork. (Courtesy of Ana Dolan)

pale buff bricks being made in Ireland, he had already located a suitable match from the Cambridgeshire Tile and Brick Co. Subsequently he had received some sample bricks and had cut and rubbed a replica of the decorative plinth. We were keen to learn more about cutting and rubbing skills and to assess the suitability of these new bricks for the repairs and re-building of lost sections of the various dressings at Jigginstown House. That day we watched him go through all the processes of rubbing the brick square to bed and face, scribing it to the templet, and then cutting and rubbing it to shape, using both the brick axe and the mason's mallet and chisel. We were particularly fascinated to see how his facsimile of a seventeenth-century 'Brick axe' was skilfully employed to hew the brick to the desired shape, just as the Jigginstown house bricks would have been all those centuries ago. He also emphasised and showed us that mason's tools can also be utilised to work mouldings too, just as he had seen many times in Flanders; where the bricks for many of their cut and rubbed enrichments are frequently built from harder calcareous bricks similar to the Jigginstown House bricks.

The day we spent with him enabled us to plan the next stage of the project. We discussed our specific education and training needs with him so our team of skilled craftsmen in Ireland could replicate the cut and rubbed brick details following their tuition with this master craftsman. Apart from this we would need his guidance in helping us to obtain the type and sizes of rubbing stones to initially prepare the bricks. These were made from an excellent source of

Irish sandstone and cut to size and shape by our stonemasons. We were also able to supply the flat marble slabs that were used as 'Bedding Slates' to 'scribe' and check any cut-moulded brick against its unique templet. Most of the correct tools for hand cutting and abrading the bricks were essentially mason's tools and equipment, and these we obtained from 'Harbro Supplies' in England. In particular we required several brick axes making and the same local blacksmith, Charles Head, of Bletchley, Buckinghamshire who had made Gerard's one subsequently made several for us.

Our own carpenters made several styles of 'chopping blocks', necessary to locate and hold each individual brick as it is cut-moulded, from a suitably robust hardwood, to the dimensions and shape provided. We needed precisely set out and cut templets for each brick moulding, within each of the cut-moulded enrichments, in order to scribe, work and in turn check each brick to. For just one of the varying plinth details there were five different brick profiles. It was decided that robust metal templets would be required for each one made as both a 'positive' and 'negative' and these were made by Bryan Harral, a highly skilled toolmaker and engineer. Later that year Kevin O'Brien and I flew into the UK and joined our Historic Brickwork Consultant on a visit to meet representatives of 'The Cambridge Brick and Tile Company' at their brickworks in Cambridgeshire. These are the sole manufacturers of handmade 'gault' bricks, and we had decided they were to be used for the restoration of the cut-moulded details. There we had a tour of the brickworks and followed the manufacturing process through each stage, and saw samples of their range of products. We discussed our specific needs and placed an order for delivery to Ireland ready for the New Year; and the next phase of works.

In June 2005, with all these things in place, we held our first bespoke workshop at our Dublin depot so that our consultant and master bricklayer could introduce and train the National Monument's bricklayers and masons and their apprentices to the art of cut and rubbed work. The District Works Manager and the Foremen also attended. Our craftsmen had no previous experience of the cut and rubbed work but were accustomed to conservation repairs in stonework. As part of the workshop, Gerard delivered a formal introduction on historic brickwork and the tools, materials and craft techniques required for the work. We concentrated on the traditional skills that he had detailed in his lecture and shown to Tom and I during our time in his workshop. After demonstrating each and every stage, he took special care to spend time with each craftsman helping and advising them on their individual techniques. Being a pragmatic craftsman himself, he also allowed for the fact that we could later use a mixture of power tools and hand cutting techniques, just as we do with our stonemasonry work. By the end of the training period, we had produced a credible copy of the decorative detail.

This work served as a model for us in the months that followed as our bricklayers and masons practiced and dutifully followed all they had learned preparing our first batch of cut-moulded bricks for Jigginstown House.

By October 2005, the gault bricks had been made and arrived in Ireland and our trained craftsmen set about cutting and rubbing some of them in earnest. Similar to historic craftsmen this work was scheduled for autumn and the winter months when little laying takes place. We had established a cutting shed area at our Dublin works and equipped this with all we would need, the rubbing stones, bedding slates and chopping blocks, as well as the brick axes and tungsten-tipped carving chisels and hand-stones. We also invested in a brand new electrically operated bench-mounted disc-cutter with diamond masonry blade. The first process was to rub all the bricks to be used so they were both flat on bed and face and square to one another. This was done on the large rubbing stone holding the brick with two hands and rubbing in a circular motion and then checking them with the try-square. Once all the bricks were squared they were then placed on the bedding slate alongside their templet and scribed to profile with a very sharp metal point. Each brick was numbered to match that on the templet for identification with the scribe. To save time all the excess brick material above the scribe lines was carefully cut away using the disc-cutter, ensuring each brick was safely clamped and not held by the operator. The bricks were now ready to be cut to shape and both axing and the mallet and the chisel did this in a similar manner to how stone is worked. To match the finish on the original Jigginstown bricks all was then rubbed smooth using the hand-stones or other shaped abrasives. As masons our team was very careful to ensure all waste was regularly cleaned away at all stages of cutting and any dust created was continually vacuumed up too.

When a large batch was made, we delivered them down to Jigginstown House ready to build some sample panels of a section of the plinth course on site. In consultation with both Gerard and Dr. Sara Pavia we had settled on a NHL 3.5 bedding mortar to a ratio of 1:2. In May 2006, our Historic Brickwork Consultant came back over to check on our overall progress and to undertake some further on-site training at Jigginstown House itself and, at my invitation, he critically examined the ‘sampler’ work that we had made. He was completely satisfied with the quality of the majority of the cut and rubbed brick units; advising on slight improvements where deemed necessary. In respect of the built sample of cut and rubbed brickwork, laid only the day before, he expressed satisfaction with it as a first trial, but with great diplomacy and respect for the efforts of the craftsmen who built it, he pointed out how it could be substantially improved. We re-examined the style and appearance of the surrounding cut and rubbed plinthed brickwork, with him highlighting the various original seventeenth-century bricklayers’ styles and nuances. This enabled us to see and note the differences between our new work and the old, allowing us to improve the aesthetics as well as the structural considerations.

Figure 51
The author demonstrating the setting out and building of the cut and rubbed plinth detailing working to lines strained from a profile template. (Courtesy of Ana Dolan)

Here, once again, the skill and expertise of a master craftsman came to the fore. Working alongside the craftsmen on the scaffolding, whilst they carefully disassembled their sample and neatly stacked their bricks according to type and position for their re-use, as he had directed, he quickly drew and then made a timber 'reverse template' of the complete plinth enrichment with our foreman, Willie Foley. This they carefully positioned and fixed to the wall, checking it for line, level and gauge to the existing run of the plinth; and ensuring all would meet precisely with the red face brickwork directly above. He further demonstrated how to set out the gauge of each course onto it so that it became a 'profile' for our craftsmen to strain lines further back along the original plinth from which they were laying. Now with all this in place he concentrated on the skills they required to lay the bricks so that the plinth course matched the original in every respect (Fig. 51). He got them first to 'dry-bond' the element and mark out the bonding of each and every course so it worked precisely to the original. The main structural emphasis, in order to fully meet up with and fully support the main red brickwork suspended above, was to tightly pack out behind each and every course of the facing bricks using off cuts from the cutting and grout with fresh mortar. The topmost course of cut-moulded plinths needed particular attention. It was vital to ram home, with a suitably sized batten, the final bed of stiff mortar so that the external red facing bricks were properly seated on top of a full bed of mortar on the plinth work and therefore fully bonded to the rest of the wall. The plinth brickwork was then carefully raked out for later pointing to match the rule-pointed finish of the surrounding original (Fig. 52).

Figure 52

The finished plinth a few months later after some gentle weathering and prior to pointing. (Courtesy of Ana Dolan)

We face many other challenges at Jigginstown but the importance of this first step cannot be underestimated. The restored section brick plinth is now beginning to weather and has lost the 'new' look. This work is just the first part of a long process in consolidating the structure, making it structurally safe, and presenting it to visitors. The primary concern now is to find a match for the red facing brick so that the next phase of work can continue after the cut and rubbed plinthed work is repaired and secure. The decorated heads of several of the large window openings are extremely unstable and some will have to be re-built. The internal splayed jambs of the windows, which are also of cut and rubbed bricks, will have to be built up to support the wide flat arches overhead. We may need to replace areas of exterior facing bricks in order to stabilise the main walls. Following recommendation, we have the services of John Addison, a pragmatic Structural Engineer with a real grasp of traditionally built masonry, to assist us with the works programme.

Our Historic Brickwork Consultant's role has been central in helping us with our examination of the building and understanding of the seventeenth-century construction techniques, and as a master craftsman, in how best to go about the numerous works of repairing and restoring the brickwork. He has played a key part in sourcing handmade materials and facilitating our conservation training requirements. His unique skill is a combination of his many years of hands-on training backed up with vast practical site experience and his passion for historical detailing. The Jigginstown project has been fortunate to benefit from all aspects of skills and personality.

Case Study: St. Mary's Chapel, *c.*1660, Historic St. Mary's City, Maryland, USA

Archaeology and Research

By Dr. Henry Miller, Director of Research, Historic St. Mary's, Maryland, USA

During the 1660s in the North American colony of Maryland, English settlers erected a unique religious building in the new capital of St. Mary's City. Its story is intimately connected to English expansion, religious persecution and the growing influence of an idea – liberty of conscience. Maryland was the proprietary colony of the English Catholic Baron of Baltimore, Cecil Calvert. Under his direction, the new colony was established in 1634 along the Potomac River near its confluence with the Chesapeake Bay. One of the most notable features of the colony was its policy of religious freedom for all Christians. (1)

Among the settlers were English Catholics and a small number of Jesuit priests. They built a wooden church in 1635 but it was burned a decade later after an attack on St. Mary's City related to the English Civil Wars. After the Restoration, significant growth of Maryland resumed and the first major brick building in the colony was erected. It was a church in the capital of St. Mary's City and was to serve as the center of Catholic worship. Indeed, when the Jesuits built it in the mid-1660s, this structure was the first major Catholic church erected in English America. As a freestanding church unconnected to a residence, it could not have been legally constructed in England or the English colonies at the time. Although stoutly built to long endure, the 'Chapel' at St. Mary's only served for Catholic worship for about 37 years. Due to a rebellion in 1689 that was stimulated by England's Glorious Revolution, Lord Baltimore lost control of the colony and it came under royal control. Initially, religious tolerance continued, although the Church of England was established as the official religion in 1692. Freedom to worship ended for Catholics in 1704, when the Royal Governor ordered the chapel at St. Mary's to be locked and never again be used. A decade or so later, the Jesuits demolished the structure and carted away nearly all of its above ground elements for reuse. Its remaining ruins and a surrounding cemetery were completely obliterated by farmers converting the land to agriculture in the 1750s. (2)

Long forgotten, the Chapel site was rediscovered in 1938 by architectural historian H. Chandlee Forman. He found a massive brick foundation in the shape of a Latin cross. (3) He reburied the foundation and its exact location was again lost. Fifty years later, Maryland's state museum – Historic St. Mary's City – began an archaeological project to fully uncover the foundations and recover as many fragments of the former structure as possible. Brick, mullion and jamb bricks, plaster and mortar, wrought nails and imported paving stone were recovered. Perhaps the greatest discovery was three 17th-century lead coffins buried inside the chapel, the first found by archaeologists in the New World. Project

Lead Coffin's scientists determined that the lead coffins contained members of Maryland's founding family – the Calverts, the likely patrons of the chapel. (4) In addition to the lead coffins, the burials of approximately 500 of Maryland's founders were found within and surrounding the chapel.

Analysis of the archaeological remains was supplemented by the collection of data about other 17th-century structures, period masonry practices, Catholic liturgical influences, and Jesuit architectural traditions. Despite extensive documentary research in America and Europe, no plans, drawings or detailed written descriptions of the 1660s brick chapel have been located. The only cursory description dates to 1697 when Royal Governor Sir Francis Nicholson wrote that the Jesuits had a few churches in Maryland, including 'a good brick chapel at St. Mary's.' (5)

The historical record is surprisingly silent about this significant structure. Consequently, archaeological evidence, architectural precedents, ecclesiastical traditions, and Jesuit practices are the only means of understanding this long lost building. Excavations showed that the structure had solid brick foundations laid in English bond that were three feet wide and extended below ground level five feet. (6) Its exterior dimensions were 54 feet long and 57 feet across at the transepts, with a nave 28 feet in width. Compared to the tiny wooden houses built in Maryland during the 17th century, this was a very large and impressive building. During the excavations, molded jamb and mullion bricks and some cut bricks were recovered, along with window glass and turned window lead fragments. Flat roofing tile fragments with peg holes indicate the nature of the building's roof. Its interior walls were covered with plaster, as attested by a large number of plaster specimens with brick traces on their backside. The near absence of plaster specimens with lathe marks indicates that the ceiling was not plastered; it more likely had a wooden ceiling in the form of a barrel vault. Excavators recovered many fragments of sandstone flooring pavers that geological analysis indicate were from England or the Continent. Based upon one nearly complete paver, over 20 tons of stone were imported to cover the floor. A major problem for the archaeologists is the thoroughness of the Jesuit's salvaging efforts. They carted away approx. 98% of the above ground elements. Because of this intense recycling effort, less common masonry elements such as water table and other cut and rubbed bricks were rarely recovered. Compounding this problem is over 200 years of plowing that further fragmented the remains. Given this situation, every architectural clue recovered from the site is of much significance.

At the same time, information from other sources is vital. Surviving brick structures of the era offer valuable insights regarding architectural practices, styles, and precedents. Regrettably, no other Jesuit chapels were built in English America during the 17th or early 18th centuries; in fact, only a few masonry structures from that era survive in the United States. Consequently, structures in England, Europe and from other parts of the world must be relied upon. Information about the people who executed the design and construction would normally be invaluable but we unfortunately know nothing about them. Most of the masons were likely English trained and the designer of the Chapel was almost certainly a Jesuit, since they owned the church, and Jesuits typically planned their churches throughout the world. All English Jesuits had continental education and experience and were familiar with the current styles of Jesuit religious architecture.

The HSMC museum's research efforts resulted in a solid general sense of what the original building was like (7) but the project required the services of professional architects with substantial experience on historic structures to fully design a reconstruction. In 1997, the museum solicited bids from qualified firms in the United States and after evaluation of the applicants, the firm of Mesick, Cohen, Wilson, and Baker, Architects, Inc. of Albany, New York was hired. Lead architects were John Mesick and Jeffrey Baker and they came to St. Mary's City to begin planning for a reconstruction. When completed, the building is not intended to be a church but a museum exhibit that presents the compelling Chapel story and the rise and fall of religious freedom in early America. As a permanent exhibit, the reconstruction has to reflect the best available scholarship, must consider the unique political and social setting of early Maryland, and would be built using the most authentic materials and methods possible. John Mesick suggested and the museum agreed that the project could serve as an experiment in historical building technology, using the effort to relearn forgotten skills and testing hypotheses about colonial construction.

Citations

1. Krugler, John D. *English and Catholic: The Lords Baltimore in the Seventeenth Century.* Baltimore: John's Hopkins University Press, 2004.
2. This history is summarized in Riordan, Timothy B., Silas D. Hurry and Henry M. Miller *'A Good Brick Chappell': The Archaeology of the c. 1667 Catholic Chapel at St. Mary's City, Maryland.* Report on file at the Department of Research, Historic St. Mary's City, St. Mary's City, Maryland, 1995.
3. Forman, Henry Chandlee, *Jamestown and St. Mary's: Buried Cities of Romance.* Baltimore: Johns Hopkins University Press, 1938.
4. Miller, Henry M., Silas D. Hurry and Timothy B. Riordan, 'The Lead Coffins of St. Mary's City: An Exploration of Life and Death in Early Maryland. *Maryland Historical Magazine* 99(3): 351–373. 2004.
5. The Nicholson quote is found in *Archives of Maryland* 23: 81.
6. All the archaeological evidence for the chapel is presented in the manuscript report by Riordan, Hurry and Miller *'A Good Brick Chappell': The Archaeology of the c.1667 Catholic Chapel at St. Mary's City, Maryland.* 1995.
7. The basic design information is summarized in Miller, Henry M. *Architectural Design of the ca. 1667 Brick Chapel Exhibit at St. Mary's City.* Final Grant Report prepare for the Maryland Historical Trust, Annapolis, Maryland. 1997.

The Architect's Perspective

By John Mesick, Senior Architect, Mesick, Cohen, Wilson and Baker LLP, Albany, New York.

More than a decade has now elapsed since we were engaged as architects for the reconstruction of the Jesuit Chapel at St. Mary's City. In many respects, our role was more akin to the Jesuits instigating the original project, who had to rely on the building skills of craftsmen to realize the design they had in mind. Today, architects usually are perceived as the central figure in the creation of buildings. After assessing the owner's needs and desires, designs are devised and ultimately detailed in extensive construction documents. However, in this endeavor, the role of artisan and craftsman actually was restored in the construction process, as it had been throughout much of the world in the seventeenth century. The artisans became the principal undertakers in realizing the structure. As we became the beneficiaries of the many individuals enlisted in the project, whose deeper knowledge shaped the final result in ways unimagined at the onset.

First, after years of fieldwork, artifact analysis and archival research, the archaeological team of Henry Miller, Timothy Reardon and Silas Hurry established what could be deduced from surviving physical evidence. Then as the project approached the construction phase, we turned to two extraordinary restoration masons in Virginia for guidance. Both had worked with us on the restoration of Thomas Jefferson's rural retreat, Poplar Forest. Henry Cersley of Charlottesville had independently retrieved the craft of molding bricks from local clays and firing them in a wood-burning kiln. We turned to Henry to produce bricks for the reconstruction from clay taken nearby the site. While working on 'Poplar Forest', after reading eighteenth century builder's manuals, he realized the proper way to work up lime mortar was to beat or pound it (rather than using a hoe to stir it). This technique facilitated the introduction of air into the mix, thereby, accelerating the carbonization of the lime by blending CO_2 more readily into the mortar.

During this same period Jimmy Price of Monroe, Virginia, while he also was engaged in the work at 'Poplar Forest', began experimenting with the burning of limestone in a wood-fired kiln. With reliance on historic texts and after a couple of years of trial and error attempts, he succeeded in producing quicklime in a low temperature kiln. This lime proved more reactive than the modern material produced at high temperature. He now was able to make available to restoration masons a lime that could replicate the properties of historic mortars. Realizing that firing oyster shells had produced the lime used at St. Mary's, Jimmy undertook another experiment, and again succeeded in producing marvellous lime from the shells.

In August, 2002, Jimmy Price enticed Historic Brickwork Consultant and Master bricklayer Gerard Lynch to visit St. Mary's City and to observe the exposed foundations as well as the archaeological artifacts of the Chapel, and my colleague Jeff Baker and I were introduced to him. Upon examining the Chapel bricks, he was of the opinion that the bricks had been clamp-fired rather than kiln-fired. While this fact had eluded us, he pointed out that the bricks were most likely close-stacked rather than open-stacked method of firing in a kiln of that period that often leaves tell-tale 'kiss-marks' on the faces. This made sense. The chapel was the first brick structure erected in the colony, and its construction required a huge quantity of brick.

After St. Mary's, we joined him and Jimmy on a tour of early masonry structures in Virginia. The sites visited included Jamestown with its church tower of 1638 and artifact collection in the archaeological laboratory there; under the care of Curator Blye Straube. St. Luke's Church at Smithfield dating from the late 1600s, Bacon's Castle nearby from *c.*1665; and Colonial Williamsburg. On several of these buildings Gerard detected surviving evidence of colour wash and pencilling. At all these sites, he also observed the telltale signs of scribe lines and chiselling on shaped bricks which we were informed came as a result of the bricks being worked post-fired with tools such as the brick axe. Heretofore, we had assumed green-clay molding produced shaped bricks, and that their rough surface resulted from centuries of weathering. It was now evident to us that masons cutting rather than green-clay molding formed most of the shaped bricks found at St. Mary's.

Subsequently, in the autumn, we began to develop final designs for the chapel. Robert Pierpont, an architect on our staff, well versed in traditional architectures, undertook an exploration of alternative designs for the exterior of the Chapel. Working with the voluminous data Jeff Baker and I had gathered on our research trips in the Virginian tidewater region, in England and the low countries. This was together with a growing file of the architecture of 17th century churches erected by the order of Jesuits around the world; he soon came to the realization that the façade historically was the principal area of architecture concern. As modern architects, who had been trained to consider the integration of interior spaces with the entire exterior design as an essential challenge, we had nearly lost sight of the powerful expressive force traditionally assigned to the frontal aspect of even free-standing buildings. Hence, the search for an appropriate façade composition resulted in dozens of schemes to organize the façade.

Several 'givens' and numerous 'precedents' guided the reinvention of the façade. The three foot wide foundations extended five feet into good soil where a couple of feet would have sufficed. Palladio and other Renaissance architects stipulated that foundations should be one-fifth the height of their walls.

Therefore, we construed this evidence as indicative of walls extending 25 feet above grade [ground level] – a great height for an early church in colonial British America – but it was a Jesuit Church! From surviving roof tile, we knew plain tile had clad the roof that dictated a roof slope of 'true pitch' or approximately 47°. Archival reference to 'pyramids [obelisks] at the base of all four gables in the specifications for both the 1670s capitol building at St. Mary's and at St. Ann's Church (Anglican) in Annapolis in the 1690s, gave us a strong hint that this common feature on significant Baroque period buildings may well have first made an appearance at the Chapel. Pyramids, obelisks or finials are almost always associated with parapet gables (where the walls project up beyond the roof plane); hence, we assumed the cruciform plan presented parapet gables to the four cardinal points of the compass surmounted by obelisks. Thomas M. Lucas S.J., an eminent historian of Jesuit architecture from the University of San Francisco, who served as a consultant on the project, remarked that the Jesuits in Maryland (educated in Flanders and Rome) would surely have known the works of Serlio and Vignola. These Renaissance architects wrote influential books setting forth the principle orders of Classical Roman architecture. Vignola was the original designer of the Gesu, the Jesuits' principal church in Rome (1560s). Realizing that a temple fronted façade, composed of pilasters surmounted by an entablature – all arranged according to classical precepts – had in all likelihood been adopted by the Jesuits (Fig. 53), we gradually arrived

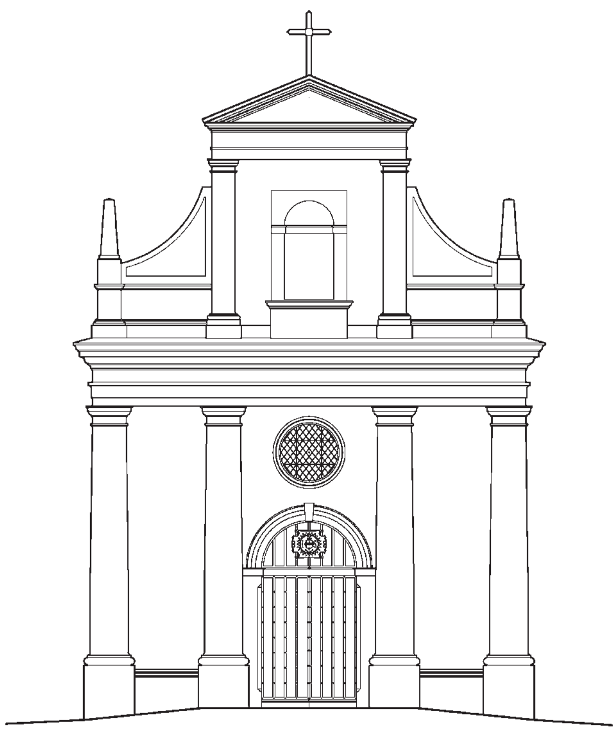


Figure 53

Drawing of the front west elevation of St. Mary's Chapel. (Courtesy of Mesick, Cohen, Wilson and Baker Architects) at a design that incorporated the known elements with others more conjectural, but most likely to have been incorporated in the façade (i.e. circular windows, niche(s), scroll gables, and a crowning pediment).

Early in 2003 with the façade design nearly coalesced, Jeff Baker and I visited Gerard Lynch in England early in 2003. Jimmy and his mason brother-in-law, Gerry Campbell, had already been working in his workshop for a week being introduced to the brick axe and learning the skills of cutting and rubbing. While we were there we learned the techniques of color washing of brickwork and the pencilling of mortar joints, which was commonly used to finish many brick façades during the fifteenth to the eighteenth centuries in Europe and subsequently in colonial America. He also took us to visit a large number of brick structures of those periods, across parts of central England where evidence of this was clearly in evidence, once one knew where to look; given the centuries of weathering. He also shared his discoveries concerning the great influence of the 'Red Masons' of the Netherlands and Flanders on the evolution of English brickwork.

From the fall of 2002 through five successive building seasons, and through the dedicated work of Jimmy, Gerry and a team of craftsmen, the Chapel walls of traditional bricks and lime mortar, enriched with cut and rubbed brick moldings, have now risen to their full height. Still surrounded by a scaffolding composed of rope-lashed poles, 'put logs' and planks, the walls await the imminent construction of a timber framed roof structure and installation of tiling used in its construction is also further evidence of how clamps would have been used to fire the large numbers of standard bricks required which the brick masons would then have simply shaped to suit their needs. The grand total is approximately 315,000 bricks of all types. This figure includes 295,000 Cushwa bricks (a Maryland brickmaking company) which were used for the back-up brickwork. 26,000+/− wood-fired bricks were made from clay obtained near to the site of the original source in St. Mary's City, that was analysed to ensure a match, excavated and carted to Charlottesville to be produced by Henry Cersley, traditional brickmaker. These bricks were used for the exterior face (to be color washed) and all 6,300 cut and rubbed molded brick shapes; together with 850 mullion bricks and 1,300 jamb bricks.

Upon completion the articulated façade will be rendered with lime stucco and joints pencilled to imitate stone construction, while the brickwork of the remaining walls will be color washed and pencilled.

Once again, the Jesuit Chapel will stand in the midst of a forgotten burial ground. Whether the reconstruction would be recognizable to the original builders we shall never know. But, by utilizing only traditional materials, original construction techniques and craftsmen endowed with unique understanding and skills, we have come in closer contact with the building world of the 1660s in Maryland than any of us could have realized a decade ago.

The Brickmason's Perspective

By James W. Price, Master Brickmason, Price Masonry, Monroe, Virginia

I formed Price Masonry Contractors in 1975, building residential, industrial, and commercial properties. We have always been involved on restoration projects, due to my own passion for historic masonry, but in 1988 we shifted our direction to primarily historic preservation. While performing the masonry restoration at President Thomas Jefferson's Villa Retreat 'Poplar Forest', we discovered that no 'truly' traditional mortars were being produced in the United States. The caliber of this project demanded the highest level in authenticity, so we set forth and built our first lime kiln to produce the quicklime for the mortars, plasters, as well as the limewashes that would be used in our works of restoration. The fruit of this endeavor was the creation of Virginia Lime Works, which, in the years that have passed, has had the honor of supplying materials to historic preservation projects throughout the United States, Canada, and the Caribbean. Today Price Masonry Contractors still maintains two crews working in the field of restoration; one currently at 'Montpelier' home of our fourth President, James Madison (1751–1836), and the other, being my own personal project, the reconstruction of the Chapel at St Mary's City.

When approached to be part of the team in the reconstruction of the Chapel, we immediately were aware of the impact this recreation could have. Although this is not the biggest project, nor the most expensive, we felt that this would become one of the most significant in the United States. The foundation which was created to pursue the reconstruction, the archaeologists, and the architects, all expressed a fervent belief that the chapel should be re-built using traditional materials that were common in the late 17th century. Our desire was not only to use traditional materials, but also the historic craft techniques employed by the masons of 1660.

In my research into traditional masonry, I came across the works of Gerard Lynch and via my contacts in the United Kingdom; I decided that no one in America could offer the same degree of input for the traditional techniques to be employed at the Chapel. All interested parties made the decision that a site visit by him to Maryland would be of great benefit to the project. During this visit, numerous seventeenth century sites were toured and the project developed into a more defined direction.

Through our discussions I was introduced to the subjects of traditional 'cut and rubbed' techniques of brickwork and also of color wash and pencilling, all of which would be heavily utilized in the recreation. As a result of this consultancy a visit was arranged and myself and fellow bricklayer Jerry Campbell, travelled to Lynch's workshop in Woburn Sands, Buckinghamshire for a weeklong masterclass in order to train and gain hands on experience in these skills. While there the architects for the project, John Mesick and Jeff Baker, of Mesick, Cohen, Wilson and Baker, Architects from Albany, New York, joined all three of us to tour British sites of significant brick-built buildings of the same period as the St. Mary's Chapel. Now, with this newfound knowledge and skills – and the foundation work on site complete – the primary reconstruction could commence.

Through mortar analysis on original mortar from the foundation, it was determined that an oyster-shell lime mortar was used. This came as no surprise because of the abundance of oyster-shell that had been discarded by hundreds of years of consumption by Native Americans, and became a readily available source of Calcium Carbonate. The St. Mary's City Foundation provided three tractor and trailer loads (approximately 600 bushels) of Chesapeake Bay Oyster-shells for use in mortar for the exterior face brickwork and interior finish plaster for the Chapel. The oyster-shells were then loaded into our lime kiln, which is an incorporation of both traditional design with my own modifications, and fired. Softwoods such as pine are normally utilized in burning, producing long flames that incorporate the burning zone with relatively little ash. The kiln is burned for approximately a day. We were able to source an ASTM graded sand which matched the color and gradient of the original sand, which was used with the quicklime to produce the hot mixed mortars used in the reconstruction.

Archaeological evidence had revealed that the original bricks used to build the church were made near to the site of the chapel. To get compatible modern replacement bricks it was eventually decided to go for handmade, slop-molded and wood fired face brick for the external walls, along with a factory produced 'Cushwa' wood mold brick to be used for the backup walling. These were subsequently ordered and later delivered to the site.

Two pole and canvas sheds were set up on site. The first allowed the protected preparation of all the lime mortars prior to any bricklaying. The second to facilitate the large quantity of hand carved brick preparation that would eventually be used on the project, such as the cut-molded plinth, arch voussoirs, and capitals to the ashlared pilasters with entasis, a niche and the terminal cornice. By cutting and rubbing our decorative brickwork the bricklayer could make very true shapes, and exactly the profile that was needed, with no distortion (which can be caused during the firing process of green-molded shapes), with proper returns, and maintain bonds.

The Cutting Shed was set out and equipped in the manner I had seen during my time in England, where we had been kindly allowed to take photographs and precise measurements of tools and equipment in order to get replicas made upon our return.

The layout of the shed was such that each 'Red Mason' would only be one step away from everything he would need, increasing productivity and efficiency. Primarily cutting and rubbing was performed on days with inclement weather. In the center of the shed, just behind the bankers, lay two large rubbing stones, made of Briar Hill Sandstone bedded on brick piers for rubbing the bricks square prior to cutting to profile and for truing work. Each side was equipped with, upon the bricks to be cut-molded were first rubbed flat on bed and then stretcher and header faces rubbed to be at 90 degrees to the bed and one another. Two benches, or 'bankers' large enough for both executing carving work and for the setting out, scribing and then checking the final accuracy of the cut-molded brick shapes on the 'bedding slate'. Each banker was also equipped with two specially shaped timber 'chopping blocks to hold the brick in a reclined angle on a right-angled seating' to allow for carving header and stretcher shapes, as well as the templets required for the various shapes. A total of 110 templets were made for all the cut and rubbed moldings (Fig. 54).

Figure 54
Various templets prepared from a full size drawing. (Courtesy of Price Masonry)

The templets were taken from full-size drawings of the architectural feature drawn by the architects and the apprentices made each templet of a gauged sheet metal on site. Following a pattern obtained from the iron brick axe we used to cut and dress the moldings in England, I had brick axes made by a blacksmith in Lexington, Virginia. One issue that had to be dealt with was the hardness and strength of the brick. Although the bricks were made in a traditional manner they were much harder than the traditional rubbing brick that we had worked with whilst in England. Therefore in the carving of these shapes, traditional stonemasonry techniques were also incorporated. Two Stonemasons, Andrew Bradley from the National Trust's Culzean Castle and Graham Campbell of Historic Scotland's Elgin Training Centre, whom I trained with on my Quinque fellowship, were of great help in dealing with the differences in the brick. Gerard had a similar experience while visiting with Flemish craftsmen applying similar skills because of the hardness of the brick, and this was supported by the techniques of stonemason and author Dr. Peter Hill.

True to traditional practice, during our winter off season cutting and rubbing was continued in our shop. The layout although similar to that on-site, could accommodate four bricklayers at one time (Fig. 55). A bench-mounted masonry saw with a 14″ diamond blade was utilized to remove excess waste, and the bricks were then cut and rubbed to the desired finished profile by hand.

Figure 55

Winter working – preparing cut and rubbed moldings at the cutting benches. (Courtesy of Price Masonry)

These bricks were then checked against the templet on the bedding slate and labeled for identification, palletized, wrapped, and shipped to site in preparation of the next building season. There was also a need for a method of laying out important cut and rubbed masonry details such as arches (Fig. 56), finials [pyramids], and other enriched work. Within our workshop a 12 ft by 12 ft drafting 'wall' was fabricated to allow the design to be drawn and to layout the full-size brick features.

Figure 56

Constructing the upper half of a large bullseye window, of cut-molded voussoirs, to the west elevation of St. Mary's Chapel. (Courtesy of Price Masonry)

On site at the chapel mock-ups were constructed of the walling to illustrate the use of stucco, color wash and pencilling and after three years of weathering and some extreme exposure the materials are performing exceptionally well.

Further testing however is still continuing, primarily in the performance of natural versus synthetic pigments in color wash, and the heating (or simmering) to initiate the mordant within the color wash. It is imperative that this structure is color washed due to the high degree of capillarity and permeability found in non-hydraulic oyster-shell mortar and this structure's close proximity to the ocean; the site being exposed to a long season of fluctuating freeze-thaw cycles. Not only will the color wash offer a stunning finish to the structure, known to have been used on a large number of historic colonial buildings, but it will also act as a protective skin to the masonry. The color wash will offer a traditional and practical solution to this natural problem.

Figure 57
Sample panel of color wash and pencilled brickwork in front of the new building work of St. Mary's Chapel. (Courtesy of Price Masonry)

Other issues that had to be addressed were the layout and direction of construction. It may seem odd, but due to the positioning of the chapel, it was necessary to build in a clockwise (not counter clockwise) direction. The chapel is laid out, as all Christian churches, on an east-west axis, which kept the north wall in constant shade and the south wall in constant exposure. By changing direction I was able to provide a maximum amount of curing time for these 'cooler' elevations. By living the experience, I feel that a campaign of color wash at the end of each season would need to occur when work is to be continued the next year. Reed mats, combined with straw, or tarpaulins would be needed to cover the wall heads. This would help protect the three foot thick masonry walls through the freezing winters, in the days before the thermal rated synthetic materials we enjoy today when the curing mortars would be most susceptible.

Re-living the experience of the seventeenth century bricklayer was made complete by the use of traditional putlog scaffolding in the 'Chapel's' re-construction (Fig. 58). Extensive research was performed into techniques that varied from Roman technology to the United State Army Corps of Engineers' guidelines on wood scaffolding. A full set of working drawings were made and presented for approval by a structural engineer. The scaffolding was then load tested, and this met, and indeed exceeded all requirements. For increased safety and support, toe boards, handrails, and guardrails were constructed. With the exception of the uppermost scaffolding, all work of lifting materials to the masons working on this scaffolding was performed by only two men, utilizing a traditional block and tackle. Also, due the numerous original graves still within the chapel and its ground a traditional windlass took the place of a forklift to hoist materials from the ground.

Figure 58

St. Mary's Chapel with its cut and rubbed enrichments, in the summer of 2006, with traditional pole scaffolding still in place, awaiting its final finishing treatments.

It was always my intention to promote this work as a world class project. The experiences, techniques, practices that have been learned and used on this project have been the education of a lifetime, and it is my goal to share this with as many people as possible. I have been fortunate enough to be able to include craftsmen and building professionals both nationally and internationally in this endeavor. From skilled American brick masons, Jamaican apprentices to National Park Service employees, Scottish Stonemasons, Architects, Conservators, and Engineers, I truly hope that the information that I have been able to share has been of service to the field of traditional masonry.

The friendship that has subsequently developed between Gerard and myself is invaluable. His passion for traditional brick masonry and willingness to share his knowledge will ensure that the work of the seventeenth century mason will continue well into the twenty-first century.

3

Post-Restoration to the Georgian Period (1660–1714)

Introduction

This period was brimming with fundamental changes in architectural styles and craft practices that had a tremendous effect on the influential city designers and bricklayers; stamping forever an indelible character on English brickwork. With it came the prolific use of a new, Dutch influenced, class of post-fired worked brickwork, prepared by first rubbing the bed and the stretcher and header faces of each brick flat and at right angles to each other prior to cut-moulding the faces to the desired profile. This enabled the work to be set, with narrow mortar joints, where it is impossible to adjust the bedding of an irregular shaped brick to present a plumb face, to precise standards of accuracy, and neatness hitherto unknown. This class of brickwork quickly became known as 'gauged work'.

Commercially and politically, England was well acquainted with her wealthy and influential Dutch neighbour, as Kuyper (1980, 210) records:

> For the seventeenth century Londoner, it was easier to travel from England to Holland than it was to visit Lincolnshire or Cornwall: even in 1700 it was easier for a London merchant to send a letter to a correspondent in Amsterdam than to a customer in Hull.

During the Interregnum, many aristocrats, members of the Royal Court, and their extensive Royalist entourage, were exiled to Europe. A large number spent time in the Netherlands, including King Charles II, who stayed at the Mauritshuis in The Hague on the eve of his return to England. At the highest level, therefore, this country was very alert to anything of note taking place in the economic and cultural circles of the Netherlands, and, in particular, the hugely rich and influential city of Amsterdam.

In terms of the Dutch architectural influence that brought with it the use of fine brickwork, Kuyper (1980, 205) affirms:

> A retrospective view shows that it was not only the severe Classicist style of between 1630 and 1670 that provided models for English architecture, but also De Keyser's earlier transitional manner and the later Dutch architecture of between 1670 and 1700, the so-called Flat style.

At the Restoration, in 1660, King Charles II reconstituted The Royal Office of Works, granting positions to most of those who had served him in exile. Commissioners, architects, and city craftsmen alike, their close professional and social inter-relationships spread rapidly and assimilated the new architectural styles, materials and craft practices that proliferate at this momentous time.

Brickmaking

Some late seventeenth-century brickmakers continued to use the slop moulding technique while others used more refined methods of pallet moulding, in which a 'stock board' was nailed to the bench. In this process the 'puddled' clay was dashed into the dampened mould, which, like the stock board, was dusted with sand to prevent the clay sticking. The excess clay was then cut off from the top and the surface smoothed with a dampened stick called a 'strike'. The mould was then lifted off the stock and the brick turned out on to a timber pallet board for removal on the hack barrow to the drying hack (Hammond, 1981, 11). This method of moulding produced a firm de-moulded 'green' brick and reduced drying time required prior to firing.

There can be little doubt that this form of moulding helped make a brick that was even better suited to being readily abraded than its predecessor. The addition of sand also helps to prevent shrinkage, warping and cracking, and reduces the hardness of the brick body.

Naturally occurring silica or, within certain limits, added silica sand is an important component within a rubbing brick. Providing one was located on the right type of clean, high-silica-bearing brickearth or clay, then the material for the rubbing bricks was the same as for standard bricks. It would not necessarily undergo any special treatment, such as washing, pugging and/or screening, to distinguish the bricks from the processes involved in normal clay preparation, especially if the brickmaker was on a rich seam of sieved down-washed alluvial material. Records are limited on this level of information, but absence of evidence must never be taken as evidence of absence. Individual brickmakers would do what was best to make a quality suitable to meet a booming market.

In the drying phase it was possible to lay out the green bricks on-edge immediately and within a few weeks to stack them into a 'hack', involving long rows built to a height of up to eight courses. When half-dry the rows of bricks would then be 'skintled' (scattered), set slantwise and further apart to complete drying. Hacking took between three to six weeks in which the brick lost about one quarter of its weight (Hammond, 1981, 19).

Firing bricks in clamps still dominated where demand was large, but occasional. Improvements in permanent kilns had led to the introduction of the roofless intermittent up-draught 'scotch' kiln, which was essentially based on the principle of the clamp (Woodforde, 1976, 60). This was more controllable and less expensive on fuel (wood and coal), than its less sophisticated predecessors. As a general procedure the kiln-fired bricks would be lightly fired for several days to prevent warping, then the heat was increased for two or more days. The fire holes, which also acted as vents were then blocked and the fire was allowed to burn out (Hammond, 1981, 22). The kiln had to be left to cool down between seven and ten days before finally removing and grading the bricks for use.

In the firing phase, however, more care might be exercised, such as placing bricks to be used as rubbers within a protected area, what brickmakers term a 'box', within the top third of the clamp, to help ensure the desired temperature (R Ireland, 2003). Alternatively, they might be reserved for a more controlled firing in a kiln; still possibly set within a box. This special treatment allowed for the extra price charged for rubbers, which could return a handsome profit over their standard bricks (Bolton and Hendry, 1940, Volume XVII, 54).

The rubbing bricks may be considered as those baked to a point just short of vitrification, within the kiln or clamp, either deliberately or naturally protected from the more intense heat by their proximity to the other bricks that themselves went on to partial or full vitrification. A visit to a clamp that was in the process of being unloaded in Boom, near Antwerp, in which over 650,000 bricks had been fired showed the bricks to be carefully graded in terms of colour, hardness, and other criteria for quality and loaded on to pallets for dispatch. Amongst this wide variation of fired bricks it was possible to select bricks that were capable of being easily cut and rubbed (Fig. 59).

Preparation of a rubber has been described by Lamb and Shepherd (1996, 68–70). The brickearth was wash-milled and pumped into a 'washback' lined with sand, in which the material is allowed to settle and mature for several months. More sand was added when moulding the bricks, and, after drying they were kiln-fired at a temperature of 1,140°C. This, however, is far too generalised a description, some of which is better suited to the second half of the nineteenth century. Also the temperature of 1,140°C is too high for producing rubbers.

During this period the over-wintered brickearth, or clay, would have been tempered to a soft consistency for moulding, utilising on-site sand to aid release from the timber mould/form. The bricks, after drying sufficiently, would then

Figure 59

Baked and over-burnt brick fresh from out of a clamp firing in Boom, near Antwerp, Belgium.

have been fired in the clamp or kiln using mainly wood or coal as fuel. The advantage of timber has been discussed earlier with a lower overall temperature than coal, averaging 850–950°C. This temperature is significant, because at 900°C vitrification begins to occur, and a fireskin develops on the brick face. This prevents the brick performing as a rubber due to the increasing hardness and mineralogical changes within the brick.

It has been repeatedly shown through chemical analysis of traditional rubbers that the best of them come from a top stratum of down-wash alluvial silt and loam-like clean material. This has a naturally high silica content, such as indicated in Lamb and Shepherd (1996, 68–70) (Table 1).

The results of chemical analysis carried out on samples of both standard face bricks and augured brickearth taken from within the boundary of Aspley House in Aspley Guise (Bedfordshire) (1692) were similar to the above general analysis; in particular the high silica contents in excess of 80% (Table 2).

Geological tests carried out by Ceram Research on samples collected from Aspley House, and the results analysed by the late Professor John Prentice, indicated that the bricks had been made from the on-site brickearth (Prentice, 1996, 1–6). Furthermore, a print of a painting of Aspley House clearly shows how it was left standing high upon the original ground level due to the surrounding excavation for brickearth to the front and sides of the property (Fig. 60). Today this mound and depression have been subtly landscaped (Fig. 61).

Table 1 Typical Components of Brickearth (Lamb and Shepherd, 1996, 68–70).

Components	%
Silica (SiO_2)	79.59
Alumina (Al_2O_3)	9.88
Ferric oxide (Fe_2O_3)	4.78
Magnesia (MgO)	0.95
Lime (CaO)	0.96
Soda (Na_2O)	0.82
Potash (K_2O)	2.10
Titania (TiO_2)	0.80
Phosphorus pentoxide (P_2O_5)	0.06
Nitric acid (HNO_3)	0.06

Table 2 Aspley House Brick Sample – Chemical Analysis (Ceram Research, 1996).

Components	%
Silica (SiO_2)	82.7
Alumina (Al_2O_3)	8.53
Ferric oxide (Fe_2O_3)	4.88
Magnesia (MgO)	0.58
Lime (CaO)	0.36
Soda (Na_2O)	0.18
Potash (K_2O)	1.41
Titania (TiO_2)	0.67
Phosphorus pentoxide (P_2O_5)	0.09
Chromium sesquioxide (Cr_2O_3)	0.01
Manganic oxide (Mn_3O_4)	0.03
Zirconia (ZrO_2)	0.07
Barium oxide (BaO)	0.03

The use of brickearth from within the curtilage of Aspley House would have reduced brick costs by 50% or more. Searle (1936, 67) states '…an acre 1ft. [305 mm] deep, or about 1,600 cubic yards [1.223 m^3] of clay, will make 1,000,000 bricks'.

Figure 60 **Figure 61**

Prints of *c.*1800, showing Aspley House, Aspley Guise (Bedfordshire), 1692, clearly depicting the lowering of the ground to excavate the brickearth, alongside a modern photograph of the house and the now gracefully landscaped frontage.

The huge numbers of bricks that were required for this property and the use of the on-site brickearth strongly suggest clamp rather than kiln-burnt bricks.

It was clear that the best of these Aspley House bricks in terms of regularity of shape, consistency of texture and colour were selected, after firing, for use as rubbers for the gauged enrichments (such as flat arches and Platt band). Cutting and rubbing a number of these original face bricks during preparation for the above testing showed them to behave (300 years on) like the very best of rubbing bricks; clean-bodied with occasional small inclusions. These presented no difficulties and were very common in most rubbers up to the mid-nineteenth century.

As Prentice (1996, 1–2) states:

> The house is situated on the outcrop of Lower Greensand (Cretaceous Age). This predominantly is a sand formation, and at first sights not thought of as suitable for the production of bricks. However, the lower stratigraphic level of this formation, on which 'Aspley House' is sited contain much argillaceous material, and could be used to produce a satisfactory, if somewhat weak, building brick.

Winslow Hall in Buckinghamshire (1698–1701) (Fig. 62) was built by Sir William Lowndes (1652–1724) who, through his official position as the Chancellor of the Exchequer, was in professional communication with Sir Christopher Wren. Wren closely examined the accounts for the construction of Winslow Hall for the owner, records of which appear in The Wren Society (Bolton and Hendry, 1940, Volume XVII, 54).

The property, constructed in the Anglo-Dutch style, has gauged brick enrichments for the arches, reveals to the openings, piers in the front garden, and a vaulted basement. The master bricklayer was John Yeomans [or Yemens] (Colvin, 1995, 1134). Transactions for the bricks made for Winslow Hall are given as follows (Bolton and Hendry, 1940, Volume XVII, 54).

Figure 62

Winslow Hall, Winslow (Buckinghamshire), 1698–1701.

No of Bricks	Bricks Made by	Location	Cost PM (1000)	£	S	d
778700	John Stutsberry	Norden	14sh	545	1	10
51300	Margaret Deely	Winslow	17sh 6 ½d	45	0	4
163850	John Spratley	Winslow	17sh 8½d	145	5	3
5000	Richard Snag	Tattenhall	15sh	3	15	0
7000	Thomas Edmonds	Stukely	18sh	6	6	0
35000	From the old house pulled down	Winslow	14sh	24	10	0
In all 1,040,850 Bricks burnt in Kilnes cost				*£769.18.05d*		
Rubbing bricks			**Cost PM (1000)**	**£**	**S**	**d**
46200	John Stutsberry	Norden and Astons Lane	£13.6	54	5	9
14650	Richard Redell	Stony Stratford	24sh	17	11	8
24000	Edward West	Dunsanger	30sh	36	0	0
2000	Richard Snag	Tottenhall	£1.4.0	2	8	0
12600	John Baily	Bletchley	£1.11.11	20	2	0
In all 99,450 Rubbing Bricks burnt in Kilnes cost				*£130.7.5d*		
1,140,300 Total of all Bricks.						
Extras. Including £10 Filling Pits at Norden. Building a Kiln £20. &c.				£69	12	11
			Total	£969	17	9
Note. The carriage of Bricks, 95,53,50 (the rest being included in the price, Cost £81.3.3 about 1sh 8½d per M).				£ 83	3	3
			Total	£1051	1	0

The conclusion is worked out that ordinary Bricks came to 17sh 5¼ per M and Rubbing Bricks to £1.8.10¼ when all charges are included.

This provides yet more proof of the practice of using locally produced bricks, with the 99,450 standard-sized rubbing bricks purchased for Winslow Hall all being obtained from brickyards within seven miles of Winslow. Also, it shows how important it is not to misunderstand Moxon who writes (1703, 239):

> But the beft Earsth that we have in England for making of Bricks, is in the County of Kent, from whence we have moft of the Bricks which are Rubbed and Hewed for the Ornaments of the chief Fronts in the City of London….

He correctly states that best rubbers were to be had by being picked-out from amongst good-quality brick. It is frequently incorrectly stated and recorded (Lamb and Shepherd, 1996, 68) that true red rubbers are a unique blend of brickearth confined to Berkshire and Kent. This is simply not correct. These counties (like Moxon's Kent) were mentioned in seventeenth- and eighteenth-century documents because of their close proximity and ability to transport – by sea and river – bricks into London.

Moore (1996, 14) reveals how two small amounts of 'Rubbing Bricke' were delivered for the enrichments of Coughton Court (Warwickshire) from Worcester by horse and cart in July and September 1665 (a distance of 18 miles), as the coal-fuelled clamped bricks produced locally were not of sufficient quality. Hughes (1994, 107), quoting Surbey's diary entry for work in Nottingham on Monday, 29th May 1699, writes 'Bricks are 12s 6d per thousand delivered, very good and will rub. Carriage is here excluded.'

In essence, both brickearth and clays of varying quality, sufficient to make rubbers, exists over various areas of England. They are, however, no longer exploited as they once were.

For the building of Marlborough House, London (1709–11), designed by both Sir Christopher Wren and his son, also called Christopher (1675–1747), including gauged work with large niches, the bricks were imported (The Wren Society, Bolton and Hendry, Volume VII, 1934, 227):

> Dutch bricks were used in the construction of the house, rather smaller than those made in England, redder in colour and cheaper, being brought in as ballast in hired transports then coming and going between Holland and Deptford.

The brickwork of the century from 1660 is considered (Lynch, 1994, 44–5):

> …by many authorities to be some of the finest artistic and skilful achievements in the world. Bricklayers, especially those in London where the centre of commercial and social activity lay, were keen to be recognised as intelligent, articulate and highly skilled. They had to be conversant with and able to reproduce the latest architectural fashions and craft practices.

The influence of classical architecture and the popular use of brick in the city in the refined manner of the Dutch were central to the acceptance and subsequent prolific use of gauged brickwork from this period. The traditional practice on some principal elevations of colour washing and pencilling joints did not always fully reduce the impact of the many busy units. A better, though expensive, solution was to use colour-matched bricks, 'baked' rather than 'burned', and easily cut and rubbed to precise shape and dimensions – rubbing bricks. These could be accurately prepared for setting by dipping into a screened mortar of lime putty: fine sand, though termed a 'putty joint', with joints frequently of 3 mm or less in width thus allowing the classical detailing to be displayed from a broad façade.

From now on, therefore, one begins to see less references to 'hewn' brick, and more to bricks that are to be 'ground' and/or 'gauged', such as at Pembroke College, Cambridge, where in a contract for the brickwork of the chapel dated 16th May 1663, Clarke (1886, 155) records:

> …and that the Heads and sides of all the bricks w^{ch} shall appear outwards shall be all ground, and fine ioynts [joints] made.

The ultimate aim of presenting the brick enrichment or ashlared façade with a smooth, rubbed surface of carefully ground, and colour-matched gauged rubbing bricks, was to de-materialise the outside appearance by reducing the joint widths to almost zero. To achieve this the bed and face of each brick needed first to be rubbed square, or at 90 degrees to one another, prior to cutting to size or shape, enabling the brick to present a flat surface to the façade once laid on its fine mortar bed. This not only homogenised the overall surface, but also created precision in preparation and presentation of plain and enriched works of finely jointed masonry that was an integral part of the rich Renaissance/classical heritage.

Gauged brickwork was, and remains, the ultimate refinement and expression of the bricklayer's craft, with setting out, cutting and abrading to shape, and setting and finishing the brickwork to a very high degree of precision. This was an essential requirement in late seventeenth-century England, where face brickwork was to be employed so that the classical articulation of the structure might be displayed from a broad, smooth façade, and not visually distracted by the 'busy' effect of many warped bricks and thick mortar joints. A good example of such use is at Kimbolton Castle (Huntingdonshire), where the East Side of the courtyard was re-fronted with ashlared gauged work set in Flemish bond, and carved stone dressings in a classical style between 1690–95. Since 1950 the home of Kimbolton School, but formerly the residence of the Montagu family; bearing the title Earl of Manchester. The family was loyal to King Charles I, who restored their lost honours during the Restoration, and this work was carried out under Charles Montagu (1660–1721), 4th Earl and 1st Duke of Manchester. Oswald (1968, 2) states:

> The four fronts were faced with rubbed bricks of a rich red colour… This work, it is believed, was to the design of architect Henry Bell (1653–1715) of Kings Lynn.

The Great Fire of London, 2nd–6th September 1666, caused extreme destruction, destroying 13,200 houses, and eighty-six of the one hundred and six churches (Campbell, 2002, 10) in the timber-built medieval city. The ashes were barely cold when Charles II issued a Royal Proclamation, consolidated by the Building Act of 8th May 1667, which ordained:

> And that they [the Surveyors] do encourage and give directions to all Builders for ornament sake, that the Ornaments and projections of the Front-Buildings to be rubbed Bricks: and that all the naked part of the walls may be done of rough Bricks neatly wrought, or all rubbed….

The use of fine rubbed brickwork detailing was clearly highly regarded and seen as an integral part of the better bricklayer's range of skills, thus allowing it to be specified for the enrichments of the proposed new properties.

The knowledge of Dutch craft practices and their materials was clearly being propagated through deeply-read leading architects and close friends like May, Pratt, Hooke and, of course, Wren. Ideas would have been discussed at great length with the best of the city master bricklayers, many of whom were also well read, to help achieve the degree of enrichment and level of refinement required. Certainly Moxon's writings on the work of the city bricklayer, effectively a seventeenth-century manual on brickwork, reveal how essential craft knowledge, skill in setting out geometry, and working post-fired bricks was considered to be.

Despite high levels of skills, contemporary craftsmen were not being as fully trained as their foreign counterparts, which was itself the subject of some concern (Beard, 1981, 11):

> In a long statement in An Account of Architects and Architecture which John Evelyn appended in 1664 to his translation of Freart's Parallele de L'Architecture, he wrote that he thought English 'mechanicks' impatient at being directed and unwilling to recognise failure, there was a current arrogance, he thought, which implied that craftsmen were unwilling to be taught their trade further when they had served an apprenticeship and worked for gentleman who were satisfied with their endeavours. He did admit that our craftsmen were capable of exceeding 'even the most exquisite of other countries' when they set their minds to it

This was still of concern 30 years later (Beard, 1981, 120):

> The humbler abilities of the majority of craftsmen were pin-pointed by Sir Christopher Wren. Writing in 1694 to the Treasurer of Christ's Hospital, he

> indicated the fundamental weakness in English training; what was wrong was the lack of education in designing or drawing. Craftsmen were capable of copying a foreign pattern so well that often they exceeded the original, but they could not measure against the common training, which everybody in Italy, France and the Low Countries pretends to more or less.

Despite these criticisms, it is freely admitted that native craftsmen in England were undeniably capable of following foreign designs within their own trade and matching, if not excelling, quality of execution. The sheer proliferation of gauged brickwork being used on English brick buildings by the 1670s tells us clearly that the native bricklayers accepted new levels of precision and quickly became supremely confident in the highest standards of its use. So much so, that the use of gauged work was fully absorbed into the repertoire of a good bricklayer's craft skills, and its use became prolific.

It is an irony that the hugely increased volume of work using brick for re-building the area of the city destroyed by the Great Fire of 1666, should have brought disaster to the Tylers and Bricklayers Company controlling the craft. 'Freemen' bricklayers were hopelessly inadequate in numbers to tackle the job of reconstruction, yet company rules excluded craftsmen from the provinces (or 'foreigners' as they were referred to). Parliament dealt quickly with this matter, in the Re-Building Act of 1667, decreeing all craftsmen who were not freemen of the city would, upon being set to reconstruction work, be entitled to the same privileges and, 'enjoy the same liberty to work as freemen of the said City for and during their natural lives…'.

Craftsmen flocked from the provinces to London to secure work under state protection. The Company was active in examining 'journeymen' for evidence of apprenticeships in distant towns, to ensure they were proficient and to prevent them working in any other trade. Ruthless speculators were also involved in re-developing London like Nicholas Barbon (*c.*1640–98) who from the 1670s was responsible for developing standardisation and mass-production in brick-built housing (Summerson, 1947, 31), that also helped to originate the form of the classic town house that dominated throughout the following eighteenth century.

An outcome of the enforced union of city and foreign bricklayers from the late 1660s was the adoption of the high skills displayed in gauged brickwork and some pointing styles. At a time when news and fashions normally travelled slowly, these sophisticated techniques spread rapidly across the country when the foreign bricklayers returned home, enriching the craft nationally. This trend, along with the fact that there was a tradition for country boy's being apprenticed in the city (Webb, 1996, vii) helped to pave the way for the building practices of the following Georgian period.

The return to the native shires of some of these bricklayers can only have helped spread nationally and rapidly the knowledge and skills of gauged brickwork beyond the closed confines of the Bricklayer's Company in London. One must, however, also acknowledge Moxon's pioneering publications, *Mechanick Exercises: OR, The Doctrine of Handy-Works. Applied to the ART of Bricklayers Work* (1703).

Some discontented freemen-bricklayers emigrated to the American colonies in the late seventeenth century, mainly because of a large slump in activity following the boom years. They took with them, as did the first craftsmen settlers, their traditions, skills and styles to states such as Virginia and Maryland and also founded American branches of the livery companies. Virginia was a colonial commonwealth; particularly wealthy from growing tobacco and cotton, where a tradition for fine brickwork grew up (Barksdale Maynard, 2000, 32).

Cut and Rubbed and Gauged Work in Early Colonial America

As in Jamestown, Virginia, founded in 1607, the first buildings were built in timber, but from the earliest settling of the American colonies brick began to be made and employed. Evidence of this has been found in the Dutch early seventeenth-century settlement at Renselaar in the Hudson Valley and at New Amsterdam; ceded to the British Crown in 1664 and re-named New York. As Lucas (1997, 146) records:

> Brick kilns were operative at Salem, Massachusetts, in 1629 and a decade later, in and around Hartford and New Haven, Connecticut. Brickmaking in and around Burlington in 1683 prompted the issue of regulatory laws by the General Assembly of New Jesey. From such small beginnings a regular trade in the manufacture and use of bricks developed, aiding the creation of colonial, later state capitals, at Williamsburg, Annapolis, Philadelphia, Providence and Boston, and providing the Eastern Seaboard with specimens of colonial brick architecture that are now revered.

Inevitably the brickmakers and bricklayers followed English practices and traditions in which they were steeped. The brickmakers would have quickly determined the quality and potential to make bricks, including rubbing quality, as were made in England. As Lucas (1997, 146) states:

> A memoir of Virginia in 1623 recorded that in that colony the clay for brickmaking was widespread; the desire for building in brick was already present and the first capital of the Commonwealth of Virginia, Jamestown was made up of houses with brick foundations and a parish church which, after a series of timber forebears, was walled solely in brick.

The brickmaking process of digging, weathering the clay, and moulding, drying and firing the bricks was broadly based on the same English seasonal practices. Bricks were moulded to a size that was little different to the typical English brick, which were wood-fired in either clamps or updraught kilns. Most brickmakers were also bricklayers, as Lucas (1997, 151) emphasises:

> Thomas Eames, resident in Medford, Massachusetts, described himself as 'Brickelayer, and maker of bricke' when in 1660 he took Joseph Mirrible as apprentice, agreeing to instruct him 'in the art and trade of a brickelayer, and brickemaker'. Contracts in seventeenth-century Virginia assumed that bricklayers made the bricks they would need to lay.

Among the first use of brick for building were places of worship, where the architectural styles, brick types and craft techniques initially employed owe much to the late sixteenth ecclesiastical and early seventeenth vernacular buildings of England and the Low Countries. English bond was at first popular with the bricklayers, but in the later seventeenth century was replaced on the premier façades by Flemish bond, and header bond, which enjoyed some popularity from the 1740s in parts of southern England, appears on some façades in the second half of that century. Although purpose-moulded special shapes were used, the prolific skills of cutting and rubbing bricks among the majority of English bricklayers meant it was frequently employed for cut-mouldings and tracery on churches like:

- St. Mary's Chapel, St. Mary's City (*c* 1660), Maryland (see case study, p. 111). The first brick structure erected in the state.
- St. Luke's, Newport Parish (*c*.1685), Isle of Wight County, Virginia, is the states oldest surviving church, and the only one to be built with an original tower as a feature. Much of the tracery of cut and rubbed work is original, but has been replaced down the years (Fig. 63).
- St. Peters Parish church (1701–03), New Kent County, Virginia – Cornelius Hall bricklayer for the body of the church built 1701–03. Williams Walker was the undertaker of the tower in 1740, but the bricklayer is unknown, though Williams employed one named William Frazer for a parsonage nearby at the same time (C. Lounsbury, 2006).
- Bruton Parish church (1715), Williamsburg, Virginia.

The same English influences are to be seen on the major sixteenth- and early seventeenth-century brick-built domestic and civic buildings in Virginia, like Bacon's Castle (*c*.1665), Surry County with its so called 'Dutch' gables and diagonally-set shafts. As the fashion for classical, Anglo-Dutch style and use of refined gauged work became popular, spreading out to the rural shires of England in the late seventeenth century, so it was by the early 1700s that this style and its associated craft practices began to be seen in the colonies. Colonial church building in Virginia was coming under similar influences

Figure 63

Cut-moulded mullion at St. Luke's, Newport Parish, Virginia.

too. Good examples are the gauged brickwork frontispieces, as employed for Thomas Nelson House, Yorktown (*d.*1729), the west door of St. John's parish church (*c.*1731–34), King William County, and for St. Stephen's Parish, King and Queen's County, now known as Lower (Mattaponi Baptist) church (*c.*1730–35), 30 miles north of Williamsburg. The latter being the handiwork of master bricklayer David Minitree, discussed later in Chapter 4.

Virginia's richest planter was Robert 'King' Carter of Corotoman, Lancaster County, discussed below, who built Christ Church in (1732) there; by as yet unknown bricklayers. Hume (1993–94, 16) states:

> '…its gauged and rubbed brick doorways [frontispieces], one with an arched and the other an appexed pediment, were closely paralleled by the north and south entrances to Rosewell'.

Further examples of gauged work are flat, or 'Jack', arches on the largely original 1700 front of 'The Wren Building' and similar arches and platt band, or

Figure 64

A gauged arch with projecting keystone below a gauged belt course at 'Rosewell', Gloucester County, Virginia, 1726–37. (Courtesy of Mesick, Cohen, Wilson and Baker Architects)

'belt course', on The Brafferton (1723) and the President's House (1732) at the College of William and Mary in Colonial Williamsburg, Virginia. There are also some fine gauged arches in the ruins of 'Rosewell' (1726–37), Gloucester County, Virginia (Fig. 64 – see also page 228 where 'Rosewell' is discussed further). According to Carl Lounsbury Senior Architectural Historian, Colonial Williamsburg, the latter is possibly by Minitree.

There are a collection of cut and rubbed and gauged bricks from the first Jamestown Church, and the Statehouse (Fig. 65), under the care of the Senior Curator for the Jamestown Rediscovery Project of the Association for the Preservation of Virginia Antiquities (APVA). Among the collection are:

1. An example of a surviving cut-moulded brick from Jamestown Church which was built in 1640. This subsequently burned and was either repaired or re-built at a later date. This brick was later used as a paving, placed on its ornamental side down and bed up. Evidence suggests that this brick may have been part of the base of a frontispiece that was on the church as early as the 1640s. It could, however, be from a late 1670s rebuild that was subsequently taken down when a tower was added in the 1690s.
2. Brick mullions (cavetto mouldings) also from the church, which possibly date from 1640s and 1650s or alternatively are from the 1670s re-building.
3. A cut-moulded brick from the Statehouse in Jamestown with traces of red wash found on it. This brick came from the excavations of the site in 1906. The statehouse was begun in the mid-1660s, rebuilt 1684–85 after a fire in 1676 and abandoned after a further fire in 1698, when the Capitol building moved to Williamsburg.

Figure 65

A selection of cut-moulded rubbing bricks out of the archival collection of the Jamestown Rediscovery Project (left to right as 1–3 above). (Courtesy of the Jamestown Rediscovery Project of the Association for the Preservation of Virginia Antiquities)

Post-Restoration English Gauged Brickwork

This dramatic change in the design and detailing of English brick buildings is most noticeable within a 50 to 60 mile radius of the city, especially from the 1690s. This can be seen in both country and town residences of the wealthy and rising new breed of middle-class merchants. One need only look to such properties as, Aspley House, Aspley Guise (Bedfordshire) (1692), Winslow Hall, Winslow (Buckinghamshire) (1699–1702); The Grange, Farnham, (Surrey) (1702); Pallant House, Chichester (Sussex) (*c.*1713); and, at the dawn of the Georgian period, Bradbourne, Larkfield (Kent) (1714). Brunskill and Clifton-Taylor (1977, 32–3) in describing the fine brickwork of Pallant House, suggest that:

> …not only are the window-heads exquisitely gauged and provided with a carved emblem on every key-block, but… cut back at their base in delicately recessed curves….

Lloyd (1925, 216) describes most eloquently the contrasting colour and precision of the ornamental gauged brickwork to the standard brickwork of the east wing of Bradbourne:

> …The dressings are bright red bricks gauged. The pilasters are built of buff stocks with bright red bricks at the angles; all gauged and only one course in six bonds with the wallings.

The differences in gauging of rubbed work to the adjoining standard facework is the manifestation of the problem Pratt (below) pondered. With almost all bricks moulded to a similar size, once the rubbers were abraded, cut, and set with the tight joint for gauged work it could not be maintained to a complementary gauge with the standard facework laid with nominal joints throughout the height of the structure (Fig. 66).

Figure 66

The difference in the vertical gauge of the standard brickwork to the ashlared gauged work at 8, Market Place, Woburn (Bedfordshire), *c.*1730.

The nation's long and deep affection for brickwork and the emergence of the popular classicist style of architecture facilitated a rapid acceptance of Dutch-styled gauged brickwork at all levels of design and use. The flowering of science, the arts and of craftsmanship of the highest order characterises post-Restoration England, and gauged work, within the art of the bricklayer, simply embodied the spirit of that age. Charles II was patron of the Royal Society, formed in 1660, for improving national knowledge at a time when science pervaded everything, including architecture. The nation began to take a renewed pride in itself, emerging as a world leader with London, and not Amsterdam, at its centre.

In examining the acceptance and correct use of gauged brickwork and how the associated knowledge and skills were disseminated, it is important to obtain an overview of four key architects. In the Restoration of 1660, King Charles II reconstituted The Royal Office of Works, granting positions to those who had served him in exile. These were Sir Hugh May (1621–84), Sir Roger Pratt (1620–85), and later Sir Christopher Wren (1632–1723), and Dr. Robert Hooke (1635–1703). These men were scholars, some were travelled, and all were well read, and greatly influenced by the fashionable continental designs and craft practices expounded in the pattern and design books that were coming into England from Europe, particularly the Netherlands. They were also closely associated with each other socially and professionally, and with the influential master bricklayers in the city. Documents, accounts, and diaries of these men show them to have been frequently meeting and dining with the master craftsmen and discussing proposed and current projects.

Sir Hugh May

The architect Sir Hugh May was the seventh son of John May of Mid-Lavant, near Chichester (Sussex), and cousin to Baptist May (1629–98) keeper of the King's privy purse. As Nicholls (1993, 445) writes:

> Little is known of his early career before the Restoration, but it is likely that his appointment on 29 June 1660 as paymaster of the Works indicates services rendered to the court in exile, rather than architectural activity.

Yet, as Nicholls (1993, 455) emphasises:

> …he proved himself …to be an inspired choice. May became one of the outstanding architects of the seventeenth century… In 1665–6 he joined with Sir Roger Pratt and Sir Christopher Wren in advising on the repair of old St. Paul's cathedral, and after the great fire was appointed as one of the supervisors of the rebuilding of the City…he was promoted to the comptrollership in June 1668.

In terms of May's contribution to English architecture, Nicholls (1993, 455) further states:

> Eltham Lodge, Kent, one of the quintessential Restoration houses, built in 1664 for Sir John Shaw, and one of the few buildings by the architect to survive. His other firmly authenticated works, all for men in court circles, included Cornbury House in Oxfordshire, Berkley House in Piccadilly, and Cassiobury Park in Hertfordshire.

May stayed in Holland during the 1650s whilst in the service of George Villiers, the second Duke of Buckingham. He was considered to be the only Restoration architect to fully understand the accord between interior planning and external form in the Dutch Classicists style, and his use of brick and stone was very much in the Dutch tradition. Kuyper (1980, 118–20) says of Hugh May that:

> His Eltham Lodge, Kent was built in 1663–5, shows complete sympathy with and understanding of the ideas expressed by Van Campen and Van's-Gravesande thirty

> years earlier. In fact it was not the Mauritshuis – as generally accepted – but Van's-Gravesande's 'Sebastiaandoelen' which provided a model for Eltham Lodge.

Dutch influence is certainly apparent in his architecture (Nicholls, 1993, 455). Colvin (1995, 647), praising May's ability and significance, suggests:

> But of his importance as one of the two or three men who determined the character of English domestic architecture after the Restoration there can be no doubt...

In advising on the conservation and repair of two huge gate piers of gauged work in the walled gardens of Chiswick Park, London, in 1993, the author discovered a previously unknown connection with Sir Hugh May.

The two piers are 1.2 m square and 4.1 m high, and of gauged brickwork laid to a very high standard of accuracy and refinement with moulded limestone plinth, scrolled console, and capping; all very Dutch in design (Fig. 67).

Figure 67

Gauged pier in the gardens of Chiswick Park, London, 1682–84.

The ashlared orange rubbing bricks have been laid to Flemish bond (as an outer half-brick casing around a stock brick core), and with joints averaging 1mm in width with mop-stick (or staff) cut-moulded quoins.

Colvin (1995, 647) recording a contemporary observation by John Aubrey, suggests:

> Twas Mr Hugh May that brought in the staff-moulding on solid right angles, after the Restauration of the king. The fashion has taken much.

Brayley, Brewer and Nightingale (1815, 73) mention the property as:

> A copy hold house with two acres of garden was sold in 1663 by Henry Broad a Chiswick resident in 1664 to Sir Stephen Fox, who between 1682 and 1684 replaced it with a house designed by Hugh May, Comptroller of the King's Works….

The house was pulled down in 1812 and the grounds were added to Chiswick House. By studying a print from Brayley, Brewer and Nightingale (1815, 73) we see an Anglo-Dutch styled brick house with stone dressings that would most certainly have linked constructionally and aesthetically with these piers (Fig. 68).

Figure 68

Print taken from A History of Middlesex of Sir Stephen Fox's house, designed by Sir Hugh May, 1682–84.

Sir Stephen Fox (1627–1716) is himself of interest with regard to the links with the master craftsmen and designers who used gauged work. He was a Treasury Commissioner and had been Paymaster General from 1661–79 and continued to control army finance after that period, hence his involvement with Wren on the Royal Hospital at Chelsea, London (1682–84) of which he was a benefactor. He became a very wealthy man with a personal fortune of £200,000, of which the diarist Evelyn (Dobson, 1906, 56), records, that his fortune was '…honestly got and unenvied…', hence he could afford the very best brickwork and craftsmen for his house. It is likely that he directly employed the master bricklayer Edward Helder, as the above piers are very similar in design and appearance to the much smaller gauged gate piers, with limestone dressings, at the church and almshouses in Fox's birthplace of Farley (Wiltshire). Helder erected these buildings in 1680–82, as Fox's benevolent gift to his native community (Fig. 69).

Figure 69

Gauged gate piers to Farley churchyard (Wiltshire), 1680–82. (Courtesy of Adrian Feltham)

Sir Roger Pratt

Sir Roger Pratt, gentleman architect who, with Wren and May, was one of three Commissioners appointed by King Charles II for the re-building of London after the Great Fire of 1666, had travelled widely in Italy, France, and the Netherlands. Very aware of the rapidly changing architectural fashions and craft practices of Europe in the second quarter of the seventeenth century, he assimilated many ideas leading to a personal style of classicism. The property at Kingston Lacy (Dorset) (1663–65) is Dutch in design and uses brick with stone dressings. Pratt's own notebooks provide a good insight into the thoughts of this knowledgeable seventeenth-century designer, revealing his ruminations over the preparation of rubbed brickwork. Gunther (1928, 228); citing a memo by Pratt, of 12 March 1669, shows an early use of the word 'gauged' in connection with cut and rubbed work:

> What qualities must brick have which will be fit to be rubbed, on what parts is it grinded, how to be gauged. How many rubbed by the day and at what rates

Clearly Pratt is analysing what constitutes a rubbing brick, how it is to be prepared, and the cost of producing bricks ready for cutting to ashlared or moulded enrichments on gauged brickwork. He worries about the quality of a brick for rubbing, particularly the gritty lime inclusions, unwanted as hard inclusions inhibit abrading, and because firing creates reactive quicklime that can cause damaging expansive slaking action upon contact with water (Gunther, 1928, 228). At his family home of Ryston Hall, Downham Market (Norfolk) (1670) Pratt (Gunther, 1928, 191) instructed the brickmaker to ensure that:

> …6,000 of extraordinary brickearth to bee picked for cutting & rubbing Brickes for ye 5 paire of Peeres.

For the earlier gauged piers at Clarendon House, London 1664 Pratt (Gunther, 1928, 155), writing on February 11th 1666 of his former instructions for the bricklayers, wrote:

> Lett such quantitie of choosen Bricks, fitt for rubbing, bee presently brought in… for ye two paire of Peeres, & ye Front-Walles ye greate Court, & lett some small shed bee set up for them to Rubbe in,…

Instructing the bricklayer to build gauged brick piers quickly, due to concerns over loosing the craftsmen to harvest work, reveals how two men would be tasked with cutting and rubbing the bricks and two craftsmen setting their prepared work, Pratt (Gunther, 1928, 192) writes:

> The Peeres of ye greate court to bee first done, & with all speede, & to this ende at ye least 2 workemen & 2 rubbers to bee sett to each paire of Peeres, otherwise Harvest comes on…

Pratt was well aware that only the very best craftsmen could be tasked with gauged work, as in his instruction for the bricklayer at Ryston Hall, that, ‘Excellent helpe to be gotten for building ye peeres’ (Gunther, 1928, 191).

Regarding brick bonding, Pratt, writing in 1669, talks of either English (old Roman) or Flemish bond, giving contemporary prices enabling a comparison of the cost of expensive gauged work to standard facework (Gunther, 1928, 230):

> This work is either set as the brick comes rough from the kiln and by London workmen in houses wrought at 30/- per rod at the lowest, to 33/-, counted a rate indifference, and in garden walls at 25/-. Or when the brick is grinded; and gauged on all sides, save only that which lies to the brick behind it, at between 45/- at the cheapest, to 50/-.

Pratt reveals how skilled labour is used to rub and gauge (size) ashlared units on upper and lower beds, the stretcher face, and either header, at 90° to them; only the rear face abutting the common back-up brickwork is not touched. He comments on the quality of rubbers used and the highly-skilled labour to prepare and set gauged work made the work around 50 per cent more expensive than standard front brickwork.

In writing on practical considerations of gauged brickwork in his notebook for February 1666 Pratt records (Gunther, 1928, 232):

> That in all rubbed work where the bricks are to be exactly ground and gauged and so to be made thinner than those on the inside of the walls, that care be taken that they may be wrought up together with the inside and so have good bond with it, and that the white joint to be no more than a quarter of an inch only, and that the inside of the walls be very well filled whether with mortar at the first, or with hot lime afterwards.
>
> To this end the rubbing bricks at the first should be made somewhat thicker than the unrubbed….

Ashlared gauged work was not only reserved for Platt bands and aprons, but (for those who could afford it) whole fronts in the post-Restoration period. Frequently set with a larger bed joint of about 5 mm (¼ inch) thick, as Pratt described above, and 2–3 mm (⅛th inch) wide for perpends. At this thickness more sand was required in the mortar and the joint could not be applied to the dampened rubbing bricks by dip-laying them onto the surface of the prepared mortar in the dipping box, normal to gauged work with joints typically below 2 mm wide, therefore a 'butter joint' technique was usually employed. This involves holding the rubber, bed face up, over the mortar and lifting up sufficient on the laying trowel to deftly apply it along each side, being careful not to smear the face, so that as the brick is laid to line it has a full bed. Ashlared gauged work with these wider joints was generally jointed with a 'struck' and sometimes 'ruled' profile, as can be seen on Wren's ashlared gauged work at Hampton Court Palace (Fig. 70). Pratt reveals his concern for the problems arising from rubbing bricks being the same size as standard bricks. Once rubbed, gauged and set on a finer joint, the outer half-brick façade would immediately fall out of continuous vertical gauge with the backing brickwork, leading to the question of how best to reconcile and tie the two leaves together.

There can be little doubt that this contributed to the popularity of the later common practice of Georgian 'facadism'; though by then it involved first-quality face brickwork and not gauged work on the outer leaf. Flemish bond was popular for ashlared gauged work, as well as standard face brickwork, due to the reduction in headers that could be snapped in two thus, for economy, gaining two expensive header face bricks instead of one. Tying-in the half-brick façade with full headers was only practised on an occasional basis. This practice used

Figure 70

Ashlared gauged work of delightfully textured rubbers laid, with 'struck and ruled joints, at Hampton Court Palace, Surrey, 1690.

primarily with Flemish bond could lead to the façade brickwork separating from the backing brickwork, which was obviously of concern.

Pratt's solution was twofold. Increase the size of a brick for use as a rubber over the standard gauge to facilitate rubbing, cutting, and thin jointing in order to maintain coursing with the standard walling set in nominal sized mortar beds. Also, to ensure the linear 'collar-joint' between the two skins of façade and backing brickwork was made solid either as work progressed or by grouting to make up for the lack of full or through headers.

Dr. Robert Hooke

Dr. Robert Hooke, English chemist and physicist, was also a respected architect and friend of Sir Christopher Wren. He designed and supervised the building of a number of London's new churches, putting him in contact with many of the leading craftsmen as his diary of 1672–80 records. He certainly met and consulted with Edward Helder, master bricklayer, at the very time he built the fine masterpiece of gauged brickwork for his own house in Enfield (1675) (see Fig. 74; this now stands in the Victoria and Albert Museum) (Figs 71 and 72).

Hooke's diary entry for Thursday 23rd September 1675 records, '…viewed Helder's building' (Robinson and Adams, 1968, 182). The entry for Monday 27th September 1675 appears to confirm that he again visited Helder's own house during its construction:

> …View at Helders, Dougate…Discoursed with Rider, Gumbledon, Gooday, Tooley, Scarborough, Helder.

Figure 71

Helder's masterpiece of gauged brickwork, 1675, now in the Victoria and Albert Museum, London. (By Courtesy of the Board of Trustees of the Victoria and Albert Museum)

He must therefore have been very aware of the fine skills of gauged brickwork that was displayed on Helder's own property and discussed materials and relevant constructional techniques with him.

As Kuyper (1980, 116) states:

> Hooke's interest in Dutch science and architecture is well known. In his diary there are many references to… town-reconstruction and architecture. In December 1672 Hooke started to learn Dutch, evidently so as to be able to read Dutch books, of which he mentions several on diverse subjects. His entry on Mr Story describing to him the recently completed churches in Amsterdam in 1674, is well known. There are in addition some indications that he visited Holland shortly before 1672.

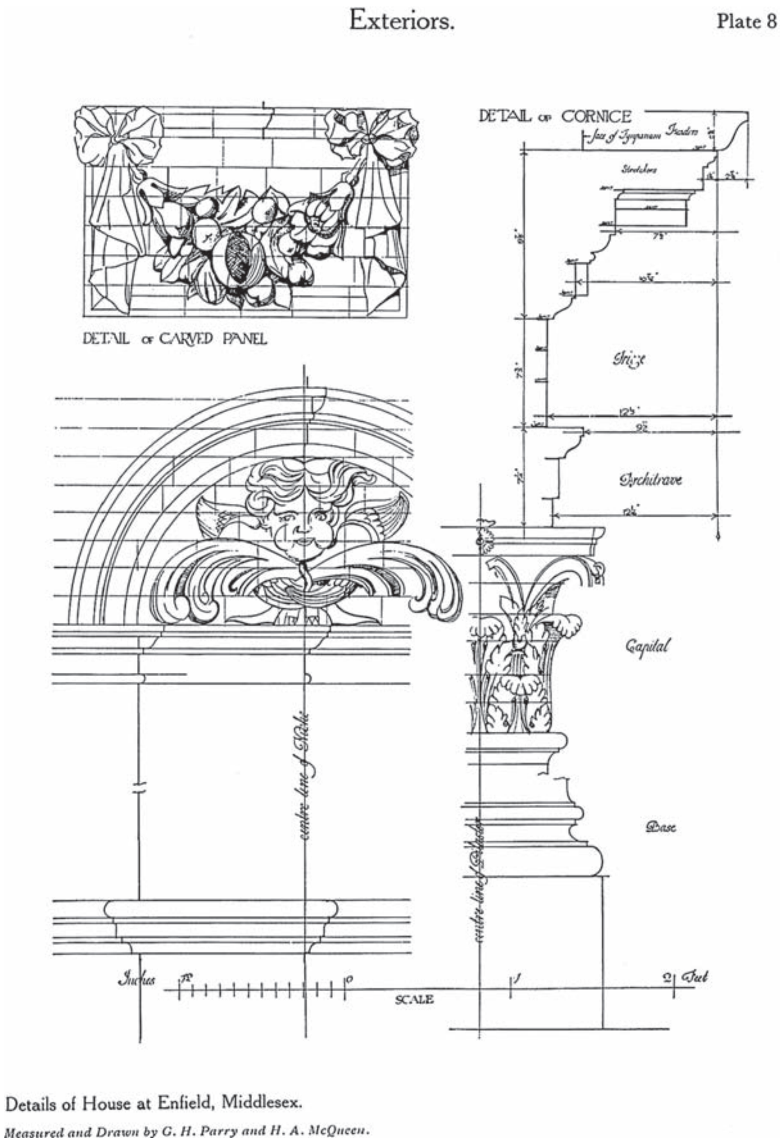


Figure 72

Fine detail of parts of Helder's gauged brickwork, measured and drawn by G. H. Parry and H. A. McQueen. (Reprinted from Period Houses and their Details, Edited by Colin Amery, Copyright 1997, with permission from Elsevier)

Sir Christopher Wren

Sir Christopher Wren was a distinguished mathematician as well as a professor of astronomy and architecture:

> Sir Christopher Wren made himself into a great architect. He had no formal training and little opportunity of knowing, at first hand, the architecture of the Continent of his own or any other age. He built nothing before he was thirty; but by the time he was seventy and still very active, he could rival any European architect then living. (Whinney, 1971, 7)

As to continental influences Kuyper (1980, 121–2) remarks:

> …Pratt and May, fused the different sources into a consistent style of their own, whereas the more enquiring, probing scientific mind of Wren tried from time to time to assimilate various complete facade schemes into his vast complexes.

Wren was quite likely to seek out the advice of these respected architects and friends, especially on points of detailing and manipulation of materials; this is particularly so with brick (an essential masonry material in the city), with a precise refinement important and attractive to Wren's taste.

Some of Wren's buildings, such as Tring Manor (Buckinghamshire) (1670) and the Royal Hospital at Chelsea, London (1682–91), do recall massing and detailing in the combination of brick and stone as seen in Dutch work (Kuyper, 1980, 122–3).

Following the Great Fire of London in 1666, it was to Wren, appointed Surveyor General in 1661, to whom the task of re-building elements of the capital fell, an opportunity unique in the annals of architecture. As stated earlier, over 13,200 houses and 86 churches had been destroyed. Wren was to build 30 of the latter and a number of other prestigious properties; though his crowning glory was undoubtedly St Paul's Cathedral (*c.*1675–1711). Wren was fortunate in having the assistance of some of the greatest craftsmen in England, as well as Europe, gathered in the metropolis who had a thorough understanding of their craft. These included Grinling Gibbons (wood carver), Caius Gabriel Cibber (stone carver and sculptor), Jean Tijou (blacksmith), and Peter Mills, Edward Helder and Maurice Emmett (master bricklayers). Wren was also very fortunate in having his most gifted chief assistant, Nicholas Hawksmoor (1661–1736) from the late 1670s, whose natural architectural talent stimulated and brought out the very best of Wren. The accession of William III and Mary II in 1688 added further impetus to the assimilation of Dutch influence during a period of major alterations by Wren to Kensington and Hampton Court Palaces at the order of the king and queen (Whinney, 1971, 161).

Wren employed constructional materials in a manner that maximised their benefits architecturally, and revealed his mathematical genius for problem solving. It is no surprise that he should triumph in getting the gauged work of his buildings, such as the Chelsea Hospital *d.*1682–91, Kensington Palace *d.*1689–1702 and Hampton Court Palace *d.*1689–1702, to the degree of accuracy and fineness he achieved (Lloyd, 1925, 61–2):

> In the Fountain Court at Hampton Court Palace, finely jointed, rubbed, red brickwork is associated with the light and dark of moulded and richly carved Portland stone, producing the gayest effect. Such use of brick by Wren has been

well described by Professor C. H. Reilly (when referring to the entrance to Middle Temple), in the following words:

> The main wall face between the pilasters is in red brick, …He has done it by a method of which he was very fond; witness parts of Hampton Court, by using very small – about 6 inches by 2 inches, instead of the ordinary 9 inch by 3 inches – soft rubbed bricks, which can be carved like cheese and yet stand the London atmosphere.

Wren achieved a wonderful use of ashlar gauged work, and several finely gauged niches built in the classical style of those seen in the Netherlands, at Hampton Court Palace. Research, however, has revealed that it is incorrect to attribute the design of the entrance of the Middle Temple to Wren. The architect was Roger North (1653–1734) who built the Great Gateway in 1683–84.

Roger North

Roger North (1653–1734) was a lawyer with the Middle Temple, writer and member of the Royal Society, so was in touch with the intellectual and scientific ideas of his time, and he was also a gentleman architect, and a friend of May and Pratt. His treatise *Of Building*, on the re-building of his own home at Rougham Hall (Norfolk) is considered 'probably the most detailed account of the planning and building of a seventeenth-century house in English architectural literature' (Colvin and Newman, 1981, xix–xx).

It was Roger North who designed the Great Gateway which still gives access to the Temple from Fleet Street and of his design for the gateway, North himself writes (Colvin and Newman, 1981, 51):

> …I was forc't upon such expedients in building the Middle Temple Gate: I designed 4 pilaster columnes and a fron tone [pediment], …and then grounded the wall with brick, rubb'd and gaged, which sett off the stone. [The master mason was John Shorthose and the master bricklayer Joseph Lem].

Influential City Master Bricklayers

All the influential city master bricklayers displayed excellence in the use of fine brick enrichments combined with a pragmatic knowledge and use of geometry to set out and work certain architectural elements such as gauged niches. Whilst Peter Mills has already been discussed (Chapter 2), it is important also to study two further individuals, Maurice Emmett and Edward Helder. In order to understand how the skills and use of gauged brickwork were being used, passed on, and subsequently proliferating at the highest level during this period.

Maurice Emmett

Maurice Emmett (also spelt Morris Emmott) (1646–94) was born in London and apprenticed to his father, Maurice Emmett Snr, who had briefly held the post of Master Bricklayer in the Office of Works in 1660. The younger Maurice Emmett held the office of Master Bricklayer in the Office of Works from 1677 until his death in November 1694.

Colvin (1995, 347) states:

> As a master bricklayer Emmett was employed at Chelsea Hospital from 1682, at Winchester Palace 1683–4, at Windsor Castle in 1685–6, at Whitehall in 1685–7, and at Kensington Palace in 1689–90.

On most of these aforementioned buildings are examples of the skilled gauged work of Emmett, his younger brother George, cousin Stephen, and many of his team of craftsmen. Of interest is the specimen of an account supplied for brickwork at Hampton Court Palace by Emmett for Sir Christopher Wren (The Wren Society, Bolton and Hendry, 1927, Volume IV, 45). Here, as was standard practice, the 'gaged' work is itemised separately from general brickwork or, in the seventeenth-century parlance, as 'over and above':

For work measured from the bottom of the water table to bottom of the first floor, together with the foundation of additional walls and chimneys and 2 wells in the Parke Garden	*£*	*sh.*	*d.*
For 148 Rodd of new brickwork reduced to brick & a half in thickness	192	8	0
For 850 ft 10 in of rubbed and gaged work over windows and doors	28	7	3
For 61 ft 4 in of coins rubbed and gaged	1	10	8
For 6 neeches each 9.0 and 4 ft wide at £2 each	12	0	0
For 70 ft of arch 7 brick and half	2	3	9
For 48 ft of arch 5 brick	1	0	0
For 100 ft of arch 4½ brick	1	17	6
For 22 ft of arch 4 brick	0	7	4
For 40 ft of arch 3½ brick	0	11	8
For 191 ft of arch 2 brick	0	11	10
For 162 ft of arch 1½	0	12	9

Emmett's gauged work at Hampton Court Palace, as at his other buildings, echoes in Metselaarsgildekamer in Amsterdam, and in particular the manner of how he constructs his brick niches (Fig. 73).

Edward Helder

The surname of Edward Helder (Holder or Elder) is highly suggestive of Netherlandish extraction, and communication with the Low Countries substantiates

Figure 73

Set of three original gauged niches, set into a curved wall, by Maurice Emmett at Hampton Court Palace, Surrey, 1690.

this. Genealogical researcher Victor Longhorn (2004) indicates that Helder may have been born in Hitchin in 1640, and that there had been a large influx of refugees (including Helders) from the Netherlands to that area in *c.*1584–85. Edward Helder wrote his will on 14th June 1683 and soon afterwards he died.

That he was a master bricklayer of the highest level is beyond dispute. Wren and many of his eminent colleagues employed him on various major projects. Among the more notable were:

- St Antholin, Watling Street (1678–82)
- The Temple Bar (1672) (Returned and reconstructed on a site next to St. Paul's Cathedral in 2004, having previously been removed in 1878 and set up at the entrance to 'Theobalds Park', near Cheshunt, in Hertfordshire in 1888)
- The Church and Almshouses, Farley (Wiltshire) (1680–82)
- Christ's Church, Newgate Street (1677–87)
- Christ's Hospital, Newgate Street in London (*c.*1682–84)

Of particular significance, Helder constructed his own magnificent house at Enfield in 1675, which later became the Cowden Clarke Schoolhouse (Fig. 74). It was on this property that Helder chose to display his supreme mastery by building the exquisite pedimented window opening of fine gauged brickwork

Figure 74

Print of Helder's house, Enfield (Middlesex), 1675, from Pam's A History of Enfield, showing the gauged frontispiece.

that can now be seen in the Victoria and Albert Museum. Charles, the schoolmaster's son (Pam, 1990, 148) described as follows:

> The structure was of rich red brick moulded into designs decorating the front with garlands of flowers and pomegranates, together with the heads of cherubim over two niches in the centre of the building.
>
> …it was demolished in 1872, it was taken down brick by brick, with the greatest care, each being numbered and packed in boxes of sawdust for carriage. Nothing could exceed the beauty of the workmanship, the bricks having been ground down to a perfect face and joined with beeswax and resin, no mortar or lime being used.

The beeswax and resin mix is part of an old mason's mix mentioned at Kirby Muxloe in April 1483 (Hamilton-Thompson, 1920, 270), as:

> …1lb. Wax, and 2lb Rosen, for syment [cement] to be made therefrom for le ffremasons.

This was a recipe for bricklayers cementing a block, or 'lump' of prepared bricks to withstand vibration and abrasion in the carving of capitals, scrolls and cartouches (Moxon, 1703, 286–7); and is discussed in more detail later in Chapter 4.

Reading Pam's account can give an incorrect impression that the entire gauged edifice was constructed in this mix, when it was only the elements to be carved. The rest of the gauged edifice was set in standard lime putty: silver sand mortar; hence the slightly thicker joint size that is clearly visible (Fig. 75).

Figure 75

A carved gauged Corinthian Capital to a pilaster, The Victoria and Albert Museum, London, 1675. (By Courtesy of the Board of Trustees, Victoria and Albert Museum)

Pam (1990, 148) concludes:

> …In this manner the whole front was built in a solid block, the circular niches with their carved cherubs being afterwards cut out with a chisel.

Whitaker (1911, 206), describing this masterpiece, says:

> …Nothing could exceed the beauty of the workmanship …. The similarity of its elevation to that of Temple Bar cannot but strike the most inattentive observer, and the arched recesses and their enrichments recall the beautiful blank windows towards the western end of St Paul's Cathedral.

Certain constructional aspects of the magnificent gauged frontispiece to the chapel at Christ's Hospital School (The Bluecoat School) in Horsham (Sussex) are similar to the above masterpiece (Fig. 76). Originally erected in 1672 in Newgate Street, London, where Helder certainly worked in the 1670s and early 1680s. The design Lloyd (1925, 96) attributes to Wren, who along with Hooke, was a Governor of the school.

This frontispiece was carefully disassembled and re-erected, when the school moved from the city to its present site in 1901. (Bryant, 1902) records:

> On the south end of the building (Old School) there is a very interesting piece of brickwork and a statue of Edward VII. This brickwork came down in little wooden boxes about a foot [305 mm] square and numbered and it was rebuilt here exactly the same as in London.

The whole edifice, from first-floor level up, is of ashlared gauged work with delightfully textured orange-red rubbers. Of particular interest are the Ionic capitals to the four engaged pilasters with entasis, and the hood of the central niche, all of which have been formed of courses of ashlared gauged work, set to bond, in either hot or cold cement to form lumps and then carved. Again, the fineness of their joints compared to the surrounding gauged work is readily apparent.

Of interest are the seventeenth-century red rubbers, with their inherent texture and visible inclusions so typical of this period, compared to the 1902 gauged arch of the entrance doorway directly below, constructed of Edwardian, washed and clean-bodied TLB orange-coloured rubbers. It is an excellent example of how the latter class of rubbers, though of first-class quality and universally copied today by the present brickmakers, are so often an imperfect match for rubbing bricks on gauged work dating from before the mid-nineteenth century.

Figure 76
Gauged frontispiece, *c.*1672, at Christ's Hospital School, Horsham, Sussex. (Courtesy of Mark Haskell)

The complexity, quality, and style of execution of several gauged entrance frontispieces to the doorways of the chambers in King's Bench Walk (1678), formerly attributed to Sir Christopher Wren (Lloyd, 1925, 277–9), suggests that they may also be the work of Edward Helder and his team of bricklayers (Fig. 77).

Correspondence with Dr C. M. Rider, archivist for The Honourable Society of the Inner Temple (Rider, 1998), reveals:

> …archives do not contain any original drawings of the doorways and there is little detailed information about their construction.

Figure 77

Fine gauged entrance doorway of 5, King's Bench Walk, London, 1678.

The original chambers were destroyed in the fire of 1666 and the tenants were eventually allowed to build again after certificates were 'read' by Peter Mills, Richard Kirby, and Sir Christopher Wren on 27th April 1670.

Rider emphasises:

> …the newly constructed chambers in King's Bench Walk had to be rebuilt in 1678 after another fire in 1677.

Hooke also records this fire (Robinson and Adams, 1968, 316):

> Friday, September 28th 1677, – fire at the temple, rose at 3, went to it. It consumed all the Kings bench building….

Rider concludes:

> The fact that most of the building works were commissioned by the tenants rather than by the Inn itself explains the lack of information in the Inner Temple archives…. Presumably the building accounts and invoices etc, were retained by the tenants and are now lost. … There is no evidence of any involvement by Sir Christopher Wren in the 1678 building.

This final point is of great importance, as Wren is often documented as the architect (such as by Lloyd, 1925, 277–9) yet there is no mention of his involvement in the King's Bench Walk doorways in *The Wren Society Volumes*.

Whoever the architect, he would have worked in close co-operation with his master bricklayer (such as Helder or Emmett). He would have gained all of his full-size working templets for every shaped part of each frontispiece from the drawing/s. From the templets, the individual bricks of the entire enrichment could be set out, cut and rubbed, numbered, and dry bonded within the cutting shed for on-site assembly. This combination would have left the frontispieces to be completed under the direction and supervision of the master bricklayer alone.

Study of measured and scaled drawings of these doorways and their details drawn by Ernst V West (Amery, 1974, plates 34–40) enables one to assess the technical superiority of the finely gauged brickwork against that of the pre-Restoration period (Fig. 78). At number 5 King's Bench Walk, the orange-coloured rubbing bricks are precisely ashlared and rubbed smooth (revealing minor inclusions) measuring (Lloyd, 1925, 279) 7¾ × 3⅝ × 2½ ins (197 × 92 × 51 mm).

These contrast favourably to the main walling bricks of 8½ × 3¾ × 2½ ins (216 × 95 × 64 mm). The bonding of these frontispieces varies between English and Flemish bonds, with a four-course gauge of 8¼ in (210 mm), the bed joints averaging 1⁄16 in (1.5 mm).

Other influential seventeenth-century master bricklayers in the city of London, most of whom worked for Wren, May, Hooke, and Pratt, were:

- Tom and John Fitch (Fits, Fitz)
- John and Anthony Tanner (Turner)
- Thomas Horne (Horn)
- Joseph Lem (Lemme, Lenns)
- Benjamin Leach
- Isaac Corner
- Richard Stacey
- John Yeomans (Yemens)
- Thomas Hues
- Richard Billinghurst
- Thomas Warren
- John Bridges
- Edward Goodman
- Thomas Harris
- Nicholas Wood
- Venturus Mandey

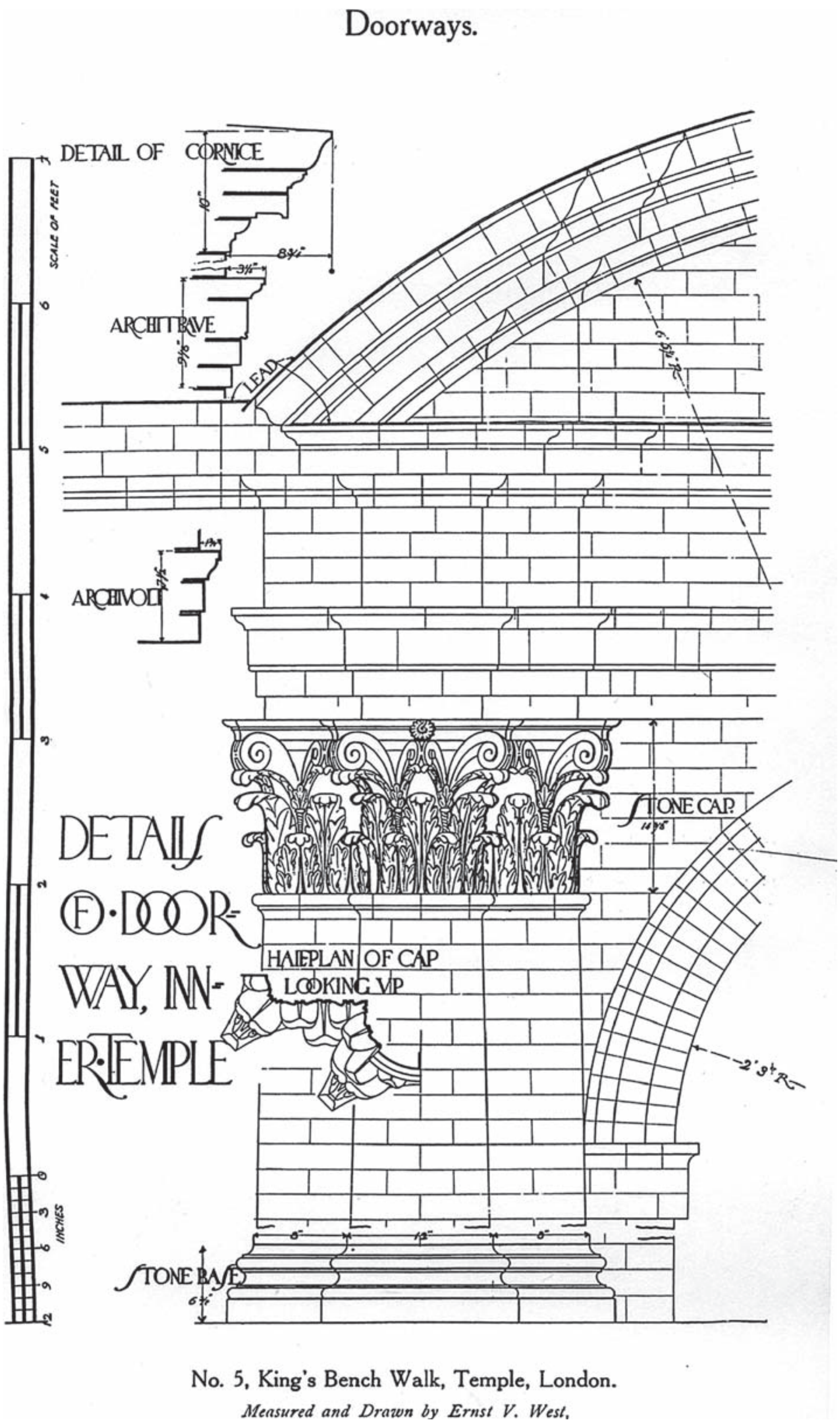


Figure 78

Detail of some the gauged work to the doorway at 5, King's Bench Walk, Temple, London, measured and drawn by Ernst V. West. (Reprinted from Period Houses and their Details, Edited by Colin Amery, Copyright 1997, with permission from Elsevier)

John Yeomans was the master bricklayer selected for Winslow Hall (Buckinghamshire) and here we have a valuable insight as to how his gauged work was priced for various architectural applications, through an abstract of payments and allowances in the accounts (Bolton and Hendry, 1927, Volume IV, 65):

Ffor Bricklaiers Work			
Ffor the Workmanship of 210 Rods 2 Qrts. 64 75⁄100 ft	£	s	D
Brickwork at 27sh per Rod	284	9	7
Ffor the Ornaments of 118 Windows at 15 sh ea	88	10	0
Ffor 2819 ft rubd work at about 6d per ft Sup.	70	9	0
Ffor 770 ft rub work in coping of new garden at 4d per ft	12	6	8
Ffor cutting 264 ft Groyning at 4d per ft	4	8	0
Ffor Workmanship of 2 Ovens	2	0	0
Ffor 291 ft rubd and gaged peers with staff moldings at 10d per ft Sup	12	2	6
Ffor 9 ½ ft Streight Arch at 10d per ft Sup	0	7	11

Undoubtedly the rising aspirations of the seventeenth-century city bricklayer would have provided added impetus to learning the finer skills of gauged brickwork, thus giving the best masters undoubted parity with the finest stonemasons. It must still be remembered that, despite the rules of the respective guilds, there was no clear separation between the craft of the bricklayer and the stonemason. This was particularly true at the highest levels of the craft, where knowledge and skills were complementary; hence how Helder was able to work on the construction of the fine stonework of the Temple Bar. As in the Netherlands at this time, bricklayers were frequently contracting for work that involved both brick and stone, and the reverse was also true. Evidence to support this can be gleaned from studying the contracts relating to the re-building of the city churches after The Great Fire; here masons such as Cartwright, Fulkes, Marshall, Pearce and the Strong brothers executed brickwork as well as stonework (Campbell, 2002, 10–21). This cross-fertilisation of skills and knowledge was particularly important for the development of fine gauged brickwork, at a time when there was a more classical and theoretical approach to architecture.

The essence of this contemporary view of the bricklayer is summed up by Moxon (1703, 237) who says:

> Whether the White Mafon, which is the Hewer of Stone, or the Red Mafon, which is the Hewer of Brick, be the moft ancient, I know not: but in Holy Writ, we read of making of Bricks before we read of Digging or Hewing of Stones; therefore we may fuppofe the Red Mafon (or Bricklayer) to be the moft Ancient.

Joseph Moxon and Mechanick Exercises

Joseph Moxon (1627–91) author and fluent in Dutch, Latin, French and German, was one of England's ablest mathematicians, a friend of some of England's greatest seventeenth-century scientists such as Robert Boyle, Edmund Halley and Robert Hooke and a fellow member of the Royal Society.

For those researching the historical development of English brickwork, and in particular gauged brickwork, Moxon's exercise on *The Art of Bricklayers Work*, first published in 1700, provides essential reading. It offers a powerful 'snapshot' of craft skills and knowledge at the close of the post-Restoration period and the dawn of the Georgian period.

Benno M. Forman in his introduction to the facsimile of Moxon's 1703 edition of *Mechanick Exercises* states (Montgomery, 1970, ix–x):

> Historically it stands as an iconoclastic work that broke for all time the medieval patterns that had long impeded the progress of the crafts. Moxon's MECHANICK EXERCISES forecast the direction of England's economic development for the next two centuries.

Of particular interest, Forman ruminates why, given the Great Fire of 1666, Joseph Moxon did not produce his treatise on the bricklayer's art earlier when it would have been in huge demand as the city was re-built in brick. Forman (Montgomery, 1970, xviii–xix) argues that there is a stylistic change in the writing from the earlier publications and as Joseph Moxon had died in 1691, this was in fact the work of his son James; hence the commercial decision to market the work as by 'J. Moxon'.

The mention of Venturus Mandey as assisting (Montgomery, 1970, xix) indeed possibly co-authoring with James Moxon is also of significance as to why Moxon's work on bricklaying is both later and different in its style. Venturus Mandey (1645–1701), was a city master bricklayer in great demand in the years following the Fire.

> The bricklayer, Venturus Mandey…seems to be the Venturus Mandey who produced a book with Joseph Moxon as joint author. If so, Moxon probably got his information regarding bricklayers' work from Mandey. (Lloyd, 1925, 77)

Mandey, from the parish of St. Giles in the Fields, London, was possibly apprenticed to his father, Michael Mandey, becoming Bricklayer to the Society of Lincoln's Inn from 1667, the year following the Great Fire, until his death in 1701. He is also known to have worked elsewhere in the city and (Smith, 2003, 16–19) through his work as a measurer, and several books, including 'Mellificium Mensionis: or The Marrow of Measuring' (1682), mathematics, science, medicine and even theology, he was indeed an exceptional bricklayer.

Mechanick Exercises: OR, The Doctrine of Handy-Works. Applied to the ART of Bricklayers Work

In his remarkable work, *Mechanick Exercises: OR, The Doctrine of Handy-Works. Applied to the ART of Bricklayers Work,* Moxon (1703, 237) explains from the start that:

> Firft, I will fhew what Materials they ufe and their Compofition,
> Secondly, I will treat of their Tools, and defcribe their Names and Ufes,
> Thirdly, I will declare their Method of Working, both in Bricks, Tiles, & c

In the first part *Of Bricks* we have the first mention of the bricks for rubbing and hewing:

> But the beft Earth that we have in England for making of Bricks, is in the County of Kent, from whence we have moft of the Bricks which are rubbed and Hewed for the Ornaments of the chief Fronts in the City of London: The Ornamental part of which Fronts, are done with the reddeft Bricks they can pick from among them; and the Rough or Plain Work, is done with the Grey Kentifh Bricks. (Moxon, 1703, 239)

Moxon reveals the need to bring into the city not only the best bricks for cutting, but for the gauged enrichments to be in the 'reddest bricks', not possible from the mass of London stocks being produced in the capital.

Moxon was also very specific about what type of lime was to be used for all forms of constructional masonry (Moxon, 1703, 241):

> There are two forts, one made of Stone, which is the ftrongeft, and the other of Chalk, both forts being burnt in a kilne.
>
> The Lime that is made of foft Stone or Chalk is ufeful for Plaftering of Seelings and Walls within Doors, or on the infides of Houfes; and that which made of hard Stone, is fit for Structures or Buildings, and Plaftering without Doors, or on the out fide of Buildings that lies in the Weather….

Moxon is advocating the use of greystone lime as the principal binder for all bricklaying mortars. Also called 'water-limes' these were capable of an internal set (even below water) due to their burning characteristics and silica and alumina within them that rendered them reactive during burning to form quicklime. Today, these water limes are termed 'hydraulic'. Pure or chalk limes, Moxon emphasises, are only deemed suitable for internal and non-structural work such as plastering. Then called 'air-limes' these were incapable of setting, but instead only hardened by absorbing carbon dioxide from the atmosphere, or ‘carbonation’; this meant they could not harden below water; hence the term today, ‘non-hydraulic’.

In his second part, ‘Tools used in Brick Work’; Moxon lists 23 tools, each with a succinct explanation of their use together with an engraved plate depicting them (Fig. 79).

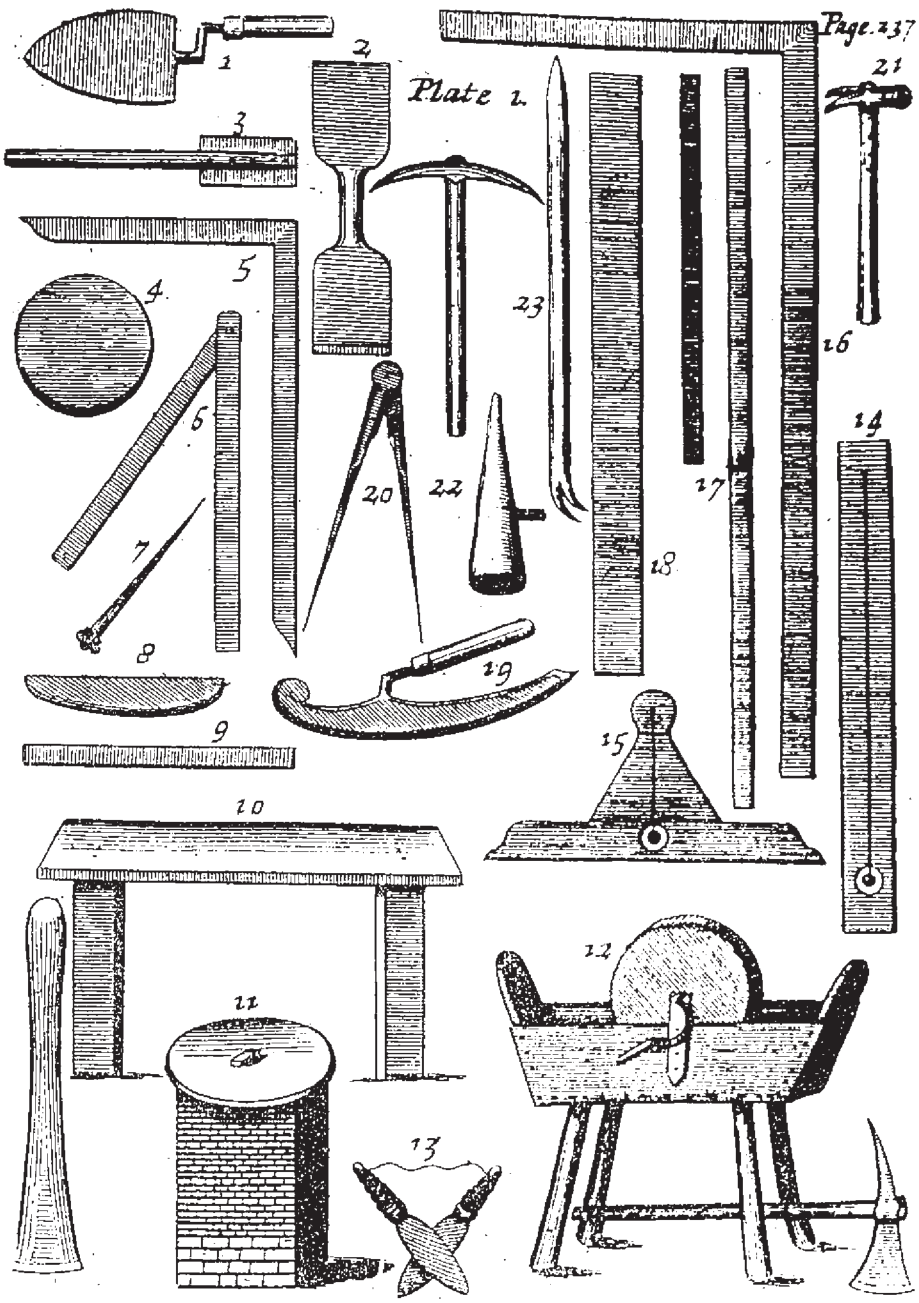


Figure 79
Moxon’s plate 1 depicting some of the tools and equipment used by the seventeenth-century bricklayer.

These tools would have been part of the hewer's equipment, kept in the cutting shed where all the setting out and cutting of architectural enrichments took place. Hugh May supplied such a place at Whitehall Palace in 1668:

> 1. A shed was built in the Pebble Court for the working of the cut, rubbed and gauged brick. The mouldings were 'hewn' in brick… and two square niches… (Colvin, 1976, 272).

We can determine how much gauged work was being emphasised as a necessary craft skill for the seventeenth-century craftsman city bricklayer by extracting the full meaning behind Moxon's descriptions of the tools and how they were to be used (Moxon, 1703, 245–8):

> 2. A Brick Ax, with which they cut Bricks to what fhape they pleafe, as fome for Arches both ftreight and Circular, others for the mouldings of Architecture, as Archytrave Friez and Cornice.

The brick axe was, as detailed earlier, the chief cutting or hewing tool and remained identical to the earlier models. Moxon reveals it was not only for cutting arch voussoirs, but also shaping mouldings for enrichments.

> 3. A Saw made of Tinn, to faw the Bricks which they cut.

Later termed a 'grub saw', and measuring about 150 mm long 75 mm high with 1–2 mm thick in-line serrated teeth. Shown as having a long wooden handle fixed to the centre of the saw blade giving two cutting edges, this was to give an extra blade, as the teeth would wear relatively quickly even on soft rubbers. Also it is not impossible that there were two different sets of teeth. Some older craftsmen still refer to cutting with a grub saw as 'tinning', or that a brick had been 'tinned' (i.e. ready for cutting to shape).

This tin saw (most likely tin-plate) would have been used in three ways. First, to cut a deep (5 mm) line into the bricks around the straight edges of a templet to give the brick axe a good start and preventing chipped, or 'spalled, arrises (edges) when cutting to shape. Second, to cut straight sections. Third, to cut a series of parallel slots above and down to the scribed lines for aiding easy removal by axing and abrading to profile.

> 4. A Rub-ftone, which is round, and is about fourteen Inches Diameter, and fometimes more of lefs at pleafure, on which they rub the Bricks which they cut into feveral fhapes, and also others which they cut not, being call'd Rubbed Returns, and Rubbed Headers and Stretchers.

Also called a 'rubbing stone', usually of York stone and round on plan although it could be square. It has traditionally been round, as of the rubbing action, is always a circular motion across the stone surface. It is likely that the first rubbing stones were utilised from old grinding-wheels. It was primarily utilised to rub the bed and stretcher faces of a rubber to be at right angles to one another, prior to being scribed to the templet and then cut to shape (Fig. 80).

Moxon also describes bricks rubbed for cutting and those not being cut. He describes preparing ashlared bricks as 'rubbed returns' for quoins, and as headers and stretchers for the remaining facework. Some of these would only be marked to a templet – 'scribed' – and then simply rubbed down to the line and required size. This, Langley (1749, 286) describes 50 years later:

Figure 80
Rubbing an oversized TLB on the rubbing stone prior to squaring

> …of various kinds, viz., Rubed only, and set in Front Mortar; or gaged, rubed and set in Putty. Those which are rubbed only are chiefly the sides or jaumbs of Windows and the external angles or quoins of buildings.

'Front mortar' was the well-screened standard bricklaying mortar reserved for the outer-face of brickwork, including ashlared gauged work with 5 mm (¼ inch) bed joints, on principal elevations, as opposed to a generally weaker mortar of crudely slaked lime and coarse sand for 'backing-up' or internal use on the building.

> 5. A Square, to try the bed of the Brick, (viz. That fide which lies in the Morter) with the fuperficies or face of the Brick, to make the Brick fquare, or at Rect-angles one fide with the other, which is done by rubbing it on the Rub-ftone till it exactly anfwers, or fits to the Square.

Craftsmen now use a carpenter's 'try-square', whereas Moxon's plate shows a large iron square, though its use for preparing rubbers remains as Moxon describes. 'Trying', or testing, the brick bed, stretcher and header faces after they had been rubbed to ensure they are at 90° to each other is known in the craft as 'squaring'. The square was also essential for transferring certain setting out lines for cutting, or carving, certain ornamented faces, from one side of the brick to the other, providing the handle, or 'stock', always rested against a 'squared' face (Fig. 81).

Figure 81
Squaring the rubbing brick with the try square

> 6. A Bevel, by which they cut the underfides of the Bricks, of Arches ftreight or circular, to fuch oblique Angles as the Arches require, and alfo for other Ufes.

Also known as a 'sliding-bevel', Moxon wrongly describes it being used to '… *cut the underfides of the Bricks, of Arches ftreight or circular…*'.

What he really meant was marking-out and checking rather than actually cutting an arch voussoir; a process termed 'soffiting'. Some radiating voussoirs meet the arch intrados obliquely so need their undersides, or soffit faces, cut to the required angle. On a 'streight' (flat) arch, apart from the central 'key' brick, all the voussoirs have different soffit bevels, as they become more inclined away from the key to the skewback position. Of course there would also be a need for bevels to be taken and transferred to the relevant voussoirs for the extradosial line too.

The bevel would establish and transfer the relevant angles on the setting out, or tracing, board to the bricks prior to cutting.

> 7. A fmall Trannel of Iron, or a large Nail ground'd to a fharp point, with which they mark the Brick, either from a Square or Bevel, or a Mould made of thin Wainfcot, or Paft-board to direct them in the cutting thereof.

A large 'rose-head', or flat 'clout' nail, ground to a sharp point is now termed a 'scribe'. This is used to score or 'scribe' the outline of any templet to the 'squared' rubber, particularly the curved sections prior to rubbing or cutting it to shape.

The small 'Trannel' is possibly also to be used as a bench-mounted trammel with a sharp point, set to the desired radius, to help make the cutting marks for curved work on plan (Fig. 82). Trammels would, where necessary, be fitted with a metal-edged reverse-moulded, or negative, templet to serve as a running mould. This facilitates scribing mouldings and checking end 'drafts' as they are gradually worked, as well as for rotating along the length of the axed brick profile to abrade the final few millimetres from the surface and test the accuracy of the finish. A variation of a plasterer's 'horse-mould', it was vital for the degree of accuracy gauged work with 1mm (1⁄32 inch) joints demands.

Figure 82
The trammel with reverse profile being used to set-out and finish a cut-moulded brick for a necking course to a niche in the author's workshop.

This technique has been used by the author and tested by invited craftsmen and it is one that works well. Furthermore, not only was it seen and viewed as a logical practice by stonemasons Peter Hill and Piers Conway, but also master plasterers Jeff Orton and Arthur Watkins (former Head of Plastering at Luton College). Both have huge experience of *in situ* and bench-run plaster mouldings, and agreed that historically crafts communicated and shared their techniques in a manner unheard of today. The technique also accords with Moxon's remarks in the first part of point 8 below.

> 8. Some use a Float Stone, with which they rub the moulding of the Brick, after they have cut it with the Ax, pretty near to the Pattern defcribed on the Brick, by the Trannel from the Wainscot, or Paftboard Mould, that fo they may make the Brick exactly to anfwer to the Pattern or Mould. Others ufe no Stone at all, but cut the Brick exactly to the Pattern with their Brick-Ax, leaving the Ax ftroaks to be feen on the Brick, which, if they be ftreight and parallel one to another, look

> very prettily, and is the trueft way of Working; but then they muft take care, to Ax the Brick off, with an Ax that is exactly ftreight on the edge, that the moulding in the Brick be neither round nor hollow, from fide to fide of a Header, or from end to end of a Stretcher.

The 'Float Stone' referred to is a small hand-held stone used for rubbing down completed, surface-dried, work to finish; 'floating' over the face of the work in a circular motion. It varies in size and shape, and the fineness of abrasive. If used on circular work, such as a niche, it must be shaped to the curve. It is traditionally made of York stone, though various grades of carborundum are also employed today. Stonemason Piers Conway suggests craftsmen could have also used a sandstone block carved to the negative, or reverse, profile of the moulding being worked. This would then be used both within the cutting shed and for finishing the set work, ensuring an accurate finish (Conway, 2002).

Moxon, in point 8, states that some dress their cut work with the brick axe, while others use the 'float stone' to rub the moulding after they have 'axed' it to answer (fit) to the templet. The latter, by the late seventeenth century, had become, as in the manner of the Dutch, the preferred finishing technique. The vast majority of the gauged work from this period is almost always rubbed smooth, which could also account for the distinct shape of the engraved 'Float stone' in Moxon's plate. It is flat on one face and, on the opposing side, shaped to fit certain curved mouldings, and/or for the relatively standard sized niches.

Moxon stresses traditional hewing practice as '…leaving the ax ftroaks to be feen on the Brick, which, if they be ftreight and parallel one to another, look very prettily, and is the trueft way of Working…'. This again reveals how some craftsmen liked to leave a 'worked' surface, finishing with a tooled surface similar to how a mason dresses stone – even after a face was rubbed – but which only appeared neat if the tooling marks were both straight and parallel one to the other. Moxon's remark that it is, 'the trueft way of Working' is not meant to be disparaging about the then relatively 'new' fashion for smooth rubbed surfaces, only to emphasise the pre-eminence of the older 'axing' technique. An interesting example of this is on the gauged dentilled entablature of the central entrance doorway of 'Queen's Lodge', Wickham (Hampshire) that dates from the late seventeenth century. The parallel diagonal axing marks, deliberately laid with the axe stokes in opposing directions on each course, on the ashlared rubbed bricks to the two engaged pilasters – complete with entasis and Ionic cappings – are clearly intended to add aesthetic effect (Fig. 83).

Moxon concludes this point with sound advice to prospective 'hewers', irrespective of whether the cut-moulding is to be rubbed smooth or not. The brick axe must be 'exactly ftreight on the edge'. In other words it could not have worn or rounded edges across the length of the axe blade, or the resultant moulding would cut either concave or convex across the width of the brick face.

Figure 83

The brick axe marks to the rubbed and ashlared bricks of a gauged pilaster on the late seventeenth-century front of ‘Queen’s Lodge’, Wickham (Hampshire). (Courtesy of Robert D’Arcy)

> 9. A Little Ruler, about 12 Inches in length, and 1 Inch and ½ broad, which they lay on the Brick to draw ftreight Lines by, with the Trannel or Nail.

This passage regarding the Little Ruler is self-explanatory, but worth reproducing as it shows its application in helping to scribe a brick prior to rubbing or cutting. Large measuring rods have a history of use on all masonry, and can be used as described for setting it out, indeed Moxon shows and describes them, as in point 17:

> 17. A Ten Foot and a Five Foot Rod, as alfo a Two Foot Rule, to take and lay down Lengths, and Breadths, and Heights.

Gauged work, of the highest quality requires accurate measurement in its execution. The more geometrically complicated and finer the enrichment that is to be constructed, in terms of joint size, the more there is a definite need to measure precisely at each and every stage.

> 10. A Banker, to cut the Bricks upon, which is a piece of Timber about fix foot long, or more, according to the number of thofe who are to work at it, and 9 or 10 Inches fquare, which muft be laid on two Piers of Brick, or fixt on Bearers of Timber about three foot high from the Floor, on which they ftand to work.

The term 'Banker' is a stonemason's term (Hill and David, 1995, 143):

> The banker, on which the stone is worked, is traditionally a large block of stone. It should be as heavy as possible, the better to resist any tendency to move as the stone is worked.

The banker described by Moxon is today termed a 'cutting bench', and is rigid to withstand vibration during brick cutting. A six-foot (1.8 m) length accommodates up to three craftsmen, depending of course on what type of work they were undertaking.

> 11. They work up a Pier of Brick-work, about the fame height to lay their Rubbing-Stone upon, which muft be laid in Morter that it may lye faft.

The bench must not move, as the accuracy of any craftsman simultaneously engaged at the bench in scribing, cutting, or moulding a brick would be affected. A separate brick pier could thus be erected to the same working height as the 'banker' solely for the rubbing stone. Moxon states the stone must be laid in 'Morter that it may lye fast'. This secures the stone from slipping and rocking, and ensures it is bedded level across its rubbing surface. The stone would also be checked periodically to ensure it was not rubbing hollow, negatively effecting the preparation of the rubber. If so, it would be 'dressed' flat and re-bedded on mortar again.

> 12. A Grinding-ftone, to fharpen their Axes, Hammers, Trowels &c. upon.

The grinding-stone was an essential piece of equipment in the cutting-shed to maintain sharp brick axes, chisels, saws and other cutting tools used in 'hewing'. These tools when in constant use, would soon have dulled cutting-edges. As mentioned earlier, a blacksmith only re-worked an edge once it began to lose its temper, or hardness, as well as became unavoidably thickened due to this constant re-sharpening.

There can be little doubt, however, though Moxon makes no mention of it, that the grinding-stone would have been utilised, where appropriate, to abrade shape on a rubber held against the spinning stone at the desired angle of contact. Such a practice has been seen to be employed by Flemish craftsmen in Ellie Degrande's workshop in Bruges, when preparing gauged brickwork for an ornate 'topstuck' to a seventeenth-century building in the town of Veurne. Moxon, for the next eight points, then lists and describes a variety of tools and equipment used for general brickwork. These are not germane to this work except for:

> 20. Compaffes, to defcribe the feveral Mouldings on Wainfcot or Paftboard.

The compasses were, and remain, important geometrical instruments for scribing the arcs and circles involved in setting out mouldings on wainscot, or pasteboard, suitably sized for cutting into templets to which the required brick shape could answer.

In concluding this examination of the seventeenth-century city bricklayer's tools, one must bear in mind how many or, more likely, how few 'cutting sheds', or 'cutting shops', and craftsmen Moxon saw or spoke with during his research. This obviously limited the depth of this writing, as undoubtedly craft secrets would not have been openly shared. One must accept, therefore, that descriptions may be incomplete or, indeed, have omissions that would have been an essential part of contemporary practice with craft tools, equipment and materials.

In the third section of his treatise, Moxon considers and elaborates on good practice for foundations and sub-structure brickwork whilst again not germane to this thesis, Moxon (1703, 257) details ten '…neceffary Rules to be obferved in the laying of Bricks, to make the Walls ftrong and durable…'.

None of these ten rules, regrettably, make any mention of preparing or setting gauged work. Although good craftsmanship is mentioned, it is not detailed. One must remember that the seventeenth-century craftsman knew how to work 'according to demand'; a phrase often written into contemporary contracts.

A craft practice that would have definitely been employed, especially with regard to the execution of gauged work, was the use of timber profiles. Profiles were and remain the standard equipment for controlling accuracy of brickwork in the Netherlands where they are termed 'profiels'.

Taking into account how the skills of gauged work came to us from the Dutch, it then follows that these essential techniques necessary for achieving the same high standards came in a similar way. Profiles, as the name indicates, are the outlined shape of the proposed walling element. Set-out to the required line, level, and vertical position, they are then marked to the relevant gauge, allowing the bricks to be accurately set to lines strained from the appropriately braced profiles. Lines cannot be strained from newly laid gauged brickwork, like standard facework, as the bricks would slide or be pulled from position. Later eighteenth-century books do occasionally refer to timber guides to erect masonry to profile, such as 'diminishing rules' for erecting pilasters, or columns with entasis. All fail, however, to relate that these would generally have been fixed rather than brought to the wall as needed in order to set-out, check, and guide construction.

Moxon (1703, 212) concludes with two more rules explaining the '…Act of Parliament…as it relates to *Bricklayers* Work'. This reference to the Act of 1667, which detailed the four classes of brick houses allowed after the Great Fire, emphasises how his treatise was primarily intended for city bricklayers and buildings.

Of singular interest with regard to the contemporary use of gauged brickwork is Moxon's plate 5. This shows the principal elevation of a new city house of 'The second sort of Building fronting the Streets and Lanes of Note, and the River of Thames'.

Through study of Moxon's plate 5 one can see how all the principal architectural enrichments are all intended to be built in 'rubbed brick' and are listed as:

B. The First Fascia
C. The Second Fascia
D. The three plain courses of Bricks over the Arches
E. The Cornice
F. Streight Arches

Elaborating further on the detailing of the moulded fascia and cornice, Moxon (1703, 267–68 and Plate 6) (Fig. 84) illustrates and emphasises the importance of sound geometrical craft knowledge in designing and executing the cut mouldings:

A. Aftragal.
B. Ovolo, or Boltel, reversed.
P. Plain Courfes.
S. Is Scima reverfa.
O. Joint of Morter.

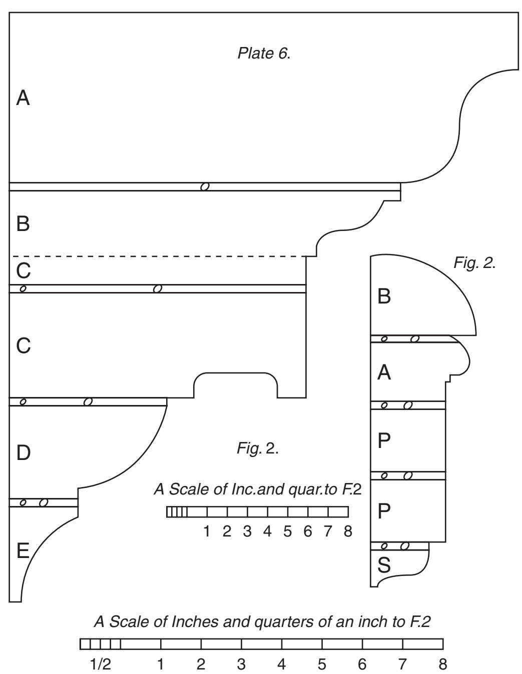
Figure 84

Moxon's plate 6 showing drawings of cut-mouldings for enriched fascia and cornice.

BRICKLAYER'S WORK – PLATE 6

Fig. 1 *Design* of a *Brick Fascia,* illustrating:
A. The *Astragal*
B. The *Ovolo* or *Boltel*, reversed
P. *Plain Courses*
S. The *Scima Reversa*
O. *Joints* of *Morter*

Fig. 2 *Design* of a *Brick Cornice*
A. The *Scima recta,* or *Ogee*
B. The *Scima reversa*, or *Scimatium*
C. The *Corona*, or *Plancheer* [Planchier]
D. The *Ovolo*, or *Boltel*
E. The *Cavetto*, or *Casement*
O. *Joints* of *Morter*



> In the same Plate, you have the design of a Brick Cornice, and the Names of the Mouldings, are:
>
> A. Scima recta, or Ogee.
> B. Scima reverfa, or Scimatium.
> C. Corona, or Plancheer.
> D. Ovolo, or Boltel.
> E. Cavetto, or Cafement.
> O. Joint of Morter.
>
> In which Cornice, the Corona, or Plancheer, ought (according to the Rules of Architecture) to Sail over, or project more; but the length of a Brick being but about 8 Inches when its head is rubbed for hewing, it will not hang, if it fail over, more than is fhewn in the Draught, which is about 3 Inches and an half. But if you would make it to project more, then you muft Cement pieces to the ends of your bricks for tailing, or to make them longer: Of which Cement there is two forts, one is called cold Cement, and the other is hot, the making and ufe whereof, we will fhew towards the latter end.

Moxon here addresses the problem of insufficient length of a brick stretcher to both cut the moulding, yet also allow it to be sufficiently tied-back into the backing brickwork in order to securely project, or ‘oversail’, beyond the stated 3½ inches (90 mm), over the lower ‘Ovolo’ or ‘Boltel’ moulding. The concern here is to ensure that the ‘Corona’ moulding, laid as a header, is properly ‘tailed-in’ to the wall and strong enough to support the weight of the two oversailing moulded courses directly above. Moxon then reveals an old craft mystery of ‘cementing’ bricks together to extend their length (1703, 286):

> There are two forts of Cement, which fome Bricklayers ufe in Cementing of Bricks for fome kind of Mouldings, or in Cementing a block of Bricks, as they call it, for the Carving of Scroles or Capitals or fuch like, &c. One is called cold Cement, the other is called hot Cement, becaufe the former is made and ufed without Fire, but the latter is both made and ufed with Fire; the cold Cement being accounted a Secret, is known but to few Bricklayers, but the hot Cement is common.

Contemporary lime mortars for brickwork were not strong enough in setting to glue bricks together to act as a whole. To extend a header for a securely ‘tailed-in’ oversailing required a ‘cement’ that would not fail under load and/or through damp penetration. Likewise, for brick carving such as scrolls or capitals, it was vital that the bricklayer used a similar ‘cement’ to construct a solidly bedded ‘block’ of bonded bricks (also termed ‘brick lumps’) ready for the ‘Trade Carver’ to execute the carving. This could then be done without dislodging bricks or a small corner falling-out where work cut across joints. These 'cements', given in Moxon and re-created for use by the author, prove so tenacious that the brick will fail before the joint parts. The 'hot cement', the recipe for which is described below, could both be made and used fresh, or left to set as a block within a container and stored away ready for re-heating and melting for use when required.

Although carving could be executed *in situ*, generally the 'lump' itself would be constructed in the cutting-shed and then set into position as a solid masonry element. Preparation and construction of the 'lump' in the cutting-shed gave improved control over quality of execution, especially with 'hot cement', which could be difficult to use on site.

Moxon (1703, 286) concludes his treatise by giving the ingredients for both 'hot' and 'cold' cement, and their respective methods of preparation:

> To make the cold Cement.
>
> Take ½ a Pound of Old Chefhire-Cheefe, pair of the Rine, and throw it away, cut or grate the Cheefe very fmall, and put it into a Pot, put to it about a Pint of Cows-milk, let it ftand all Night, the next Morning get the Whites of 12 or 14 Eggs, then take ½ a Pound of the best Unsclackt or Quick Lime that you can get, and beat it to Powder in a Morter, then fift it through a fine Hair Sieve into a Tray or Bole of Wood, or into an Earthen Difh, to which put the Cheese and Milk, and ftir them well together with a Trowel, or fuch like thing, breaking the Knots of Cheefe, if there be any, then add the Whites of the Eggs, and Temper all well together, and fo ufe it; this Cement will be a White Colour, but if you would have it of the Colour of the Brick, put into it either fome very fine Brick-Duft, or Almegram, not too much, but only juft to colour it.
>
> To make the hot Cement.
>
> Take one Pound of Rozin, one Quarter of a Pound of Bees-Wax, half an Ounce of fine Brick-Duft, half an Ounce of Chalk-Duft, or Powder of Chalk, fift both the Brick-Duft and Chalk-Duft through a fine Hair Sieve (you may beat the Brick and the Chalk in a Morter, before you fift it) boil altogether in a Pipkin, or other Veffel, about a quarter of an hour, ftirring it all the while with an Iron or a piece of Lath or fuch like, then take it of, and let it ftand 4 or 5 Minutes, and 'tis fit for ufe.
>
> Note, That the Bricks that are to be Cemented with this kind of Cement, muft be made hot by the Fire before you fpread the Cement on them, and then rub them to and fro on one another, as Joiners do, when the Glew two Boards together.

The remainder of Moxon's treatise is wholly concerned with the setting out of arches, being of interest as they are of gauged construction. He concentrates primarily on the, 'Semi-Oval, being an Ellipfis Arch' [semi-elliptical] and the 'Streight Arches' [flat] (Fig. 85).

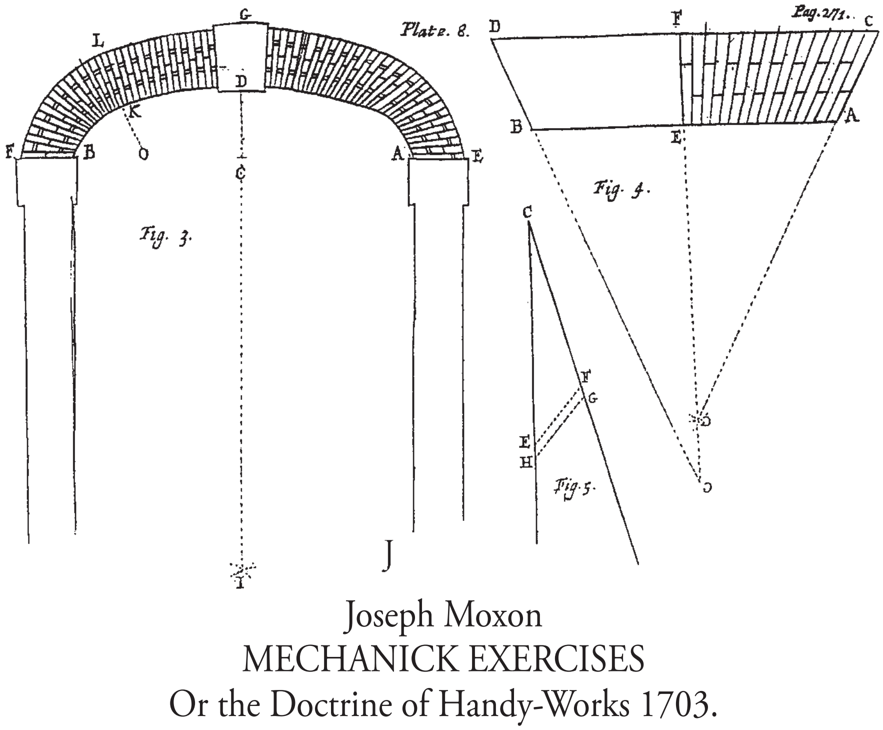


Figure 85

Moxon's plate 8 showing drawings of the setting out of a flat and semi-elliptical arch.

In this respect Moxon (1703, 279) emphasises:

> Other kind of Circular Arches, as half Rounds and Scheams [segmental], being described from one Centre, are fo plain and eafy, that I need fay nothing concerning them.

The first reason for choosing semi-elliptical and straight arches to explain the setting out procedure was the popularity for the semi-ellipse for wide-span entrances into courtyards; here most horse-drawn vehicles could pass with the driver still in position as this arch gave maximum height, and thus headroom, within its span. The straight arch was desired for classical brick façades as a means to securely bridge an opening yet provide the desired flat beam-like effect.

The second reason for the selection of semi-elliptical and straight arches is the intricacy of their setting out, establishing individual voussoir positions and their precise shapes for the cutting templets; vital for accurate gauged work. In the straight arch individual voussoirs up to the central 'key brick' are unique to their position; replicated (but only as a mirror-image) on the other half of the arch. With the semi-elliptical arch, the same factors apply. However, the arch is geometrically set-out from three separate centres or 'striking points' and so individual voussoirs relate only to their relative radial point. It is therefore a complicated arch to draw, set-out, cut and 'turn' (build) to ensure an accurate, neat, and precise arch.

In reading Moxon's description of drawing, setting out, and establishing the face templets, for gauged arch voussoirs, one needs to be aware of his seventeenth-century terms and their meanings in modern terminology to relate more clearly to his instructions:

> Hanse – The curved rise situated mid-way between the 'crown' and the springing-line'; today known as the 'haunch'.
>
> Scheam – The arc of a larger radius in the middle of a three-centred or elliptical arch. It can also mean an arch that is the same as a segmental, but the voussoirs radiate to the centre of the opening rather than the geometric radial-point of the arc.
>
> Sommering – The radiating lines representing the sides of the voussoirs as drawn to either the 'striking-point' or from the 'extrados' to the 'intrados' of the arch face.
>
> Chaptrels – An 'impost' or small capital more usually associated with vaulting.
>
> Oxi (Oxigonium) – Or 'from the Oxi'. The setting out of the 'skewback' in a straight (flat) arch by drawing an inverted equilateral triangle, with its apex at the 'striking-point', to create an angle of 60°.
>
> Prick – The setting out mark made by the point of the compass or divider, when 'pricking-out' or marking the positions of the voussoirs along the extrados, and sometimes the intrados, prior to drawing them out.

The difficulty today in correctly following and understanding Moxon's instructions so that either arch could be prepared and set as gauged work, becomes very apparent upon reading his instructions on establishing the size of tight, or very narrow, joints between voussoir templets:

> …then make another fommering mould to fit between two of thefe Lines, abating fo much as you intend the thicknefs of your Joints of Morter to be, which if you fet very clofe Morters, the breadth of the Line [black-lead pencil] will be enough to allow… (Moxon, 1703, 275)

It is important to study and tease-out the hidden meanings within Moxon's detailed explanations, made difficult by the use of old craft terms. It is however vital as one gains a deeper understanding of contemporary practices of late seventeenth- and early eighteenth-century bricklayers, and the consequent subtle aesthetic effects of their skills on their gauged arches.

The Semi-Elliptical Arch

The radiating, or sommering, of the voussoirs to the arc of the arch from Plate 8 of Moxon's treatise is taken from the centre, or 'striking-point', marked I (see figure 83). Moxon gives two methods for setting out the haunch. In the first, the extrados (F-L) and intrados (B-K) are divided into so many equal parts (in this case 18 courses) and the lines then scribed between them. Moxon points out, however, that this method of establishing the voussoirs, although the strongest (or indeed dividing the upper hanse to their geometrical striking point at centre marked 0), makes them noticeably smaller.

On the right-hand side of the same arch, Moxon shows an alternative method, with accompanying explanatory text, whereby the courses of the scheam and hanse divide into equal voussoir sizes, deemed visually more harmonious.

It is interesting to note that, until the Restoration, it was generally the tendency for arches of whatever size to be constructed in half-lapped stretcher bond. In Moxon's treatise his arch is drawn in English bond. This reflects a change in fashion towards showing some arch faces in aesthetic quarter-bond, which appears to be uniquely English; though its use also spread to the British Colonies. Indeed, the flat arch of Helder's masterpiece of 1675 (at the Victoria and Albert Museum) is constructed with an English Bond face. The same bonding is also used for the gauged flat arch above the entrance doorway to the south wing of Morden College, Blackheath (Kent) (1695). Generally, however, it is Flemish bond that was preferred when quarter-bonding a flat arch face, that being a voussoir course bonded stretcher and header, followed by a course bonded header, closer, stretcher.

Moxon has two errors on either side of his drawing of the English bonded semi-elliptical arch. On the left-hand side the error is simply one of scale, as the central header between the two closers appears like a stretcher compared with the other headers in the same course. On the right-hand side, however, the bond is incorrect, as one of the 'closers' is placed on the stretcher course instead of being placed between the headers, as correctly depicted on the left-hand side.

This quarter-bond was often a part-aesthetic, created by 'scribing' false or 'dummy' joints on to the constructional half-bonded brick veneer to create the illusion of thick-walled English or Flemish bond. An interesting use of dummy joints has been noted on a half-bonded gauged semi-elliptical arch to the main gateway at Chatham Dockyard (Kent) (1718), to create the illusion of English bond (Fig. 86).

Figure 86

Semi-elliptical gauged arch to the main gateway, Chatham Dockyard (Kent), 1718. (Courtesy of Nigel A. Howard)

Figure 87

Close-up of the use of 'dummy-joints' to create aesthetic English quarter-bond to the central stretcher on a structurally half-bonded gauged arch of the main gateway, Chatham Dockyard (Kent), 1718.

To create a 'closer', either side of the central header on alternate header courses, dummy joints were scribed into a stretcher, a quarter brick in from both ends and parallel to the soffit of the arch at that point (Fig. 87). This was repeated on the two-brick-deep soffit. These dummy joints, measured at ¼ in (5 mm) depth would have been carefully pointed before the final rubbing-up phase to complete the overall illusion.

The Straight Arch

It is the 'straight' (also spelt 'strait' or 'streight) or flat arch that comes to mind when one considers the brick architecture of the Renaissance. It was originally employed to horizontally span an opening to be stuccoed so creating the appearance of the stone lintel or beam it was substituting; and can be seen as such in some of the Roman ruins of Pompeii, Italy. This style of arch became popular in England at the time of the Anglo-Dutch style of architecture and craft practices. Moxon emphasises the importance of this form of arch construction and the related craft knowledge (Moxon, 1703, 279):

> But fince streight Arches are much ufed and many Workmen know not the true way of defcribing them, I fhall write fomething briefly concerning them.

Moxon discusses establishing the skewback, or the inclined surface of brickwork from which the arch springs. He stresses how the angle may be made less acute, by dropping the radius, or 'striking point', down the centre line of the opening, if the width of the piers between openings was two bricks or less (1703, 279–80):

> …Streight Arches are ufed generally over Windows and Doors, according to the breadth of the Piers between the Windows, fo ought the Skew-back or Sommering

> of the Arch to be; for if the Piers be a good breadth, as three or four Bricks in length, then the Streight Arch may be defcribed (as its vulgarly faid) from the Oxi, which being but part of a Word, is taken from the work Oxigonium fignifying an Equilateral Triangle, with three fharp Angles; but if the Piers are fmall, as fometimes they are but the length of two Bricks, and fometimes but one Brick and an half, then the breadth of the Window or more, may be fet down upon the middle Line for the Centre, which will give a lefs Skew-back, or Sommering, than the centre from an Oxi.

The two common methods to determine or 'describe' a skewback are detailed. First, by geometry, creating an equilateral triangle below the opening from either 'springing point' to establish the 'striking point', from this the skewback could be drawn giving a constant angle of 60°. This has always been considered to be the best angle for this arch as it gives a perfect counter-thrust to the reciprocal equilateral triangular area of direct load above the opening.

The second method creates a less acute skewback achieved either by geometry or a mathematical formula known as the 'One-Third Rule' (see page 220). This gives Moxon's skewback on the left-hand (see Fig. 85) side a drawn angle of 65°, whereby 70° is usual. In Moxon's example on the right-hand side, he establishes the striking point a vertical distance down the centre line from the springing line that equals the span of the relevant arch.

Moxon gives as the need for this reduction the narrow piers between openings – especially on narrow-fronted terraced houses – unable to accommodate the 60° angle of skewbacks as, for example, with a one and a half-brick wide pier the opposing springing voussoirs would collide. In reality the angles of skewbacks on straight arches could and did vary, as discussed in Chapter 4.

The straight arch is generally, though not always, found to be set-out to a vertical face height of four standard courses of brickwork which, in the seventeenth century gives:

> 12 Inches; but moft commonly thefe fort of Arches are but 11 Inches in the height, or thereabouts, which anfwers to four Courfes of Bricks, but you may make them more or lefs in height according as occafion requires…. (Moxon, 1703, 274)

Having drawn the outline of a straight arch, Moxon details the techniques of dividing the arch face into the number of courses the arch would contain. The first involves setting out, or more correctly 'pricking out', the voussoirs on the extrados with the aid of:

> …Compaffes the thicknefs that a Brick will contain, which I fuppofe to be two Inches when it is rub'd. (Moxon, 1703, 281)

This method of setting out creates a flat arch with voussoirs of regular widths at the extrados. Curiously, though Moxon correctly provides for the arch being worked to a 'key brick', which is best practice, he shows a joint at the centre in his drawing.

To establish the shape of individual voussoirs, for setting out templets, two methods are given. In the first, the positions are 'pricked-out' on the extrados and drawn from each by pencil run along a rule resting against a nail placed at the striking point of the arch. In the second method, voussoir positions are evenly spaced on the extrados, but also – to lesser widths – along the lower line or intrados by subdividing them both. These radial lines are then drawn along a ruler placed to link these two opposing marks.

Moxon finally considers the bonding pattern of the straight arch face as a half-bond of alternating stretchers and headers (see figure 83); this is in the manner of the Dutch. He correctly advises caution when bonding courses in an arch if odd or even in number. If odd, preferable for symmetry and bonding of the 'key-brick', then the first, or springing, voussoirs can be identical, either headers or stretchers at the bottom. If even, then the 'springers' on either side must be different, a header opposing a stretcher.

Summary

The post-Restoration period heralded a golden age for English brickwork, once again influenced by the craft practices of the Dutch. The degree of accuracy required to set-out, cut and rub, and lay a superior grade of low-fired rubbing brick, with joints as fine as 1 mm, saw the emergence of the term gauged work. The reduction of the joint size was part of the classical masonry tradition of minimising the detracting impact of many bricks within a classical enrichment. Gauged work was an essential part of the principal fronts of new brick buildings after the Great Fire of 1666. That it was an integral part of a first-class bricklayer's range of skills is emphasised by study of Moxon's seminal craft treatise, *Mechanick Exercises: OR, the Doctrine of Handy-Works. Applied to the ART of Bricklayers Work*, of 1703.

Case Study: Eltham Orangery Niche, *c.*1700–20, Eltham, London

Architects Perspective

By Caroe & Partners, London

The Eltham Orangery is an early 18th century grade II* listed structure and was originally part of Eltham House, which stood on what is now Eltham High Street in the London Borough of Greenwich. Believed to have been commissioned for Colonel John Petit, and built between 1717 and 1720. The Orangery was built against the rear garden wall facing South. Parts of this wall, the earliest structure on site, still remain.

The Orangery may be the work of the architect John James but other names have been suggested. The Orangery is a handsome baroque building with impressive architectural features. The main South elevation is faced with fine red gauged brickwork. The centre piece of the elevation is a niche with a scallop shell carved in gauged brickwork. The rear elevation and the flank walls, are constructed with eighteenth and nineteenth-century stock brickwork, although the gauged red brickwork pilasters also appear on either side of the East and West elevations.

The building had lain derelict since Eltham House was demolished in the 1930s. In the 1970s it was taken over by the local authority, and there had been several unsuccessful attempts to find a use for it. The building is listed grade II*. It had suffered from vandalism and neglect with increasingly dire consequences. A fire in 1978 burned the roof down. Despite security measures taken and a supporting scaffold and temporary roof being erected, vandalism damage continued, to the point where the West wall suffered a collapse in 2000.

In the same year, the building passed from local authority ownership to Freeman Historic Properties, who appointed Caroe & Partners to assist with its repair and restoration. Work started on site in January 2002 and was completed in March 2003 with an English Heritage grant of 93.75%.

The brickwork of the central niche was repaired by Emma Simpson and Gary Carter of Nimbus Conservation with guidance and advice from Mr Gerard Lynch.

The Craftperson's Perspective

By Emma Simpson, Simpson Brickwork Conservation

The brickwork of the pediment area comprises a gauged brick semi-circular niche, spandrels and abutments. It is constructed mainly out of red rubbers, with contrasting use of yellow cutters in the abutments. This brickwork, framed by the solidity of the Portland stone pediment, entablature, capitals and string, was in a far poorer condition than the rest of the gauged brickwork on the building.

The red rubbers, in happier circumstances, would survive for centuries, but had suffered extreme decay. In the main body of the niche, it appeared that up to 70% of the brickwork had shattered. In some locations, dramatic erosion of approximately 40 mm from the face had occurred. The ingress of water, able to course through the structure from open joints in the pediment, must have contributed significantly to this devastation. A chemical reaction between the limestone, water and atmospheric pollution may have accelerated decay, and frost action will also have played its part. With the erosion, came a weakening of the brickwork structure and two large cracks opened up, particularly severely on the right-hand side.

The niche had a jumbled and disrupted appearance, having lost the glorious precision of gauged work maintained in other areas of the Orangery. The semi-circular bonded arch face, with its intricate mouldings, had lost so much of its detail that the profile was only fully detectable on one original brick. The hood of the niche was blackened with sulphation and much of the surface had de-laminated. Where open blisters had formed, surfaces were friable. The boss feature appeared to be a scallop shell, although most of the outer edges had disappeared. Originally an exceptionally fine piece of brickwork with joints less than 1 mm, it was so badly decayed that its true form was barely discernible.

Due to the advanced level of decay, it was decided that a bold attitude towards brick replacement should be adopted. Each element of the niche was considered on its merits and an appropriate approach was established.

The niche body was distorted, possibly through structural movement. Using measurements from the survey, a full size plan drawing was produced and a templet was made of the shape of the curved bricks that make up the main body. This templet was handed to the joiner who made a cutting box out of robust hardwood. Two pieces of 18 mm thick timber cut to the exact shape of the barrel curve were fixed to a sturdy baseboard at the correct width apart to accommodate two 62 mm rubber blanks, with a space between them for wedges. The sides of the box had to be at perfect right angles to the base and all dimensions thoroughly checked. The bricklayer is reliant on the robust and precise nature of the cutting box to produce work to the required accuracy for joints of 2 mm or less, and it is therefore helpful if the joiner has some understanding of the gauged work process.

Red rubbers were cut to the correct gauge to be placed in the box for cutting to the curve. One way in which modern technology can help to speed up the process of gauged work is with the use of electric bench saws. These machines typically have a 14 inch (350 mm) diamond blade and can be used wet to minimise the considerable dust generated. A rubber block can be reduced to gauge in a matter of minutes. Before using the bench saw, the block must be bedded and squared by hand so that it can go through the saw on a flat and true bed. Although these machines are immensely useful and economical, it is important to remember that they cannot always be as accurate as hand cutting and rubbing, due to slight movements in the blade as it turns. For this reason, it is a good idea to cut the blanks 1–2 mm oversize all the way round, and to hand finish on the rubbing stone.

Once these correctly gauged blanks had been produced, the next stage was to hand cut them in the box with the traditional bow saw. A temporary workshop was set up on site. First of all, the box was thoroughly swept out to avoid any build up of brick dust that would throw the brick out of line during cutting. Two brick blanks were placed in the box and tightly wedged with small wooden packers. On a firm bench, the box was then fixed down with a piece of timber

Figure 88

Filing bricks to finish within the profiled cutting box for the body of the niche, after being cut to shape with the wire-bladed bow saw. (Courtesy of Emma Simpson)

strutted from a convenient section of the scaffolding. A blade was made for the bow saw by twisting together a doubled length of galvanised wire using a ratchet brace. Using a sharp nail, the profile of the box was scored into the brick blanks to help guide the blade. With steady strokes, the blanks were cut, allowing the bow saw to follow the curved sides of the box (Fig. 88). Once cut through and the timber strut removed, it was then possible to briefly hand finish the shapes, running a file over the box to remove any ridges. This process was repeated until the required number of replacement bricks had been produced.

Before replacement work was begun, the stone pediment was propped in order to avoid placing any further stress on the damaged brickwork. Bricks for replacement were marked up and carefully removed in small groups to minimise any risk of collapse. The thin joints were cut into using hacksaw blades and the bricks were gently pulled out. During this process, it was possible to see that the gauged work was not tied in to the core of the niche and was approximately 100 mm thick.

The core was made up of brick rubble and mortar, with some voids. In many places, the gauged work skin had become detached from the core, creating a gap into which mortar and debris had fallen as a result of structural movement. This process had exacerbated a bulge in the face work that could eventually contribute to a collapse. It was also noted that many of the bricks being extracted were, as well as being heavily eroded on the face, also fractured down their length, as if they had been subject to unbearable compression.

In order to help to tie the face work back in to the core, it was decided to introduce tie bricks in a staggered pattern, approximately every four courses.

A hooked 4 mm diameter threaded stainless steel dowel was resin-fixed in to the replacement brick. A hole was then drilled in the appropriate position in the core and filled with lime mortar. The tie brick was then carefully lined up and fixed in to position. All the replacement bricks were lined up with the joints of the original work, dry fixing before being dip-laid.

The fixing mortar was carefully prepared and kept in a covered box. First of all, the lime putty was sieved through a mesh (1.5 mm diameter holes) to remove any lumps of unslaked lime, stones or other impurities. A small amount of very fine sand (approximately 10% of the mix) was then added and thoroughly mixed in. Finally, a drop of linseed oil was added and mixed in. The mix by this stage had a glossy, smooth and creamy texture. It is well worth the time taken to prepare the mix very carefully as it is vital to the success of fixing. The addition of sand helps to minimise any cracking as the work dries out and makes for a more cohesive mix and the linseed oil increases the plasticity. It is important to cover the mix to prevent debris dropping into it, especially from those who may be working on the lift above. Even light traffic on the scaffold causes debris to drop down, and can ruin a carefully prepared mix, making it impossible to lay to tight 2 mm joints.

Once the mix was ready and trowelled to a flat surface in the box, replacement bricks were thoroughly soaked in a tub of clean water. Getting the soaking time exactly right took careful judgement as various factors determined the fixing conditions: the relative porosity of the bricks, the prevailing weather conditions and temperature, and the porosity of the existing background. If the bricks were too dry, it became impossible to ease them into position and to form a successful bond with the existing material; if they were too wet they slid about and caused unsightly smearing. The prepared bricks were dipped into the putty mix and the mortar was trowelled to an even thickness that allowed it to exude once compressed. This bead of excess mortar was then carefully cut off with a sharp small tool, leaving full beds (Fig. 89). There is only a limited time that the bricks can be adjusted to fit whilst the bed is still pliable. This became even more of a challenge on the tie bricks, which had to be located into the drill holes in the core.

A rubber mallet or the end of a lightweight hammer was used to tap the bricks home and adjust their position, making sure that a regular, 2 mm joint was achieved. Once a section of replacements had been completed, any gaps in joints had to be thoroughly filled. A drier mortar was used for this in order to avoid smearing. Only small sections of replacements could be completed at a time. The reveals had to be very carefully dismantled and rebuilt due to the fragile nature of the brickwork in those areas. The extent of cracking and voids on the right hand side made minor controlled collapses unavoidable.

Measurements were taken of the span and rise of the arch in order to produce a full size drawing. From this, a voussoir templet was made and the

Figure 89

Drilling holes to aid fixing of the prepared replacement rubbing bricks to the body of the niche. (Courtesy of Emma Simpson)

voussoirs were cut using the bow saw and a reducing box. This box has a movable bed that can be adapted to produce ashlared units of varying gauge, as well as to produce voussoirs by fixing the bed to the required tilt for cutting. A further templet was made of the moulding of the original voussoirs and this moulding then had to be cut individually in to each voussoir. The profile was first scribed onto the side of each voussoir and then these lines were transferred across the face to mark out the cutting lines. It was decided to cut these shapes entirely using hand tools: chisels, small saws, files and a variety of rubbing stones. This method provided the flexibility needed to ease in the old and the new where the new replacements abutted the three-and-a-half original voussoirs that were to be retained. As with the work in the main body, distortions made it a difficult job to match old to new. As well as allowing flexibility, this method would also have been akin to the original craftsmen's method of producing the mouldings as the Orangery pre-dates the use of the wire bow saw in gauged work.

Once the voussoirs had been produced, they were dry laid on the full sized drawing with an allowance for the correct 2 mm joint size. As in the main body, the decayed bricks were carefully cut out for replacement. As the arch is bonded, yet no replacements were to be made in the hood, it was decided to partially cut back in to the hood to allow a 'key' for the bottom bonding header (Fig. 90).

This had to be done very carefully, and the joint faked with coloured mortar in an attempt to minimise the visual disturbance. As replacements built up toward the vertical position, tie bricks were introduced, again tied using 4 mm threaded dowel. Finally, a code 4, lead flashing was introduced as further protection to the arch and hood.

Figure 90

Replacing cut-moulded voussoirs to the arched face of the niche hood. (Courtesy of Emma Simpson)

The scallop-shell boss represented a particular challenge because there was barely enough evidence in the original material to suggest a way forward in its repair. After discussion, it was felt that it would be in keeping with the spirit of the building to try to re-establish the outline of the shell. Clay was modelled directly on to the brickwork to build up the scallop shell outer edge in order to agree a shape for the new work. Following careful recording and production of a drawing all the outer nine bricks were removed. Using paper templets, brick blanks were cut which had to fit accurately together in order to avoid any opening up of joints once material was carved into and to replicate the very fine joints of the original. These blanks were then marked up with the proposed lines of the ribs and scallops, matching up as far as possible with the original lines, although these were eroded in many places. The bricks were then carved and dry laid before setting in a compound of whiting and shellac. Once the whole piece had hardened off, fine-tuning of the carving was possible and mortar repairs were carried out to build up the eroded ribs (Fig. 91).

The hood of the niche was dry brushed and the loose blisters were removed. This instantly improved its appearance and stopped them from providing pockets for grime or frost. A more systematic but gentle clean was carried out using minimal water and soft bristle brushes. Following this treatment, it was decided to leave the hood. Further rubbing back could have opened up joints and weakened the fragile nature of this element of the niche.

The use of mortar repairs was kept to a minimum, as it was feared it could detract from and deaden the effect of the gauged work. However, in small areas, mortar repairs were used to protect a brick that had a relatively minor defect that could lead to further decay. The basic mix used was:

5 parts hydraulic lime (St. Astier 3.5)
8 parts brick dust (original discarded Eltham rubbers)

Figure 91

Final *in situ* adjustments to the carved scallop shell boss prior to building it in. (Courtesy of Emma Simpson)

2 parts washed sand
1.5 parts Burnt Sienna natural earth pigment
1.5 parts Yellow Ochre natural earth pigment.

With conservation works having been completed, the pediment and niche had regained structural stability as well as the visual strength provided by re-establishing the clear lines of the arch intrados and extrados and the niche reveals. The fine crispness of the Portland stone carvings re-emerged and the contrast between the monumental whiteness of the stone and the red glow of the gauged brickwork was enhanced, helping to bring the building back to life (Fig. 92).

Garry Carter and I carried out this project whilst working for Nimbus Conservation Ltd. Although we are both qualified bricklayers to NVQ level 3 standard, the skills needed for this type of project were not covered in our initial training. We had both pursued further training in order to take on specialist tasks such as gauged work. The training in gauged work and its repair we received from Gerard Lynch was vital to the success of our work at Eltham Orangery. These courses enabled us to work out the geometry to produce drawings and templets for the replacements and to have an appreciation of the historical context of this type of work. We also gained a deeper understanding of the materials and tools through observation and practical experience in his workshops. The opportunity to practice cutting, rubbing and fixing on these courses was invaluable.

The process of carrying out this project developed our skills further as we came across problems that we had not anticipated. Having the chance to deepen our knowledge through direct experience left us in a better position to meet the challenges of the next job.

Figure 92

The restored niche at Eltham Orangery, London, *c.*1717–20. (Courtesy of Caroe & Partners Architects)

4

The Georgian Period (1714–1830)

Introduction

The Georgian period covers the reigns of George I (1714–27), George II (1727–60), George III (1760–1820) and George IV (1820–30), although the period from *c.*1800 to 1830 is also sometimes termed the Regency.

This was a time of great social, technological, and scientific change. It was also one in which the population began to grow and transform the nation from a rural to an urban society and, despite the problem of poverty, greater wealth was being generated and shared to a wider section of the populace. The expanding British Empire created colonies providing raw materials for the factories, benefiting from the many scientific and technological innovations aiding quality and quantity of production, but also markets for their manufactured goods.

This greater prosperity had many consequences Lawrence and Chris (1996, 17–18) suggest:

> [It]enabled more people from the top end of society to make the Grand Tour and be exposed to other cultures, particularly the classical. They were extremely impressed by what they saw and their views filtered down – many became infected with an enthusiasm for everything classical, which, in turn, became synonymous with the notion of 'good taste'….
>
> Georgian houses appeared in a complete range of sizes – the small one was the latest to appear in the final quarter of the Eighteenth century. By then it was one style in a variety of different sizes, thus catering for upper, middle and lower classes…

The nation's strong affection for brickwork and a popular classicist style of building allowed the love affair with Dutch-styled gauged brickwork to be fully 'Anglicised', at all levels of design and use. When the English take something to their heart and embrace it, they do so with an almost all-consuming passion. It is either right or wrong and no half-measures are tolerated. They also want to fully examine and explore all its possibilities; often to the point of eccentricity.

Georgian builders often combined coloured bricks for a reticent polychromatic effect, especially around door and window jambs, pilasters, and some quoins, the best of this brickwork being executed in rubbers, for arches, aprons, cornices and pilasters, etc of contrasting colours to the facework. An example of such finely gauged pilasters is at Bradbourne, Larkfield (Kent) (1714). Describing the gauged work of The Convent at Longbridge, Farnham (Surrey), Lloyd (1925, 220) says:

> The walling is built with 2–2¼ins bricks, rubbed and edged, with ¼in joints. The dressings are built with 2⅛ins bricks and invisible joints. This house is a fine example of cut, rubbed, and gauged brickwork…

Also in wealthy Farnham, where there was the money to finance such costly brickwork, Lloyd (1925, 222) describes the fine red brick outside of Wilmer House as:

> Perhaps the most remarkable elevation in cut and moulded brickwork extant. The whole front is gauged. The bolection mouldings of window architraves are exceptional. The cornice is also excellent.

Chicheley Hall at Chicheley (Buckinghamshire) (1719–24), designed by Francis Smith of Warwick, has the main south and east facades of finely coursed ashlared gauged work and enrichments; and niches on some of the associated buildings. All local bricks, including the orange/red-textured rubbers that match the standard face bricks, were used for this most gracious of buildings (Fig. 93).

Figure 93

Close-up of some of the ashlared gauged work to a pilaster and the surrounding standard facework at Chicheley Hall (Buckinghamshire), 1718, which reveals they are of the same bricks.

The brick-built Grade II listed 'Queen Anne Summerhouse', Old Warden Park, Old Warden, Bedfordshire, built for Sir Samuel Ongley, a director of the South Sea Company, is believed to date from 1710–14, though it first appears on an estate map of *c.*1736 (Briden, 2005, 2). The Summerhouse is rectangular on plan with round towers to each of the corners, though sadly derelict and awaiting restoration, is undoubtedly a fine example of eighteenth-century gauged brickwork. All four façades are in gauged work of ashlared orange-red bricks that are of 'exceptional quality' set in a white lime:fine sand mortar. Following contemporary practice the bricklayers laid the gauged work as a half-brick façade in accurate Flemish bond, including cut and rubbed radial bricks for the towers, rarely tied-in to the backing brickwork, as can be seen on a partial collapse of the façade at the top of the south-west tower. Where necessary the bricklayers also used 'dummy joints' to create aesthetic quarter-bond. By these dates, however, the fashionable use of gauged work for whole fronts was fast declining, perhaps due to cost as much as, in the opinion of some, architectural indigestion (Cruickshank and Wyld, 1975, 185).

Georgian brickwork could also be accentuated with terracotta enrichments modelled to resemble stone, which came to prominence again during this period. The most famous factory was that founded by Eleanor Coade in the 1760s, producing the high-quality 'Coade stone' from 1767 until 1835. This artificial stone product was particularly prized for embellishments to openings, for arches with vermiculated voussoirs, rusticated with brick, and for a wide range of sculptured keystone motifs (Fig. 94). The use of gauged work declined, becoming confined to arches, aprons and other dressings, as this period drew to its close.

Figure 94

A close-up of a gauged arch of malm cutter voussoirs and rusticated blocks and a keystone of 'Coade Stone', at the entrance of 7, Bedford Square, London; a development built *c.*1775–83.

Building Acts and Builders' Pattern Books

The Building Acts, which only applied in London, following the Great Fire were, to a degree, nationally influential as their interpretation and enactment affected the fashion for the popular use of brick and how it was subsequently structurally and decoratively applied. This was not only reflected in the choice and articulation of gauged work, but in establishing the first strictly Georgian house out of its late seventeenth-century roots.

Summerson (1947, 52) states:

> Continued fear of conflagrations prompted a Statute of 1707, which abolished the prominent wooden eaves-cornices which were such a striking feature of the streets and squares of the Restoration….

By the London Building Act of 1709, timber window frames, instead of being almost on the same plane as the brick face, were to be set back 4 ins (102 mm). The more stringent and effective London Building Act of 1774 virtually prohibited the use of exposed timber work on buildings, stating that entire fronts were to be of brick, stone, burnt clay, artificial stone, or stucco.

These and other Acts, and the influence of numerous pattern books, gradually led to the standardisation of architectural design and, in turn, the components themselves; even the bricks. This influence of pattern books on Georgian architecture was considerable, providing builders with sufficient knowledge to erect a building to the satisfaction of the client. Publications also gave technical guidance to skilled craftsmen; examples include *The City and Country Builder's and Workman's Treasury of Designs* by Batty Langley (1740), and *The Complete Body of Architecture* by Isaac Ware (1756). These enabled building owners to become more conversant with details of proposed works, a consequence of which was the erection of many fine buildings spoilt only by the repetition of detail. R. Campbell in *The London Tradesman* of 1747 warns of the perils of master bricklayers designing and building.

> 'A master bricklayer thinks himself capable to raise a brick house without the tuition of an architect…It is no new thing in London for these master builders to build themselves out of their own houses, and fix themselves in gaol with their own materials' (Lynch, 1994, 51)

Despite this cautionary note, Amery (1974, 12–13) emphasises the importance of pattern books to eighteenth-century domestic architecture which:

> … between 1715 and 1730, was stable and uniform. The Palladian gospel had been spread by the pattern books. These books were compiled by carpenters like William Half-penny of Twickenham or the carpenter/architect, Batty Langley,

> and they were full of good drawings of details and the orders and contained accurate plates of doors, windows and other elements. Sold to both the gentry and craftsmen, they spread the word of self-improvement….

The proliferation of pattern books reached its height in the years between 1725 and 1760, after which it diminished (Summerson, 1947, 58):

> …with the expansion of the architectural profession and the coincident repression of the craftsman's initiative. In the latter part of the century we get a very different wave of book-publishing, sponsored not by craftsmen but by architects, and designed not to instruct the workman, but to charm the potential client.

Yet, and with particular regard to the majority of brick-built Georgian London, Cruickshank and Wyld (1975, 1) emphasise the elegance:

> …was formed not by great architects but by master builders, entrepreneurs and all kinds of speculators. Yet the coherence it had, both in construction and design, belies this curiously multiple parentage and reveals that a great binding force was at work: the orderly flexibility of 18th century architectural classicism.

Brickmaking

Brick manufacture in London was still controlled by the Tylers and Bricklayer's Company; though their powers were receding, necessitated by the demands to quickly re-build after the Great Fire of 1666.

Brickmakers no longer used only the overlying clay or Pliocene layer, but older geological clays such as Eocene. Though some bricks from this period have 'Spanish' (ground sea-coal ash finely sieved with clay giving an integral fuel) within their body, which was a unique feature of the 'London Stock' brickmaking process, it was preferable and more common to use unadulterated clean brickearth or clay for rubbers or cutters. Creating an internal fireball within a rubber meant it was likely to burn harder internally, or leave particles of clinker within its body, impeding cutting and rubbing to shape.

Bricks continued to be made by either slop or pallet moulding. A major problem for all brickmakers was ensuring that the thrown clay filled all the corners of the mould. The answer was found in a clever development on the stock board in pallet moulding, the exact date of its introduction is not known, but as Hammond (1981, 11) states:

> From the late eighteenth century a raised block or kick was fixed to the stock to form the frog or recess in the bottom of each brick.

The kick, which changed in size and shape with the passage of time, had the effect of forcing, or 'kicking', the thrown clot of clay outwards, tight into the corners and creating sharp arrises; this not only speeded up brick moulding but also allowed for deeper moulds to be used. It had many other benefits too: being a clay saving device, enabled more efficient drying and firing, made the brick lighter and assisted in giving the mortar a better grip to the brick; providing it was laid 'frog up' and thus properly filled. Some bricks from the late seventeenth century onwards have been found to have a shallow recess, but, as Harley (1974, 80) suggests:

> …it was not until about 1690 that a depression was deliberately produced, at first as a slot scooped out by the finger of the brickmaker after he had moulded the brick.

The recess on a de-moulded brick is generally termed the 'frog', though terms such as 'kick' and 'sinking' are less commonly used also. The origin of the term frog is lost in antiquity, although one idea is its similarity to the cleft in a horse's hoof. A sight familiar in the pug mill area of the brickyard, and itself called the frog (Lynch, 1994, 10). Time spent researching in the Netherlands, however, has given the author another and more likely origin to the term. The Dutch word for frog is 'Kikker', very close to our term for the raised block, or 'Kick', that creates the frog in the brick, so it seems quite possible that the English term originally comes from a contracted translation of the Dutch.

At the beginning of this period, and later in the eighteenth century, red brick was fashionable for gauged work. Nicholson (1823, 344) observes:

> …the Red Bricks …are made of a particular earth, well wrought, and little injured by mixtures; and they are used in fine work, in ornaments over windows… These are frequently cut or ground down to a perfect evenness, and sometimes set in putty instead of mortar; and thus set they make a very beautiful appearance.

One particular rubbing brick is deemed worthy of naming by Nicholson for its excellence (1823, 344–5):

> … is the Hedgerly Brick: it is made at a village of that name, of the famous earth called Hedgerly loam… of a yellow-reddish colour, and very harsh to the touch, containing a great quantity of sand….

Nicholson urges caution, however, regarding selecting bricks for rubbers, in words that still apply today:

> The Red Cutting Brick, or fine red, is the finest of all bricks. In some places that are not at all acquainted with this; in others, they confound it with the red stock, and use that for it….
>
> The Red and Gray Stock are frequently put in gauged arches, and one as well as the other set in putty instead of mortar: this is an expensive work but it answers

> in beauty for the regularity of the disposition and fineness of the joints, and has a very pleasing effect.
>
> The fine Red Brick is used in arches ruled and set in putty in the same manner; and, as it is much more beautiful, is somewhat more costly. This kind is also the most beautiful of all in cornices, ruled in the same manner, and set in putty.

By 'Gray' [grey] stock, Nicholson is referring to the 'London Stock' brick, generally clamp-fired, varying in colour from brown through plumb red to purple, and where mixed with lime it would burn to the more familiar buff to yellow tones. The latter suited the fashion of the period, as orange and red-coloured bricks became less regarded; '…the colour is itself fiery and disagreeable to the eye' (Ware, 1756, 61). The aspiring middle classes wanted their homes to resemble the stone-coloured Palladian manor houses of the wealthy.

Lloyd emphasises the type of 'London Stock' employed for the gauged enrichments:

> The tendency to build with grey, cream and yellow stocks which became general in London and its vicinity was not unconnected with the development of Kentish and other brickfields where the available earths produced these colours, and here mention should be made of those bright yellow bricks, called Malms, a good example of the use of which is the elevation of Bath House, Piccadilly, and which are still used for gauged arches, etc (Lloyd, 1925, 58)

'London Stocks' were in 12 grades, according to Dobson's writing of 1850 (Searle, 1936, 80), the premier grade being:

> 'Malms'. These are the best building bricks, and are only used in the best descriptions of brickwork; their colour is yellow.

Alan Cox (Hobhouse and Saunders, 1989, 4) explains precisely the term Malm:

> In its pure state it was referred to as 'malm' and 'malms' or malm bricks and considered the best type of London stock brick. The brickearth is high in silica (about 65–75%), low in alumina (8–11%), and with a higher than usual lime content of between 7–9%. Normally the iron oxide in a clay will tend to produce red brick but lime will nullify this and produce a characteristic yellow- or white-coloured brick (this is true of any yellowish or whitish brick whether it be a London stock, a Suffolk white, or a yellow gault)…

In the London Stock range of bricks it was the malm cutters that were used as rubbing bricks (Fig. 95).

Figure 95

Gower Street, London, *c.*1780, showing the use of malm cutters for the construction of all the gauged arches.

Of note, studying Cox's description is the naturally high level of silica in the Malm (65–75%), a feature of bricks used for gauged enrichments. 'Malm cutters', like contemporary rubbers, were produced to the same size as the standard bricks.

The prices for best malms during the Georgian period were (Cox, 2002):

Year	Price per 1,000
1787	80 shillings
1794	80 shillings
1810	105 shillings
1813	130 shillings

A Building Agreement, dated 15th October 1807, between the Earl of Northampton and Thomas Hughes, for houses to be built by Hughes on the Clerkenwell Estate of the Earl in the vicinity of Northampton Square, included the following:

> …the whole of the front to be faced with seconds and grey gauged arches [i.e. all in London Stock brick including gauged arches] (London Metropolitan Archives: ref E/NOR/L/3/545)

In other areas, the desire to copy this fashion for 'grey' bricks could be met with such bricks as gaults (variously spelt galt, galte, and golt) from the burgeoning brickfields of Bedfordshire, Cambridgeshire, and Norfolk; as well as Kent and Hampshire (Fig. 96). Gaults are made from a stratum of calcareous clay that lies between the Upper and Lower Greensand formation. There is, however, 'widespread and indiscriminate use of the term "Gault" as a descriptor for pale-coloured bricks, irrespective of their origin or physical characteristics' (Firman, 1998, 10–11). Other calcareous white and yellow burning mudstones, brickearths and clays exploited across these regions produced bricks that were not gaults. The 'Suffolk Whites' are one such brick – 'the brickyards were 30 to 40 miles east of the nearest outcrops of Gault and Greensand'.

Figure 96
A gauged semi-circular arch constructed of gault rubbing bricks to the Bowling Green House, said to be 1735, at Wrest Park, Silsoe (Bedfordshire).

The best 'Suffolk Whites' were prepared and used as rubbers (though harder) for gauged work. These were termed Suffolk 'cutters' or 'clippers'; many of these were 'imported' into the city for rubbed and gauged arches, such was their regard.

Of major significance to the use of brick in this period were the changes in transportation with the advent of the canals from the 1750s. Barges, capable of carrying up to 25 tons over 3,000 miles of national canal network, meant that bricks were delivered much further afield, beyond their traditional area of manufacture and use.

Brick prices varied enormously over this period and with rubbing or cutting bricks continuing to demand a premium. On September 14th, 1733 Earl Fitzwalter paid Methums, brickmaker at Blackmore [about 5 miles southwest of Chelmsford] his bill of £6. 2. 9d for rubbing bricks; priced at £1. 5. 00d per

1,000 (Edwards, 1977, 52). Summerson (1947, 64) lists brick prices delivered per 1,000 in 1748:

Place bricks	14s.
Grey stocks	18s.
Do. (specially picked for uniformity of colour)	20s. or 22s.
Red stocks	30s.
Cutting bricks [for gauged work]	60s.

By 1813 these prices, according to Cox (2002) were:

Place bricks	55s.
Grey stocks	65s.
Cutting/rubbing bricks	85s.

Nicholson (1823, 345) reveals this was still true towards the end of the period:

> The fine red cutting English Bricks are twice, or more than twice, the price of the best Gray Stocks; the Red Stocks half as dear again as the gray; and the Place Bricks, as they are much worse, so they are much cheaper, than any of the others.

The Georgian Bricklayer

In the hierarchy of the Georgian building trade, the premier craftsmen were the masons, bricklayers, and carpenters in that order, with the master mason or master bricklayer responsible for a structure in either stone or brick.

The guild system, such as the Tylers and Bricklayers Company in London, was still operational at the beginning of the period, but rapidly losing its power and control, due to the faster pace, quantity of construction, and an ever more mobile workforce.

By 1814 'The Statute of Artificers' of 1563, that provided a legal basis for apprenticeships was abolished. A time-served apprenticeship, however, continued to be the route into the craft, with periods of learning varying from between four to seven years before qualifying as a journeyman, the best going on to become respected master craftsmen.

These craftsmen bricklayers dressed very much like their seventeenth-century predecessors, wearing knee-length trousers, stockings and boots, along with a shirt and neckerchief under a wide-sleeved jacket, all protected beneath a sheepskin apron tied at the waist; and topped-off with a broad brimmed hat (Campbell, 2003, 25).

Summerson (1947, 53) describes a Georgian London master craftsman as being:

> …as a rule, a man of considerable skill and status – proud, conscientious and expensive. He lived well, and drank heartily. He was capable of writing a fairly

> good letter and could usually (if he were a mason, bricklayer or carpenter), make a plain "draught" of a small building.

A new capitalist breed of bricklayer emerged aspiring to being a 'master builder' contracting for complete structures, and not just the brickwork, in the fast developing speculative property market of the hugely influential city of London.

Some of the influential city master bricklayers of the Georgian period were:

- William Tufnell
- John Prince
- William Emmett
- George Hoare
- Solomon Bray
- Joseph Pratt jnr.
- Robert Todd
- William Stacey
- William Whitehead
- John Whitehead
- Francis Read
- Martin Stutely

Such craftsmen, Russell and Chris (1996, 29) record:

> Often worked on each others' contracts and consequently a system of barter was widespread. Houses were frequently built with very little money actually changing hands.

Obviously there were many times when brickwork had to be charged for and in such instances contracts would be drawn up in a perfectly legal manner. Payment 'by the piece' was a popular eighteenth-century craft practice and price books recognised rates on a rod of bricks laid, or 272 square feet (25 square metres) of wall; about 4,500 bricks on a one-and-a-half brick thick wall. How gauged work was measured and priced in this period can be assessed by studying Neve (1726, 12):

> [Of meafuring Arches]. In meafuring of them, whether they are Straight, or Circular; they muft be meafured in the middle, i.e. If a ftraight Arch be twelve Inches in height, or depth, the length muft be meafured in the middle of the twelve Inches, which length will be no longer than if it were meafured at the underfide, next to the head of the Window, by fo much as one fide of the fpringing of the Arch is skew'd back from the upright of the Jambs, Peers, or Coins of the Windows.
>
> 14. Price] For the Workmansfhip of ftraight Arches, well rubb'd, and handfomely fet (of Brick) in London, about 8d. or 9d. per Foot; but in fome parts of Sussex and Kent, they will not do it under 12d. per Foot, running Meafure. But in London, if the Workmen find Materials, then 'tis about 10d. or 12d. per Foot.
>
> Skeen, or Scheam Arches, and Elliptical ones; of rubb'd Brick, are common about the fame Price with ftrait ones. But Sheam Arches of unrub'd Bricks are commonly included with the plain Work, unlefs the plain Work be done at a reafonable Price: But you muft here note, that the Mafter of the Building (or Owner) is at the charge of the Centers to turn the Arches on; and not the Workman, unlefs he be allow'd for it in the Price of the work.

Pain emphasises that gauged work is measured and priced upon a different and more expensive system:

> Rubbed Arches of any Sort are done from 1s. 6d. to 20d. per Foot; workmanfhip from 10d. to 1s. – Plain Facios rubbed 1s. 1d. per Foot; Workmanfhip 8d. – Brick Cornices from 4s. to 5s. per Foot; workmanfhip from 3s. to 3s. 6d. – Cutting Bricks for rubbed and gauged Work, from 40s. to 2l. 10s. per Thoufand (Pain, 1769, 1)

He concludes by providing a valuable exercise in how a new house might be priced for a bricklayer's work. From this, one can determine how gauged work was considered an essential part of a brick-built property; and was around five per cent of the overall brickwork price (Pain 1769, 8).

An Eftimate for Building a New Houfe.

		£.	s.	d.
To 600 Loads of Digging in Cellars and Foundations, at 6d.		*15*	*0*	*0*
Per load				
68½ Rods of Brick-work, reduced to 1½ Brick, at 6s. 5d. per Rod		*428*	*2*	*6*
21½ Square plain Tiling, at 1l.8s. the Square		*30*	*2*	*0*
150 Feet Run of Arch Drain, at 2s. 6d.		*18*	*15*	*0*
45 Yards Brick Paving in Morter, at 2s. 6d.		*5*	*12*	*6*
92 Feet of rubbed and gauged Arches to Windows, at 1s. 6d.		*6*	*18*	*0*
112 Feet of rubbed and Gauge in Facio, at 1s.		*5*	*12*	*0*
270 Feet of rubbed Returns, at 6d.		*6*	*15*	*0*
120 Feet Run of rough Splays, at 1½d.		*0*	*15*	*0*
45 Feet fuperficial of fummered Arches 1½ Brick, at 4d.		*0*	*15*	*0*
165 Feet Run of Groin, at 6d.		*4*	*5*	*0*
236 Feet 6 Inches of Foot Tile Paving, at 4d.		*3*	*19*	*0*
143 Feet Run of common Drain, 10 Inches wide, 9 Inches high,		*7*	*3*	*0*
4 Inch Walls, covered with Foot Tile, paved with flat Bricks, at 1s.				
Total of *Bricklayers* Work	*£.*	*533*	*14*	*0*

Dearn (1809, 34), remarking on pricing gauged work, states:

> The gauged arches, are most commonly deducted; but whether deducted or not, are always charged separately as the price of gauged work is seldom less, than five times as much, as is allowed for the best facing.

Under the general heading of Rubbed and Gauged Work, he states (1809, 58):

> This work is measured either by the foot superficial, or by the foot run, and set either in putty or mortar.

> Gauged arches to doors, windows, &c, are set in putty and charged by the foot superficial according to their different constructions…
>
> Also that an extra price is allowed for gauged work set on a circular, elliptical or any swelling bow plan.

Dearn (1809, 99–101) then goes on to detail contemporary practice in measuring various gauged arches to determine their individual prices, the prices charged reflecting the degree of complexity and accuracy demanded in the gauged enrichment. He also discusses brick cornices, adding that they were formerly very much in use but had entirely fallen out of fashion and that work set in front mortar [of quality sand and lime, well-screened for façades] was half the price than that set in putty [lime putty and silver sand].

Tools and Equipment for Gauged Work

As Moxon's treatise is an invaluable source of information on the tools, materials, and craft practices of the seventeenth-century bricklayer, so the building and pattern books of the eighteenth and early nineteenth century are for the Georgian period.

At the beginning of the period, Moxon's descriptions of the art of the bricklayer remained true for the Georgian cutting shed and site. This is largely why Neve, in his original publication (under the pseudonym T N Philomath), of *'The City and Country Purchaser and Builder's Dictionary'* of 1703 (second edition, Neve, 1726), uses many of Moxon's own words within his text. One needs to go to the end of this period and read another's observations, therefore, to fully assess how things had continued to develop in the cutting shed and gauged work.

Nicholson (1823, 384–9), in describing the tools and their use, emphasises how gauged work was now being reserved mainly for arches; hence his emphasis on preparing voussoirs rather than mouldings. Several of the tools Nicholson lists (except the brick axe, as it underwent a significant change) are omitted here as they have already been given and their use described in Chapter 3.

> BEDDING STONE – A straight piece of marble used to try the rubbed side of a brick.

This is an early reference to a 'bedding slate', a flat slab of marble for testing the bedding of a cut and rubbed brick to ensure it is flat on its bed face and follows exactly the shape of its templet. This became particularly important once joints of 1–2 mm or less were being routinely employed on gauged work, because absolute precision of the cut size and shape to the face templet, and that the brick face was square to bed was essential with joints too fine to take-up any inaccuracies. Later in his list (Nicholson, 1823, 389) returns to elaborate on the bedding stone:

> The Bedding-Stone consists of a marble slab, from eighteen to twenty inches in length, and from eight to ten wide, and of any thickness. It is used to try whether the surface of a brick, which has been already rubbed, be straight, so that it may fit upon the leading skew back, or leading end of the arch.
>
> The Hammer used by bricklayers (fig 7) is adapted either for driving, or dividing bricks…the axe part, more nearly resembles an adze, but is not so broad in proportion to its length.

This is what we now term a 'brick hammer', though the drawing in Nicholson's plate is incorrect. The axe blade, as drawn, should be turned through 90º so that it 'resembles an adze' as he correctly describes – in his drawing it does not.

The development and popularity of this particular cutting-tool, to cut and trim the brick to the desired shape, was undoubtedly instrumental in the decline of the use of the Moxon-styled short brick axe.

> The Chopping-block is made of any chance piece of wood that can be obtained, of about six or eight inches square, when for two men to work thereon; and lengthened in proportion for four or more. It is generally supported, about two feet three inches from the ground, upon two or more fourteen-inch brick piers. It is better to have several blocks when they can be obtained, in preference to allowing many hands to be employed at one; because the vibrations communicated by one workman are liable to inconvenience another.
>
> The Chopping-block is used for reducing bricks to any required form by means of the axe.

The term 'Chopping-block' denotes its use – to facilitate the cutting, or chopping, of a brick to shape. It was not placed on the bench or 'banker' as Nicholson terms it, but was frequently positioned so as to isolate the resultant vibrations created from precise work being undertaken at the bench.

Nicholson shows an error within the text and in his accompanying Plate of tools and equipment (Fig. 97), for he has 'The Banker' and 'Camber Slip' as '(*Fig. 13*)' in his text, yet denotes both, as *'Fig 12'* within the plate. Clearly he intended one, 'The Banker', as it comes first in the text, to be *'Fig 12'* and 'The Camber Slip' to be *'Fig 13'*. Also the Rubbing-Stone is not marked B, in his plate, as he states.

All drawings and templets would have been prepared on the 'banker'; the rubber squared on the rubbing stone and then scribed or 'tinned' for axing at the chopping-block. The prepared rubber would then be returned to the bench for the axed surfaces to be rubbed flat on the rubbing stone and

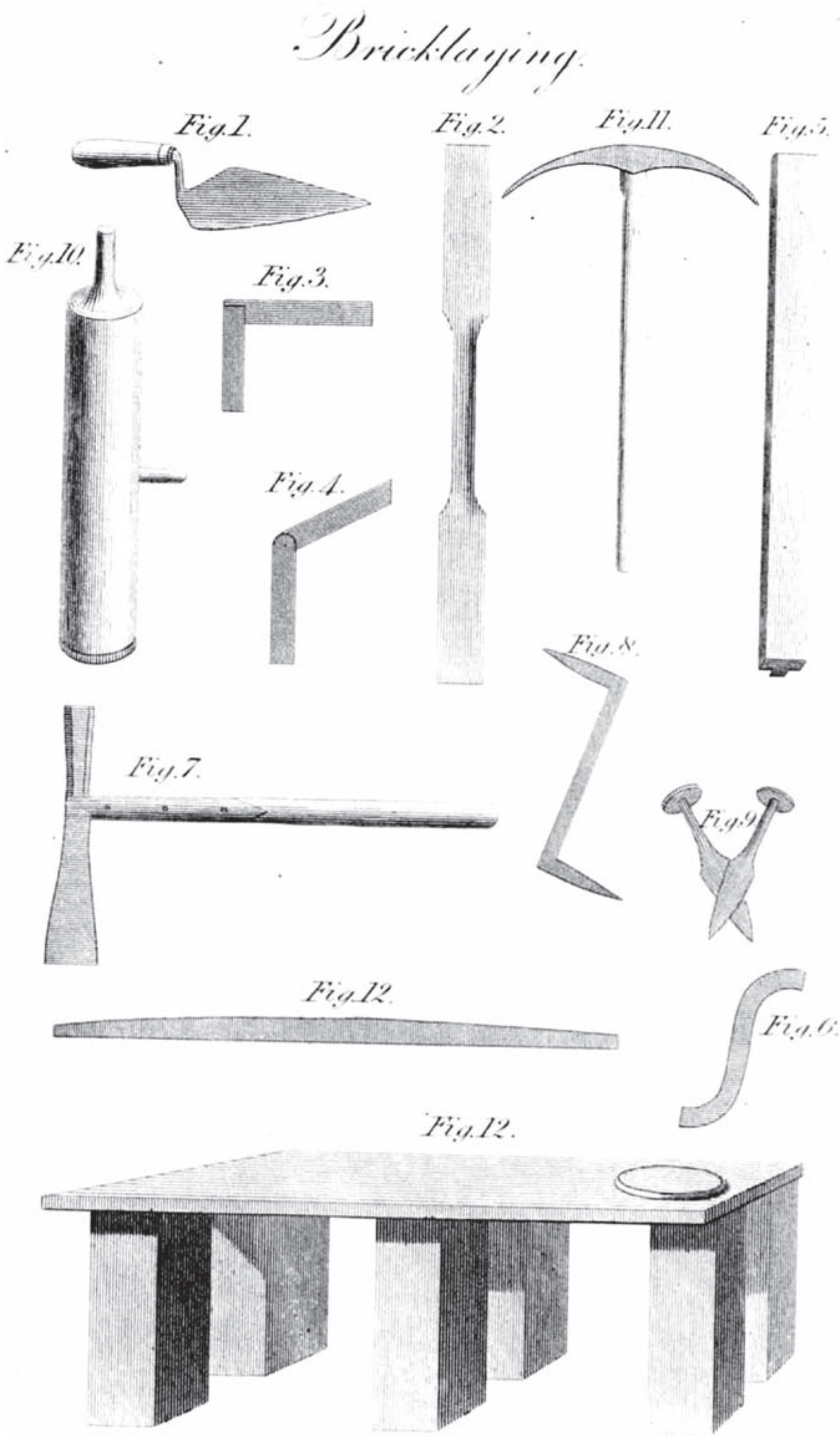


Figure 97

Plate depicting some of the tools and equipment used by an early nineteenth-century bricklayer, from Peter Nicholson's 'New and Improved Practical Builder and Workman's Companion, Carpentry and Masonry' of 1823.

checked on the bedding slate against its templet. Here also would be performed any final fine shaping, using the reverse profile running moulds, as described earlier. This would be in conjunction with any bevelling, fine cutting, and trimming with the tin saw. Within certain arches, such as a straight or Venetian etc, where each voussoir had its unique position, the prepared brick would then be scribed with its positional number, for example LH VI, denoting the header voussoir in the sixth position from the left skewback. Roman numerals being straight lines were preferred, as they were easier to scribe on to the brick. This would be followed by final dry bonding of the feature (or part of it) to test accuracy before sending out on to site for setting.

> …the Camber-slip (fig 12,) is a piece of board of any length or breadth, made convex on one or both edges, and generally something less than an inch in thickness: it is made use of as a rule. When only one side or edge is cambered, it rises about one inch in six feet, and is employed for drawing the soffit lines of straight arches: when the other edge is curved, it rises only about one half of the other, viz. about half an inch in six feet, and is used for drawing the upper side of the arch, so as to prevent its becoming hollow by the settling of the arch. But some persons prefer having the upper side of the arches straight; and, in this case, the upper edge of the arch is not cambered. When the bricklayer has drawn his arch, he gives the camber-slip to the carpenter, who by it forms the centre to the curve of the soffit. The bricklayer, in order to prevent the necessity of having many camber-slips, should always be provided with one which is sufficiently large for the widest aperture likely to be arched.

The knowledge and use of the 'Camber-slip' is all but lost to modern craftsman, yet was, and remains, ideal to set out the camber and establish the soffit bevels on a camber arch. It is also needed by a carpenter to set out the solid timber former, or 'turning piece', over which the arch is constructed. It is explained, in detail, later in this Chapter, pages 217–8.

> The Mould is used for forming the face and back of the brick to its proper taper; and, to this end, one edge of the mould is brought close to the bed of the brick previously squared. The mould has a notch for every course of the arch.

This is describing what later becomes termed a cutting, or reducing, box. The 'squared' bricks are placed into this box, made up of a front and rear templet, and then scribed or 'tinned', removed for axing to shape, and replaced into it for abrading flat between these two opposing edges; far easier to use than the standard free templet. Here Nicholson (1823, 389) is describing one for voussoirs.

> The Templet is an instrument for taking the length of the stretcher and the width of the header, in building walls, &c

> The Brick-axe is used for reducing or cutting off the soffits of bricks to the saw-cuttings, and the sides of the lines drawn by the scribe. Much of the labour required for rubbing the bricks may be removed by the axe being managed with dexterity.

The early style of brick axe (examined in Chapter 1) is clearly not that shown in Nicholson's fig 2. The stated use of it, for 'cutting off the soffits to brick to the saw cuttings, and the sides to the lines drawn by the scribe', is revealing. This brick axe is considerably bigger and heavier. Lloyd (1925, 289) reproduces a photograph of the two different types of brick axes placed side-by-side with their respective details recorded beneath. The larger brick axe having narrow 3 inch (76 mm) blades, was 25½ ins (645 mm) in total length, with a similar sized grip to that shown by Moxon, but it weighed about 6¼ lbs (2.83 kg). A similar, but slightly larger brick axe, in the possession of Richard Filmer, was 28⅝ ins (728 mm) in total length, with blade widths of 4 ins (101 mm) with a thickness of $^{5}/_{16}$ ins (8 mm) down to a cutting edge; and weighed 6.6 lbs (3 kg) (Fig. 98). The brick axe tapers from both sides, in a regular fashion, to form each of the two cutting edges. The central handle is 4½ inches (108 mm) long, the thickest point at the centre of the handle measures 1⅛ inches (28 mm) high with a width of 1¼ inches (32 mm). These styles of later brick axes, being large and heavy, were never intended for fine shaping, like the Moxon axe, their sizes negate such use. They were designed to cut as large a waste portion of brick as possible, something which was important because of the large amounts of 'axing' (or cutting) of brick arches in the cutting shed.

Figure 98

A large brick axe viewed in comparison to its earlier and smaller counterpart. (Courtesy of Richard Filmer)

Lloyd (1925, 72–30) quotes the larger brick axe in use from *The Dictionary of Architecture:*

> …The lines having been first marked on the brick by a species of small saw, the axe is then taken by the middle and held in a perpendicular position, its edge is then applied to the brick where marked, and both being raised together, it is struck smartly on a block of wood, by which the brick is cut into shapes. The rough edges of the brick are then rubbed on a piece of grit stone.

This definition, and the description by Pasley (1826, 241), 'A brick axe to complete the cutting begun by the saw. It has an edge at each end, like a very large chisel, with a round stem in the centre for grasping it. It is used by striking down over a chopping block', reveals the changed use of the tool. Clearly its long chisel-type blade design and heavier weight was intended to 'cleave' bricks in a manner akin to a chopper splitting timber. This brick axe is incapable of trimming and dressing rubbing bricks to cut-moulded shapes as its smaller predecessor.

A large brick axe was forged, by a traditional blacksmith, as part of the author's research, following the exact specification given by Lloyd, and used in a series of trials to determine its performance in the manner described above. These trials were carried out using different rubbing and soft handmade bricks, using a grub saw and a chopping block of 75 mm thick timber. The intention being to determine the practicality of the above quoted axing technique, assess the overall effectiveness of the brick axe, and finally judge the speed a hewer could both cleave a brick to shape and rub its surface flat.

In all tests the grub saw was used first to cut a 6–10 mm deep groove all around the brick, defining the waste portion to be cut away. Stood upright on the chopping block, the brick axe blade was then located centrally into the saw cut on the brick. Initially it was noted that the sharpened end of the brick axe blade was only penetrating about 2 mm into this cut because of the bevelled edge thickness (5 mm) of the brick axe blade. The blade was 'shouldering' and not fully entering the saw cut. It was decided to proceed. With the brick held by the left hand and the brick axe held vertically with the right, the two were raised simultaneously about 50 mm off the chopping block and brought down smartly upon it (Fig. 99).

The results were most revealing. With modern harder rubbers, the brick axe simply 'cleaved-out' sizeable chunks of material, failing to cut through the brick from top to bottom, or from side to side. The thickness and therefore inability of the axe blade to sit deeper into the cut was deemed partly responsible for this, but it was felt that the major factor was the harder modern brick. This latter opinion was subsequently confirmed when tested on softer, more traditional, low-fired rubbing bricks, which the brick axe split accurately in one go, leaving a reticulated surface that 10–15 seconds on the rubbing stone rubbed flat to line (Fig. 100).

Nicholson (1823, 389) advocates the use of sand to aid abrasion if the rubbing stone is working smooth. Though not unacceptable, dry silver or very fine loam sand would be necessary to avoid creating a scratched appearance on the rubbed brick faces. Of particular importance was that the ends of the bricks, impacting the timber chopping block, in this cutting process, were not damaged as anticipated, thus allowing them to be squared or bevelled as their intended use demanded.

A blacksmith subsequently thinned the ends the brick axe blades so it located more effectively into the grub-saw cut, further improving its effectiveness in

Figure 99

The author using a large brick axe to cleave a rubbing brick to size, after scoring with the grub saw, on the cutting bench in his own workshop.

later trials. It also confirmed this was a quick and efficient method to cut off brick waste and rub the roughened surface smooth. This was very important in a busy cutting shed where hundreds of bricks needed quick cutting to size and shape, that would have quickly blunted saw teeth, prior to finishing the many gauged arches and aprons dominating numerous brick façades.

Peter Hill, who had never seen such an 'incongruous cutting tool' before, made the following comments on the large brick axe, after cutting with it (Hill, 2000):

> It is clearly very unsatisfactory for dressing bricks owing to its size and weight. It seems rather elaborate for splitting bricks. The final trial with the tool did show that it could be used to split soft rubbers quite satisfactorily. With this tool in one hand and the brick in the other, however, there is no risk of the two halves of the brick falling after splitting, which would risk breaking them.

Figure 100
The two parts of the rubbing brick directly after being cleaved to size with the large brick axe.

Gauged Enrichments

The brickwork of this period was at first a consolidation of the fine work of the post-Restoration period. This was especially true of gauged work in the early part of the eighteenth century, which continued to be employed to great artistic effect through the personal input of artisan architects and master bricklayers. Later, as the century progressed, its use became increasingly tame and style-bound, as the period settled into a rigid architect-led, or pattern-book copied, conformity, revealing the all-important loss of creative craft input. Importantly, with this change, bricklaying began being viewed no longer as an 'art', but rather as a 'craft' where craftsmen were losing intellectual and imaginative input in the design and creation of their work.

Gauged Arches

The shapes of arches over window openings were subject to the variations of fashions. As Cruickshank and Wyld (1975, 161) states:

> During the 1700s straight arches were common but were almost totally superseded between 1710–30 by a segmental variety. In the 1730s the straight arch reappeared once again in force and although it held the field throughout the rest of the Georgian period it was occasionally challenged at the end of the 18th century and beginning of the 19th by the semi-circular arch and less often by elliptical and ogee specimens.

No matter what shape was used the basic cutting techniques for the bricks remained the same, and it was here, in the cutting shed provided for this purpose, that the old-time bricklayer jealously kept from his less fortunate workmates the art of setting-out, preparing templets, cutting and gauging the arch.

Initially the arch had to be drawn out, full-size, so either individual templets, or a single and longer 'running templet' could be obtained. In general, only half the arch needed to be drawn, as the other half was a mirror image. Also from the drawing the exact number of voussoirs could be determined, the size of joint, the soffit as well as the extradosial bevels, or the correct curve to the extrados of the voussoirs. As stated earlier, some arches like the straight (and its development the camber arch) and the Venetian, or Queen Anne, had a different shaped voussoir for each position, every brick having a different bevel. This would only apply to one half of the arch, as each voussoir would have its mirror image in the other half. Therefore it was necessary to number each brick related to its position and indicate its side and to set the voussoirs out on the scaffold in order of use.

The setting, or building, of a gauged arch could be accomplished in different ways according to the situation and number of similar arches needed on a job. If the arch were large or with voussoirs having each soffit bevel of a different shape then they were sometimes assembled in small sections in the cutting shed and then joined together to complete the arch over the opening. If the façade of the building had many similar arches, as was common, then all the arches might be complete assembled inside wood jigs. These were then raised into position over the openings for which they were ultimately intended. The jig was left securing the arch until it was bonded with mortar into the face: the technique resembled that of the modern lintel, in that there was no delay on the progress of the building while the arch was constructed *in situ* and hardening.

Generally though the method most favoured was to construct the arch *in situ*. In this instance the temporary timber support, or centre, was checked for position, level and plumb, and then the intrados position of the voussoirs were obtained from the full-size drawing and transferred and marked-out upon the support; and the all-important centre line too. Lines were then erected across the opening where the arch was to be turned from the main walling to ensure the arch would be constructed flush; or perhaps a little proud to allow for it being so after the final rubbing-up. Also a line, or a thin batten was fixed to the radius, or striking point, of the arch centre to check that the joints were normal to the curve and that the extrados height was maintained. Another common practice, to ensure the accuracy demanded with gauged work, was to erect a temporary timber beam above the arch, upon which the centre line and all the voussoir positions were carefully set out, called a 'profile tree'. Nails were then fixed against these lines to which lines from the striking point could be strained to accurately line-in each consecutive course. If there was an inaccessible striking

Figure 101

Placing the voussoir into precise position checking against the line from the profile tree to the striking point. (Courtesy of John Bryn)

point then the intrados positions would be established on the turning piece and lines strained between them and the profile tree to guide the setting of the voussoirs (Fig. 101).

The porous rubbing bricks which were kept dry during all stages of preparation were now soaked in a tank of clean water, to a point just short of saturation. This was to ensure that in laying the voussoirs would not dry-out the lime putty: silver sand mortar too quickly, allowing time for the joints to be applied and prepared, and each voussoir precisely positioned; ensuring good bond strength for the overall arch. To produce joints of such fine measurements for gauged work, it was important that the slaked putty lime, of the preferred Greystone (feebly hydraulic) lime, was brought to a fine state of division by screening it through a suitably sized mesh. It was run into either a dampened cut-down timber barrel, then used for the general walling mortars or into a specially made shallow 'dipping box'; placed hip-high on a stack of bricks to reduce bending. Some craftsmen would add a small amount of screened silver sand, but as some limes slaked to a consistency that could be a little gritty this would be accepted as fine aggregate. This 'fine stuff', as it was sometimes referred to, was prepared to suit the size of the joint desired, which was generally to the consistency of whipped cream. Throughout the whole laying process it would be periodically stirred to maintain this consistency and the top of it levelled-off to facilitate applying the bed joint to the voussoir, which for the typically fine joints was done by dip-laying. This process of picking-up the putty joint involves floating the voussoir on the top of the levelled mortar so that the brick's bedding surface just contacts the mortar and sufficient adheres to it to form a full joint.

With the numbered and prepared voussoirs stacked in order of use, the arch would then be constructed, or 'turned', with the voussoirs dip-laid in numerical order, working evenly, from either side of the opening; thus ensuring the turning piece or centre was equally loaded. The turning of the arch would be finished once the final, or 'key', brick at it's top, or middle, was placed. This key brick had to be carefully dipped on either bed into the lime putty mortar and then quickly lowered down tightly into position. Once turned, or completed, some craftsmen asserted that it was best to very slightly 'ease' the turning piece or centre so that the bricks took up their bearing and locked tightly together, reducing the possibility of a settlement crack when removing the support later. The inevitable small exussion of excess mortar from the face of the laid bed joints were left untouched until they suitably stiffened; before being neatly trimmed flush with the arch face. With all the joints full and true, some gauged arches were made secure by filling joggle joints, cut or filed into the opposing voussoir beds to create a channel, with a liquid hydraulic lime: sand grout. The final cleaning of the arch face and soffit, by rubbing-up with the hand-held float stone, was normally left until the arch face was dry and the whole building was completed.

When one is discussing gauged arches the straight or camber arch deserves an individual mention. This arch was widely used yet was considered the most difficult to set out and construct correctly. Though highly favoured they were generally a weak form of construction, hence they were generally only a half-brick in thickness with a timber lintel to the rear upon which was built a shaped brick core to receive a segmental 'rough' relieving arch; its skewbacks above the ends of the lintel. Camber arches were sometimes used over a large opening, however they were best limited to a span of 1.3 m (4 feet) as the centre could sag. In essence this arch cannot truly be classed as an arch but as a scheme for spanning an opening.

It is interesting to note that for the flat or straight arch, Neve (1726, 10) states:

> Thefe Arches commonly confift of a stretcher, and a header in height, the stretchers being a whole Brick's length, and the Headers a Brick's breadth.

Study of Batty Langley's own figures (Fig. 102), depicting the accurate bonding of a façade and arch in his 1749 edition of *London Prices of Bricklayer's Materials and Works*, show both straight arches not half-bonded, but quarter-bonded. The stretchers are cut with dummy joints to create closers [quarter bricks to create correct bond] next to the headers.

Generally aesthetic arch bonding followed the rules of the popular Flemish bond at the quoin, with alternating courses of a stretcher and header in one course, followed by header, closer and stretcher (a three-quarter bat on a face height of four courses) in the next. Bond at the springing was normally dictated by placing a stretcher in the lowest position at the centre or key on the arch face, and working back to the first, or 'springing', bricks at the skewbacks.

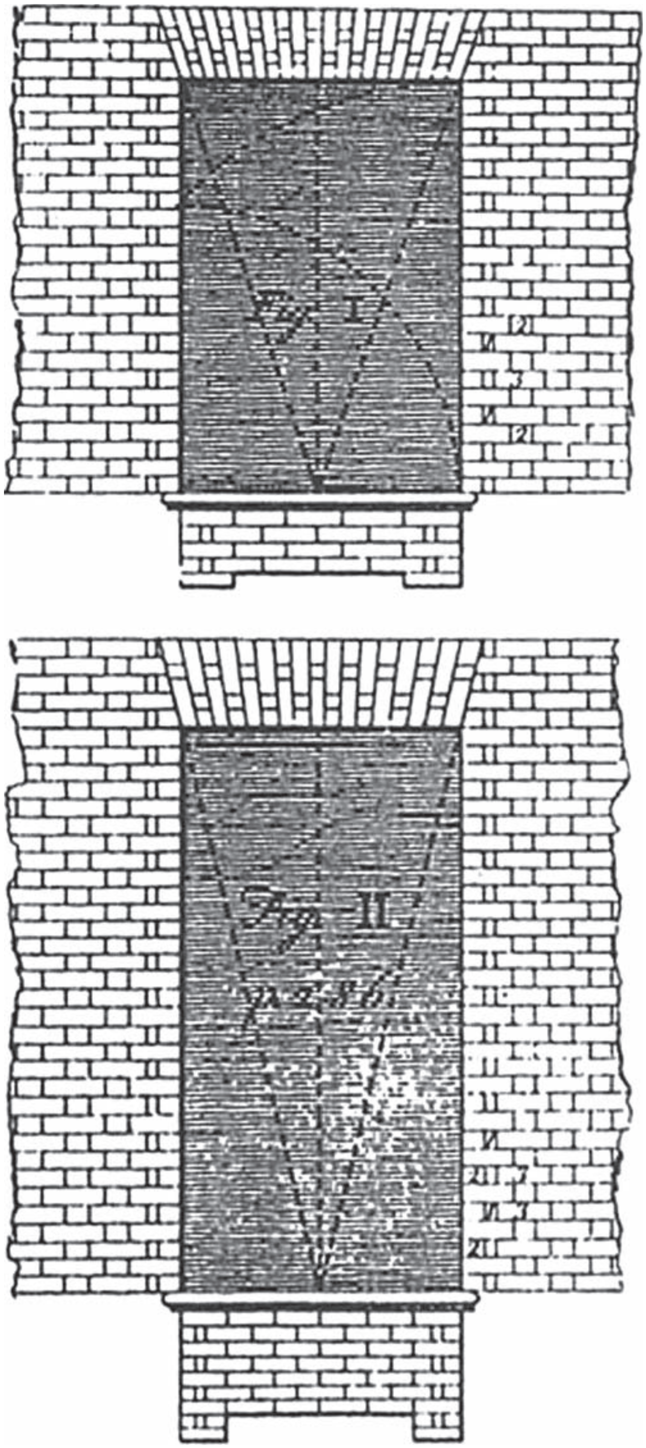


Figure 102

Setting out the splay of a straight arch and quarter-bonding the arch face, as depicted in Batty Langley's *London Prices of Bricklayer's Materials and Works,* 1749.

Langley has an error of scale in his *Fig 1.* by placing closers in each course of voussoirs of the straight arch, which has a face height of four vertical courses. He does not create the closer by a dummy joint in the stretcher but places it next to the stretcher, the resultant space left for the header would in reality only allow a closer. This is incorrect unless the stretcher in reality has been reduced to three-quarters in length. One can only correctly aesthetically bond with a closer in each course when the arch has a face height of five vertical courses – normally 13¾ ins (350 mm), or 15 ins (380 mm) as in his *Fig II.*

Observers are frequently mystified as to the reasons for the small sections of cut bricks above the horizontal cross-joints of stretcher voussoirs, on either side of the springing of an arch; as can be seen in Fig. 103. The explanation is simple. Springing bricks in a flat, camber, or indeed a Queen Anne arch are always the longest in terms of their overall voussoir length, as opposed to the 'key brick', which is the shortest. When setting out arches to establish individual templet lengths, given that the majority of rubbers during this period were the same size as standard bricks, it was impossible to cut the longest voussoirs from full-size stretchers. To use a craft term, the bricks would not 'hold-out' to the overall required length.

Figure 103

A gauged camber arch with a face height of five vertical courses showing closers in alternate courses of the arch voussoirs. Note the use of dummy joints to create closers. Also the first five springing bricks are lengthened to bond with cut bricks, the joints of which would have originally been 'blinded-out' to hide them.

The problem and one common solution can be explained as follows. The prepared stretcher would be placed upon the full-size drawing to extend sufficiently below the intradosial line in order to allow the brick to be scribed to its bevel, or soffit. The brick was then cut with the hand-saw leaving it correctly angled to its radial position; a process known as 'soffiting'.

This with a then common standard sized rubber would, however, leave the top of the brick down from the set out voussoir position and length on the working drawing. The portion that had been sawn off the bottom of that stretcher voussoir when 'soffiting' was turned over and, with or without adjustment placed to the top of that voussoir. This works perfectly as the bedding angle to extend the voussoir and meet the horizontal cross-joint as drawn is identical. This constructional joint was then 'blinded-out', by deliberately rubbing into it damp brick dust during an early rubbing-up in advance of the final 'stoning' with the hand-held float stone so as to retain the desired aesthetic appearance of the arch face. The deceit only becomes visible when, with years of weathering, the joint is exposed.

Concern for structural weakness of straight, or flat, arches was discussed by Neve (1726, 10–11):

> Theorem the 2d Bricks moulded in their ordinary Rectangular Form; if they be laid one by another in a level row, between any Supporters fuftaining their two ends then all the pieces between will neceffarily fink even by their own natural Gravity…

Emphasising how it is strengthened if curved, an early indication of the need to camber the soffit of a straight arch, Neve continues:

> Theorem the 4th If the Materials figured Wedge-wife,…fhould be difpofed in the Form of fome Arch, or Portion of a Circle, pointing all to the fame Center, in this cafe, neither the pieces of the faid Arch, can fink downwards for want of room to defcend….

Though seen earlier, by the middle of the eighteenth century, a cambered soffit to a straight arch was firmly accepted good craft practice and Pain (1769, 11) gives the measurement:

> The soffits of the arches … to camber an ⅛ of an Inch in a Foot, that is ½ an Inch in 4 Foot &c.

This measurement of ⅛ inch to a linear 12-inch run of span remains the accepted camber today, now given as 3 mm per 300 mm. Yet this was not purely for structural reasons, if these arches were set with the soffit perfectly level, they appeared to sag in the centre. To overcome this illusion they were given the rise to the measurements above; and it was from this action that the term 'camber arch' arose. In some eighteenth-century books it was also suggested that a rise of half that to the intrados could be given to the extrados, but this was not such a common practice.

To draw such a shallow rise to create the curved camber across the opening would be impossible from a trammel or 'radius rod' as it's 'striking point' would be far off. The method adopted was to use a length of specially-shaped timber termed a 'camber slip', traditionally made from a length of mahogany or oak, which would not shrink or twist, about 300 mm longer than the widest opening expected and so convenient for all spans of arches. Richards (1901, 57–8), though writing later, gives an explanation of the camber slip and it use (Figs 104–106):

> The mode of obtaining the camber slip is as follows (an extreme case is given, as being easier of illustration): Suppose the opening to be 3′0″, and the rise 1′ to the foot, then the camber slip 3′0″ long would have a rise of 3″; take a rod 3′ 0″ long, measuring in width 1″ at each end and in the middle 2½″, or, in other words, having in the centre half the required rise; shoot this piece from the middle to the two ends perfectly straight, thus forming two triangles, as it were, upon a common base; call the centre B, and the two outside points A and C (Fig. 104)

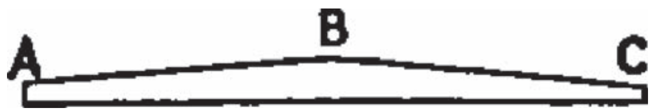


Figure 104 Drawing of a camber slip.

> Then take a piece of board a little over 3′ 0″ long and 6½″ wide by ½″ thick, planed both sides, and one edge shot [planed true], draw a centre line upon the face of it, and 18″ each side of it draw two other lines; call the centre line E, and the two outside lines D and F (Fig. 105).

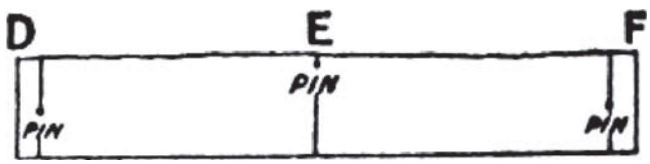


Figure 105 Pins positioned on the drawing board awaiting application of camber slip.

> Upon the centre E, 6″ up from the shot edge, drive in a pin, and upon D and F, 3″ up from the shot edge, drive in other pins. Then take the first piece (fig. 153), already prepared, and with a pencil held at the centre B, apply it to pin F; and with A on the same piece pressed against the pin E, move the piece with the pencil from F to E, describing half the curve (Fig. 106).

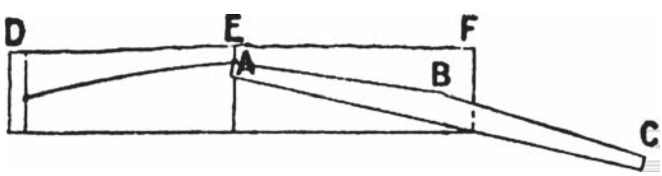


Figure 106 Camber slip with pencil on point B travelling across the face of the board controlled by the pins to trace and scribe the camber of the arch.

> Repeat this process on the other side, moving the centre B with the pencil from D to E, and the curve will be drawn; then cut the curved side to the line drawn, and the camber slip will be completed. To prove the camber slip, lay it down and mark all round it, then reverse it, and if the camber slip coincides with the lines drawn by it, it will be correct. In using the camber slip always work from a centre line.

The emergence of the camber arch is contemporary with moving timber frames back from the face of the brickwork of the window and door openings, so removing the support the flat, or straight, arches gained from them. This is also a time when one begins to encounter the use of rendered reveals and soffits to window openings, painted white to reflect light.

As, following accepted fashion, window openings reduced in size with each consecutive storey, especially on the terraced town houses, so generally did the face heights of the flat/camber arches also, from 1¾ to 1½ to 1 brick high respectively; and often the quality of execution diminished too. Ground-floor arches were of best quality rubbers set finely gauged; first-floor arches of good rubbers – not necessarily colour-matched – set with slightly thicker joints; and at the top floor, utilising the lowest grade of rubber, as an axed arch.

In order to effect the appearance of gauged arch of red rubbers, especially when buff-coloured cutting bricks were used, the face would be 'colour washed' [not limewashed] to the desired hue using ochres fixed with glue-size and alum. A good example of this is the 'Red House', 60, Watling Street, Fenny Stratford, Buckinghamshire, which dates from the early to mid-eighteenth century, but was altered and enlarged in the late eighteenth century (Fig. 107).

Another practice to create the illusion of gauged work, where an axed arch had instead been constructed was to 'tuck and pat' ['tuck pointing'] point its face. This is an English term denoting a highly-skilled, refined method of pointing brickwork in which a pigmented base mortar joint, or 'stopping', is flushed-in to the joints to match the natural colour of the bricks, or the applied colour wash. Once sufficiently stiffened, it is then 'grooved' to directly receive a carefully placed 'ribbon' of lime putty:silver sand mortar trimmed precisely to size to create the illusion of gauged brickwork. This technique could also be used on remedial works to gauged brickwork as a means to create the desired aesthetics, as in this reference to repairs at Kensington Palace (Gaunt and Knight, 1804, 591):

> William Whitehead Bricklayer
>
> Repairing the piers to the entrance to the Palace Court next to the Town of Kensington…241 ft. sup. Colouring and tuck pointing…at 7d.
>
> ………………………..£7.0.7. 29 ft. 6. Gaged [gauged] arches repaired and pointed with Roman cement coloured and drawn…at 1.4d. …£1.19.4. 223 ft. Red gaged brickwork to Piers with rais'd pannels cut out and made good with

Figure 107

Red colour washed gauged camber arch built, of buff coloured voussoirs, on the late eighteenth century 'Red House', Fenny Stratford, (Buckinghamshire). The surrounding brickwork has sadly been the recent victim of poorly applied and wholly inappropriate cement:sand re-pointing.

> new where decayed and rendered and set with Roman cement and coloured and drawn in imitation of Red gaged work...at 2s.0.
>
> ....£22.6.0.

There are also instances during this period of flat gauged arches over window heads built of brick tiles, also called mathematical tiles, introduced and employed onto the façades of some properties to create the illusion of solid walling with face brickwork. O'Shea (1981, 14), commenting on their use for straight arches of gauged work in Lewes (Sussex), records:

> These are made in the classical Georgian manner with red rubbers worked to tapering voussoirs, but sawn down the 4½″ thickness to give two matching bricks and ends of the bricks dry rubbed with brick dust to give a butt joint. The staggered horizontal dummy joints are formed by cutting a groove and filling with mortar.

In respect of this within same notes on the practice in East Kent, Terence Paul Smith, in his paper, 'Brick-Tiles in East Kent: an Interim Report', p. 5, states:

> Window-heads are sometimes simple, with the tiles taken straight across a flat top. Many buildings have tiles only on the top storey (of two) and here in the wooden cornice or facia *(cf. infra)* double as the window-head. In quite a large number of cases, however, 'flat-arch' windows of apparent gauged work are present: in a few instances these use purpose-made tiles, which must have been very expensive…'

A good example of a gauged flat arch of brick tiles is 64, High Street, Salisbury, Wiltshire, which dates from the mid-eighteenth century. The façade is built of brick tiles laid header bond placed over an early seventeenth-century timber-framed building.

Though the angle of 60º for the skewbacks remained the ideal, study of Batty Langley's plate of the two straight gauged arches (1749) (see Fig. 102) reveals another common bricklayer's practice. That of placing the 'striking point' along the vertical centre line to the opening at window cill level; regardless of the height. This gives Langley's fig. I a 70º skewback, whereas his taller fig. II has a much steeper angle of 76º.

A long accepted method practised by craftsmen bricklayers, for determining a skewback angle, is the One Third Rule, as explained by Nicholson (1823, 352–3):

> The proper method of skewing all camber arches should be one-third of their height. For instance, if an arch is nine inches high, it should skew three inches; one of twelve inches, four; one of fifteen inches, five; and so of all the numbers between those….

Using this method a consistent angle of 70º is achieved for all skewbacks, no matter what the face height of the arch is.

Two other methods were used that involved setting-off a specified measurement out from a jamb line extended above the springing line a face height of 1 ft (306 mm) to the extrados. The first measured ⅛th of the span of the opening along the line of the extrados beyond the extended jamb line. So for a 3 ft (915 mm) opening, this would be 1½ inches (39 mm) per foot, making the measurement for the top of the skewback 4½ inches (117 mm) also creating an angle of 70°. The second method measured out 1 inch for every foot of span (or 25 mm per 300 mm), so for a 3 ft (915 mm) span the measurement at the top of the skewback would be 3 inches (76 mm) beyond the extended jamb line, creating an angle to 75°.

Acute-angled skewbacks between 30° to 45° are sometimes seen on flat or camber arches. These angles, however, are not only visually disturbing, but they also contribute weakness to the arch, particularly on wide spans, reducing their effectiveness in being strong enough to accept, resist, and discharge the thrust brought to bear upon it from the loading above. On the majority of such arches there are frequently cracks to either side of the arch face directly up from the jambs, due to the stresses created in the haunch or shoulder of the arch as the unsupported central area of the arch is forced down through gravity.

Though it is never stated in any craft books, it has always been accepted best practice to set the first or 'springing' bricks on either side of the arch from their skewbacks with the same size putty joint as the rest of the arch. Frequently this is not attended to, a larger bed joint of front mortar being used instead, seriously detracting from the overall precision and appearance of the gauged arch. Cutting skewbacks to the correct angle from the sliding bevel, obtained from the drawing must always be precise. The shaped bricks must then be set into position with the angle strictly maintained throughout the full length of the skewback by working to either radial string lines, or using fixed wooden guides (guns). The skewback bricks must also be perfectly flat across the full depth of their cut and rubbed surfaces in order to take the fine joints of the springer bricks. This is why skewbacks are frequently constructed of the same rubbers as the arch – though their faces are not rubbed and they are laid as standard facework in front mortar – as they cut easily and accurately (Fig. 108).

Figure 108

Skewbacks cut precisely from standard sized rubbing bricks laid in standard or 'front mortar' to facilitate a sharp cut facilitating a tight 'putty joint' at the springing points.

In concluding this examination of gauged camber arches, and concentrating on constructional faults, Nicholson (1823, 352) highlights a poor craft practice responsible for a common construction defect:

> …the faults alluded to, are the bulging or convexity in which the faces of arches are often found, after the houses are finished, and sometimes loose in the key or centre bond. The first of these defects, which appears to be caused by too much weight, is, in reality, no more than a fault in the practice of rubbing the bricks too much off on the insides; for it should be a standing maxim (if you expect them to appear straight under their proper weight) to make them the exact gauge [sic] on the inside, that they bear upon the front edges; by which means their geometrical bearings are united, and all tend to one centre of gravity.

This practice has been encountered on many occasions whilst repairing defective gauged work; and it is not reserved only for arches. On some ashlared walling the bricklayers would frequently rub more off the top and bottom beds towards the back of each brick, so that, in taking an on-end view of the brick, one finds some resemble a cone shape. The difference from the measurement of the overall face gauge to the rear of some of these bricks can be as much as 10 mm (i.e. 5 mm) being rubbed off either bed. This bad practice is not confined to English gauged work, but is seen also in Flanders and the Netherlands. The loss of brick was typically made up with a trowel-applied mortar, to a stiffer consistency, allowing the brick to be manipulated more easily to line and 'face plane'. This was not a good practice, however, as it reduced the effective load-bearing area, especially where there were voids or mortar shrinkage so concentrating it towards the front edges and leading to bulging and loss of overall wall strength.

Gauged Niches

In thick walls of many mansions and public buildings, circular recesses, or niches, were occasionally formed. A niche, from the Italian 'nicchio' meaning 'shell', was usually semi-circular or semi-elliptical on plan and covered with a semi-dome of the same character built in gauged brickwork. The origin of the niche is rather obscure and though it is not uncommon to see them empty, there seems no doubt that they were originally designed to house statues or other works of art.

A niche had little to do with the general stability of walling, as it was simply decorative, yet it still had to be constructed carefully so that it did not weaken the wall. The lower part of the niche is called the 'body' and its upper part, the 'hood' (Fig. 109).

The construction of a gauged brick niche, an area of the craft termed 'circle-on-circle', has always been considered to be one of the most artistic pieces of work in connection with their craft and the supreme test of a bricklayer's skill as a craftsman. It not only draws on excellence of manual dexterity, but also sound knowledge and application of geometry. Without these attributes it would be impossible to set-out, cut, and construct a niche.

It is in the design, execution, and finished appearance of the wonderful specimens of gauged brickwork niches from the post-Restoration and early Georgian periods that one determines the depth of the Dutch influence on this branch of the craft. Amongst the early seventeenth-century 'gildeproeven' masterpieces of 'geslepen metselwork' – gauged work in De Waag, Amsterdam (see Chapter 2), are several fine examples of gauged niches. These are either to be found as full-depth, or shallow-bodied niches, constructed of orange/red rubbers and set in fine lime putty:silver sand mortars, with joints that range from 0.5 to 2 mm in width.

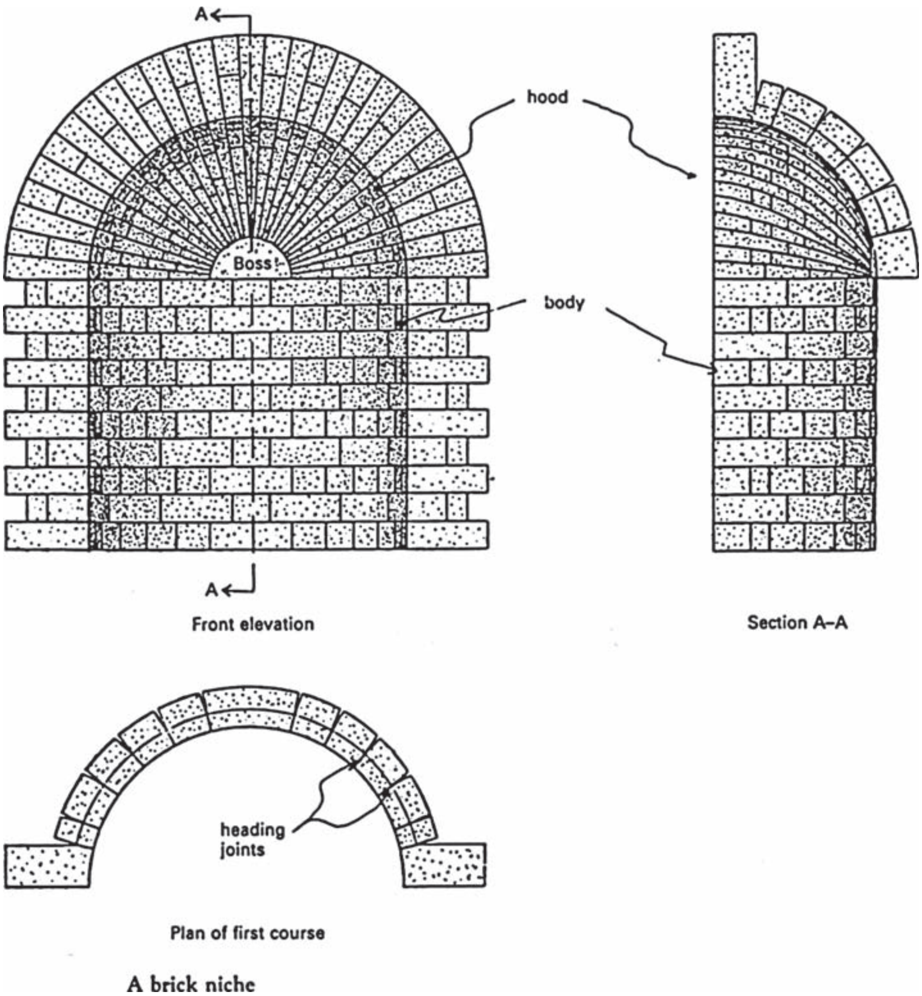


Figure 109
Drawing of a gauged niche depicting its parts.

Their construction follows a similar theme of squared or 'mop-staff' cut-moulded jambs, or alternatively with cut-moulded architrave leading into the curved body of the niches. The body of each niche is terminated with projecting plain or cut-moulded 'necking' courses on which rest the 'hood', set-back to follow the original line of the body. The hoods are all constructed of radial voussoirs to follow the bond and detailing of the body.

It is impossible to cut hood voussoirs to the wafer-like thinness at the extreme of the striking point from which they all radiate. A brick (or frequently several courses of set bricks) is thus hand-shaped as a miniature hood and rubbed to the same curve. This element, the 'boss' – is frequently, though not always, set-out by the rule of one-third of that of the overall radius of the hood – and all voussoirs abut to it. Almost all of the De Waag bosses have a small projection to facilitate carving with variations of the scallop-shell motif. Sometimes the bricklayers selected the softest of the rubbers for the hood as they could be cut and carved more easily for this delicate part of the work on a niche.

There are many fine examples of Dutch-styled gauged niches throughout southern England, for example, at Hampton Court Palace (*c.*1690) and at Finchcocks in Goudhurst (Kent) (*c.*1725). A good example of a gauged niche with a carved boss is one originally from Bradmore House, Hammersmith (*c.*1700), which has been re-erected in Geffrye's Garden at the Geffrye Museum, London, where the delightfully carved boss is particularly worthy of note. This niche, like that for the Eltham Orangery in London (dated *c.*1710, with the boss carved as a scallop-shell), have both undergone successful conservative restoration under the guidance of the author.

Normally the gauging of the niche hood is more accurate and finely set than the gauged work of the body, though an exception to this rule is to be found in the niches at Chicheley Hall (Buckinghamshire) of 1723. The two niche hoods at Mottisfont Abbey (Hampshire) of 1836 are also particularly worthy of note, being of superior quality of clean-bodied rubbers neatly wrought with a most wonderful carved boss; displaying the main brickwork tools, including the large brick axe, used to set-out and cut the niches. The bodies are of low-fired face bricks, cut and rubbed and exposing their inclusions so rendering them incapable of the fine cutting necessary for the hood, set to a standard gauge, and pointed flush with a pigmented mortar to reduce the impact of the wider joints (Fig. 110).

Figure 110

Gauged hood to a niche with a carved boss displaying some of the tools used in its construction. Set on a body of cut and rubbed standard bricks at Mottisfont Abbey (Hampshire), 1836. (Courtesy of Mike Hammett)

Study of these and other niches reveal first how they have to be considered in two parts, the body and the hood, which were always set out and cut as two distinct and separate operations. Secondly that the hood needed to be more accurately set-out, cut and constructed to maximise its strength to accept and transmit the masonry directly above it.

Niches with Horizontal Hood Courses

Occasionally niches were constructed with horizontal hood courses continuing on the bond of the body, almost always when it was intended to carve *in situ* a major part of the hood; a craft practice that appears to be uniquely English.

When executed, the hood brickwork was either bench-built in the cutting shed and set into position, or laid *in situ* across the opening on a temporary timber support to create what is termed a brick 'lump'; with fully-filled joints so none would work hollow with carving. A wonderful example of this form of carved niche head construction is Helder's (re-built) masterpiece in the Victoria and Albert Museum (Fig. 111); also the large central niche of his (re-built) frontispiece originally from Christ's Hospital School, London, now re-erected at their Horsham campus in West Sussex (Fig. 112).

Figure 111

Carved 'Amorini' to the niche hood of horizontally laid gauged work, 1675. (Courtesy of the Board of Trustees, Victoria and Albert Museum, London. Photo Will Pryce © Thames & Hudson Ltd, London. From Brick a World History, by James W.P. Campbell, Thames & Hudson)

The construction of these niches generally reveals hood joints of approximately 0.5 mm in thickness, in contrast to the, still fine, average of 2 mm thickness to the niche body. This is due to the lumps being constructed in either

Figure 112

Carved niche hood of horizontally laid gauged work, Christ's Hospital School, Horsham (West Sussex), *c.*1672. Moved from its original site in London and re-erected in 1901. (Courtesy of Mark Haskell)

hot or cold 'cement' (see Chapter 3). Later in this period, however, a white lead and shellac matrix was beginning to be used as well, both facilitating close and unbreakable jointing. If desired, by mixing dust from the rubbers being cut for laying in these 'cements', the joints could also be effectively 'blinded-out' so reducing visual disruption to the appearance of the carved hood.

Despite the fact that the joints were so finely set and possibly 'blinded-out', the bonding of these lumps still called for considerable forethought and ingenuity on the part of the craftsmen to avoid exposure of the vertical cross-joints where carved back. The carving of the hood, and indeed all gauged enrichments, was essentially the preserve of the 'trade carver'. The trade carver was a most prestigious artisan and high-skilled craftsman with whom the virtuoso bricklayer enhanced many an ambitious façade. The carving was executed with soft stone tools and a wood mallet. These tools comprised chisels, gauges, files, drills, conduits, of a variety of materials and shapes, including bespoke-made tools to suit certain situations, as these bricks were delightfully easy to work.

A dried-out plant called 'Dutch Rush' was still used extensively during this period until the advent of modern sandpapers, for abrading surfaces. Also known as 'Shave Grass', 'Pewterwort', or 'Scourwort', it is a primordial plant that grows in sandy soil. Feeding through its root system, it draws up silica in nutrient form eventually forming a fine glass paper-like surface on the leaf. Carvers, like Grinling Gibbons (1648–1721) used 'Dutch Rush' which abrades particularly strongly when worked sideways, frequently leaving its tell-tale striations; especially noticeable in areas having restricted access.

Taking into consideration the nature of the rubbing brick, when carved it was considered good practice not to so undercut it as to leave half a brick unattached. Although the white lead and shellac (or other earlier craft 'cements') made an ideal 'iron hard' adhesive, it would have been foolish to expect an exposed over-hanging part of a rubber to withstand our British climate for long.

To prevent damage by the elements all the top edges of the external carving had to be 'weathered', that is rounded, or sloped away, so as to throw off the rain. Recesses or hollows where water could collect would lead to frost 'blowing' any projections. The upper surfaces of most upper projections were generally protected by a lead flashing to prevent flushing-out of the cross-joints and saturation of the carving, which would most certainly have led to a rapid deterioration.

Eighteenth-Century Gauged Brickwork in Colonial America

As stated earlier, the influence of classical English gauged work began to be seen in the early 1700s in Colonial America. By the middle of the eighteenth century the fashion for building in brick with gauged work dressings in the Anglo-Dutch style had really took hold and reached a high-quality of execution. Examples of this can be seen on the flat ('jack') arches and rubbed string courses at the Courthouse (1768) in Edenton, North Carolina. 'Hammond-Harwood House' (1774), Annapolis, Maryland, an outstanding elegant "Anglo-Palladian villa", built for Matthias Hammond by English joiner/architect William Buckland (1734–74), has similar gauged brickwork detailing (Fig. 113). According to Carl Lounsbury (2006), rubbed and gauged work appear:

> In Charleston, South Carolina, and on a few outlying plantations, from about the 1730s through the 1760s. Good examples are Drayton Hall (*c.*1740) on the Ashley River; and in the city the pre-eminent example is the Miles Brewton House, from the late 1760s, with fine arches. After this time, Charlestonians turned to stucco in a big way.

There is some nice gauged 'jack' arches and a 'belt course' on the façade of 'Liberty Hall' (1796), Frankfort, Kentucky, home of John Brown; the state's first senator. As Lounsbury (2006) states, 'There is not much rubbed work north of the Chesapeake [River]. Here and there are buildings with rubbed corners and 'jack' arches, but very little gauged work of the quality found in Virginia'. Virginia has several wonderful examples that are worthy of note and

Figure 113
Hammond-Harwood House, Annapolis, Maryland, 1774. (Courtesy of the Hammond-Harwood House Association)

study. As mentioned in Chapter 3, the lavish, classically English three-storey 'Rosewell' (1726–37), Gloucester County, Virginia – sadly burned in 1916 – remains 'a masterpiece of the mason's craft', with imported Portland cut stone dressings for the window openings and chimneys and exquisitely executed gauged brickwork dressings of the highest order of craftsmanship (see Fig. 64, page 139). In the remaining brick shell one can still determine accurately gauged 'jack' and segmental arches, cut-moulded belt courses. It is not known if the rubbing bricks were imported at the same time as the stone and several other items used on and in the property. It is more likely, however, that the bricks were made locally.

David Minitree (c.1700–1774) – Brickmaker and Master Bricklayer

According to Colonial Williamsburg archival records, Whitehead (2005):

> The exact date birth of David Minitree is unknown, but it is believed that he was born in Virginia around 1700–05. He was the son of a French Huguenot blacksmith, also called David, who arrived in Virginia on the ship 'Peter and Anthony' in 1700, and is recorded as having worked on the original Capitol building and Public Gaol in 1710.

> By trade the junior Minitree worked as a brickmaker and brickmason [bricklayer]. He was a Williamsburg resident by 1724 when he acquired two lots in the city limits. Archaeology revealed that Minitree used these city lots as a materials preparation area; with features such as the clay borrow pits. Though no buildings in Williamsburg can be specifically attributed to him, it is believed that Minitree worked throughout the city as it was being constructed during this early period. He held these lots until 1736 when he sold them to a local carpenter. Minitree would also own land in neighbouring James City County, about 5 miles west of Williamsburg and may have been living there by then.

In the 1730s David Minitree began working in other parts of Virginia. The first major project with which he is confirmed with is Mattaponi Church (*c.*1732–34). It is a cruciform building with brick walls laid in Flemish bond with glazed headers used throughout the building, measuring 8⅞ins × 4⅜ins × 2⅝ins. Located above the side of the gauged frontispiece of the south end door of the church is a single brick carved and painted with the name 'David Minetree' into it. The gauged work to the two frontispieces to the north and south doors and semi-circular arches are built of orange-red rubbing bricks set with fine lime putty:silver sand mortar joints. All are built very much in the English tradition in bonding, the use of 'dummy joints' to create some of the 'closers' and headers, as well as in the style of execution. Regrettably both doorways have fallen victim to some areas of poor quality modern repairs that are inappropriate and aesthetically disfiguring.

Minitree was working in 1746, 80 miles north of Williamsburg in Stafford County, making 116,304 bricks for the building of a now demolished house called 'Marlborough' for a John Mercer. It was, however, in the 1750s that Minitree, with the construction of Carter's Grove (1751–53) really came to major significance (Fig. 114). This was a large brick-built house constructed 8 miles south-east of Williamsburg, in James City County, for one of Virginia's wealthiest landowners, Carter Burwell. A very handsome building, upon which, as Lounsbury (2003, 18–19) details, Minitree:

> …embellished the two-story [storey] brickwork with delicately attenuated gauged and rubbed jack arches in every aperture on the building from the cellar to the second story. Minitree maintained the hierarchy of the stories [storeys] by building shorter jack arches on the cellar appetures, which also blended more closely to the colour of the plinth bricks. The rich red bricks of the second-story jack arches extend four courses in height compared to the five courses of the main story. He demarcated the plinth with a three-course molded watertable. A Flemish-bond cavetto course sits atop a double row that forms a torus, all of which are rubbed and laid in wafer thin, white-lime putty joints. However, Minitree muted the contrast between the watertable and walls by choosing bricks of a similar color range. The precision of the watertable is matched by a three-course rubbed stringcourse

with the same narrow joints. The stringcourse stops short of the lightly rubbed corners. The entrances of both the land and riverside of Carter's Grove are marked by pedimented frontispieces whose gauged bricks [rubbers] are rubbed a deep red and whose thin putty joints were covered with a red wash. By the time of the Revolution (1763–76), the contrast coloring at Carter's Grove was beginning to loose favor. Fewer patrons chose to augment their buildings with gauged and rubbed string courses, watertables and frontispieces, though rubbed arches remained a staple of the bricklayer's art through the second or third decade of the nineteenth century.

Figure 114
A gauged frontispiece by David Minitree, at Carter's Grove, Williamsburg, Virginia, 1751–53. (Courtesy of Jason Whitehead)

There were times when people wished to have gauged enrichments on their property but were without rubbing bricks and so resorted to an aesthetic deceit to create the impression of gauged work, as Robin Lucas (1997, 156) explains:

> Colonial buildings sometimes lacked the moulded and cut bricks [rubbers] required to complete a composition: at Brick House Farm or the Zaccheus

Newcomb House in Pleasant Valley, Dutchess County, New York, raised about 1760, painted timber balks above the windows take the place of arch bricks or voussoirs.

The popularity of gauged work, according to Dr. Lounsbury (2006), begins to die out in America during the last fifteen years of the eighteenth century, according to and after the Revolution (1784) there are only a few examples. Rubbed work does not flourish past the first decade of the nineteenth century, though there is still some examples of occasional use for 'jack' arches, window jambs and quoins. The cut-moulded cornice to the Boiler House building (1855) at the old railway depot in Savannah, Georgia, built of local bricks believed to have been made on the former McAlpin family plantation, utilising river mud, is a good example of this later cut and rubbed work in America (Clark, 2006).

Summary

The Georgian period was a consolidation of the fine gauged brickwork achieved in the late seventeenth century, though its use became less adventurous as the neo-classical architects, rather than the master bricklayers, designed the features. After the Great Fire the return of country bricklayers to their native shires had allowed their assimilated skills and knowledge of gauged work to spread out beyond the confines of London and its craftsmen. This facilitated all improvement in national brickmaking and bricklaying and it witnessed quality brickwork with fine gauged work dressings as an almost ubiquitous feature of every brick-built Georgian town and country properties.

Case Study: Warfield House, Warfield, Berkshire, England

By Mr Derren D'Archambaud, Craftsman Bricklayer, Proprietor 'DGD Limited'.

Warfield House is a mid-eighteenth century three-storey brick-built large country house. The brickwork of this Grade II listed building is of historical and social importance, constructed with orange-red bricks laid in Flemish bond with gauged brick enrichments, with more recent additions and alterations.

All the external brickwork had been severely damaged by aggressive sand blasting to remove earlier paintwork. This had unfortunately destroyed the face of the bricks. There were large areas of plastic repairs to individual bricks and widespread use of inappropriate cement:sand mortar re-pointing. All the gauged enrichments were seriously damaged as a result of the sand blasting, and on one elevation some enrichments had been removed. The result of all of this was that the disfigured brick facades were left vulnerable to further damage. It was clear that in order to preserve the building substantial restoration to the external fabric was needed.

Mr R.C. Willes, a chartered building surveyor with Willes Simpson Woods, was appointed by the Clients, 'Warfield Establishments', as project manager and contract administrator in respect of the external restoration works. In this capacity he appointed Gerard Lynch as Historical Brickwork Consultant, who subsequently reported on the condition of the brick fabric and specified the scope of remedial works. Further to his report and specification, the client retained him as 'Clerk of Works' to give on-going advice and supervise the repairs and restoration. 'Holloway White Allom Limited', were appointed as the main contractor, and, my company, 'DGD Builders' were sub-contracted to undertake all of the repairs and restoration of the external brickwork, including all the gauged work.

I have been contracting in building for over 20 years, and learned about the knowledge and skills of gauged work and its repair from Gerard Lynch by attending his courses at the 'Weald and Downland Open Air Museum' in Sussex, and through private tuition at his workshop. In the years that have followed, I have successfully specialised in repairing historic brickwork from all periods, using traditional materials and craft techniques. In all of these contracts I always take an active lead role on-site. Having also been trained in aspects of bench-joinery I make all the templets, cutting boxes, profiles and templates necessary to undertake such works, at my fully-equipped workshops in Leighton Buzzard, Bedfordshire. As part of the full service I try to provide the customer, some of my team and myself have been fully trained in the correct use of the Jos® and Doff® masonry cleaning systems purchased from Stonehealth Limited.

The overall remedial work to the brickwork involved:

- Cleaning of masonry – using a combination of Jos® and Doff® systems.
- Recording, dismantling and rebuilding chimneys.
- Dismantling and re-building parapet walls and renewal of failed limestone copings.
- Recording, dismantling of isolated areas of fractured brickwork and bowed outer-leaf facework due to Georgian 'facadism'.
- Recording and dismantling of failed central area of east elevation and re-build re-introducing gauged features removed during previous inappropriate remedial works.
- General remedial works to gauged work including re-pointing.
- Wholesale re-stabilising of the sand blasted brickwork and re-pointing.

Germane to this case study were the remedial works to the gauged brickwork. These works can be sub-divided as follows:

- Recording, dismantling of flat arches and re-building
- Recording, dismantling of flat 'circle-on-circle' arches to semi-circular bay and re-building

- Cutting-out eroded ashlared bricks and replacing to Platt band and re-pointing
- Re-introducing lost original gauged work features to the central bay of east elevation

In order to undertake repairs and restoration of the gauged enrichments on all elevations of this property, it was first important to establish a covered workshop area, where materials could be carefully stored and prepatory works undertaken. This area was equipped with a setting out bench made from timber, where full-size drawings could be traced and the various templets established. I also set up a cutting bench with a large beam above it to strut down from onto bricks in the cutting boxes for cutting with the bow saw fitted and twisted wire blade from 18 gauge mig wire. All the cutting boxes were made in-house, the profiled moulding boxes being copied from the various templets obtained during the course of remedial works.

On this bench, at either end, were positioned large rubbing stones; one of York stone and the other of limestone. The York stone was used for the general rubbing to get each and every rubber ‘squared on bed and stretcher faces, prior to boxing for cutting. The limestone rubbing stone was also useful in giving a fine face to some of the rubbers; as the original salvaged rubbers re-acted differently to the slightly harder new bricks. Once cut to size and shape, within the box by the bow saw, the bricks were abraded flat, using a selection of flat files, timber battens etc, to remove all saw marks and to answer to the controlling sides of the boxes.

Also within the compound we established a storage area for all the recorded and dismantled gauged enrichments, stored within labelled boxes, and for the new oversized rubbers for bespoke work, as well as the pre-cut ashlared units and arch sets; delivered in protective timber boxes and bubble-wrapped. Having worked with other companies rubbing bricks I made my selection base on matching the colour and texture of the originals and so these were purchased from W.T. Lambs (Bricks and Arches) Limited, Sussex. Warfield house is very close to where the old ‘Tommy Lawrence’ brickyards were who produced the famous TLB orange/red rubbers, and all the rubbers used on the later Victorian gauged work were of these bricks. That said the original Georgian gauged work was built from pre-Lawrence rubbers made from the same local material, though un-washed.

There were a large number of flat arches to repair as the inappropriate grit-blasting had removed up to 20 mm of their faces, seriously pitting them and eroding and shattering many of the joints; and all needed to be taken apart and after preparation, re-built.

The first thing to do was record each and every one of the arches, by giving them a specific number in relation to their position on each elevation. Each numbered arch was then drawn out on paper following the same system of measuring the length of the intrados and extrados, working equally either side of the vertical centre line to each opening; which also helped to determine the individual skewback measurements and geometrical angles. At the centre line, which in most cases ran up through the centre of each 'keybrick', we also measured the face height of each arch. Upon each of the overall arch drawings we recorded the positions of the individual voussoirs, joint sizes and face bonding; the latter varying between half and quarter bond. Once fully drawn and bonded every voussoir was uniquely numbered for its position on either side of the arch e.g. the first springing brick on the left side being a stretcher, with its mirror-image on the right-hand side would be numbered LS 1 and RS 1 respectively; and so on. Finally we measured and established the radial centres, or 'striking points', of each arch along their respective centre lines; which were plumbed down onto battens placed within, or below, the openings. Nails were then fixed at all striking points so lines could be strained from them to check the skewbacks and the radial alignment of the voussoirs of each arch, and ensure accuracy of re-building to the original positions.

Once satisfied that each of the arches had been properly recorded we basically followed a similar sequence on each one. Timber 'centres' were placed and wedged tight up to the soffits of openings built with recessed reveals, but this was not necessary on the flat arches built directly on top of the timber window frames. Upon either of these supports the centre line was measured and drawn, then the positions of all the voussoirs were marked on them with a pencil and numbered to correspond to that on its unique drawing. The first few courses of standard face brickwork over the top of the arch, having been recorded was then carefully disassembled in order to gain full access to disassemble the arch, each brick marked for re-locating back to its original position. Above the arch was positioned and fixed a horizontal timber batten to serve as a 'profile tree' and onto this the centre line was plumbed-up from the turning piece or window head, and the positions of the voussoirs through the intrados marks from lines strained from the striking point.

All the arches were carefully dismantled from the key to the skewbacks in the reverse order of how they had been assembled, and each voussoir was scribed to have a number corresponding to the drawing. These were then scraped clean of old mortar and placed in a protective numbered box and removed for repair and individual replacements to be bespoke cut where necessary.

The remedial work basically involved carefully re-rubbing the face smooth to remove all pitting, new bricks being introduced only to replace those bricks that had completely shattered or severely eroded. These were worked to match those they were replacing, being scribed to the templets and cut in the traditional manner. This completed, the arch could be reassembled within the box to be brought back to its opening.

Working from the profile tree, positioned above the arch before it had been disassembled, all the positions of each voussoir were transferred from the striking point through the intrados marks along the turning piece or frame head to join up to the tree. It was now possible to relay the bricks back to these lines and their original positions. All the arches were dry-bonded, using a suitably sized proprietary dpc for joints, to check accuracy of fit and bonding. Once we were satisfied then the bricks were ‘quenched’ – soaked, but not saturated in clean water contained within a plastic heading tank ready for laying. Each voussoir was carefully dip-laid in a pure lime-putty and silver sand mortar and lined-in to its correct position.

Upon completion all the joggle joints were grouted with a NHL 3 lime:silver sand mortar containing a little boiled linseed oil in the mix. Once the exuding bed joints had stiffened they were neatly trimmed flush using the sharp blade of a plasterers small tool. The dummy joints were then carefully pointed using an suitably sized tuck jointer guided by an appropriately positioned timber straight-edge.

To finish, once the arches were sufficiently dry, they were each lightly rubbed-up with a hand-held ‘float stone’ of varying grades to suit the type of rubber.

Circle-on-circle work means that the voussoirs are not only radiating on elevation but also on plan. It was therefore important to establish the radius of both, so the arch could be drawn and each face and its bed templet could be created and numbered to its relative position. Once again these arches were propped up and carefully recorded, as described above, but this time so that new bricks could be cut for each arch. This was because the original gauged arches to the semi-circular bay had been rendered over with hard cement: sand mortar upon heavily hatched voussoir faces, done to gain an improved key. Regretfully it proved impossible to salvage any of these arches, despite our very best efforts.

Due to the urgency of the work within this contract, I contacted W.T. Lambs, and a representative, Mr Richardson, arrived at site and I handed over all the relevant information. He also took independent dimensions of the arch and bay. The bricks duly arrived within the time stated.

With the pre-cut voussoirs checked the work was put in hand to build them. I had already set out the positions of each voussoir onto the curved-on-plan timber turning piece and cut a second length of curved timber, working to the drawing, upon which I marked the extradosial positions of the arch voussoirs. This was placed almost directly above the face height of the arch upon which the setting-out lines had been transferred between the profile tree and the centre (Fig. 115). As expected when dry-bonding the purpose-cut arch there was a need for some minor adjustment due to past movement of the surrounding brickwork on the semi-bay to be accommodated. The arch was then built and finished in exactly as described above.

Figure 115

Replacement gauged arch to semi-circular bay showing the setting out marks for the extradosial positions of the voussoirs on upper curved template.

Remedial works to lengths of Platt band involved careful cleaning using Doff®, to remove biological growth, followed up with the Jos® system to remove areas of heavy carbonation. This was left to dry whilst we engaged on other works, upon our return to the brickwork it was finally lightly cleaned with a hand stone. The Platt bands requiring attention were all carefully recorded. Placing a length of batten on both the underside and top of it we transferred the bond onto them. Using a hacksaw blade we carefully cut down and along the lime mortar cross and bed joints to release the defective ashlared bricks so they could be re-faced or reversed. Any brick that had severe decay was simply drilled in order to 'collapse' it and then carefully chiselled out.

Again all bricks were carefully boxed for protection and then brought down to the workshop area. Salvaged bricks were gently scraped of old mortar so not to damage the brick and then the spalled faces were re-rubbed. Replacement bricks were sourced from out of my stock of old rubbers, or by re-using some from other salvaged gauged elements that matched colour and texture. A cutting box was made to the exact gauge of the Platt band courses so that replacement bricks could be squared and then cut to gauge. That done it was simply a case of 'lengthening' the brick, or cutting the brick to the required size. This was done by placing a timber 'stop', to the measured distance in from the front of the box, onto the baseboard of the cutting box. The brick was then placed into the box so it came up against the 'stop' and the protruding part of the brick was then cut off with the bow saw and filed to finish. The important thing to remember when doing this is to always cut up from the bottom first, to form the 'curf cut' and then cut down from the top, to prevent the brick tearing.

All prepared original and replacement works were then re-laid using lime putty:silver sand mortar. The dusted and dampened prepared pockets to receive individual ashlared bricks were then given a backing of this mortar so that as the brick was carefully positioned it was fully bedded. To do this, and ensure solid bedding, the back arrises of each of the ashlared bricks were chamfered so the mortar could easily slide around the back and the brick. With each brick supported on the laying trowel they were carefully slid in until the brick was back flush and level with the surrounding brickwork (Fig. 116).

Figure 116
Re-building of the second floor platt band.

Other areas of the Platt band required pointing, which is not an easy thing to do on tightly jointed gauged work if you have not been taught properly. We would first clean out all the debris from the old joints back to a solid and clean base. The mortar is then prepared from lime putty and silver sand to a consistency of glazier's putty as used for tuck pointing. Once the brickwork is prepared this putty is placed on the back of a feather-edge positioned to the joint and using the appropriately sized jointer is lifted off and placed into the joint until flush; any excess being neatly trimmed with the knife or 'frenchman'. Once all the joints have been filled it is firmed up with the jointer and lightly brushed clean. It was important to keep spraying this work intermittently with

Figure 117

The completed platt band prior to final rubbing-up to finish.

a fine mist setting for a week to prevent it drying-out too quickly and help it cure (Fig. 117).

The reason for this radical measure of reintroducing lost original gauged work features to the central bay of east elevation, was because the original gauged features between the second and third floors had been removed or chiselled back from the face. This included flat arches over the window openings, and both a plain Platt band and cut-moulded platt band between the first and second floors. These areas had also been rendered with pigmented cement:sand mortar; which had then been raked out to simulate joints and bonding, pointed with cement:sand mortar. This was most dis-figuring.

Luckily we were able to determine the majority of the original enrichments from what was located behind the render, including the cut-mouldings to the platt band examples of which were still inset within the side walls. Also what could be gleaned from the study of some old photographs taken before this wholly inappropriate work had been carried out.

Again due to our volume of work and the need to progress on a defined time schedule, W.T. Lambs supplied all of the bricks purpose-cut to the drawings. The original gauged work had been set with 1–2 mm joints. Despite a high standard of cutting, there were some unavoidable discrepancies between bricks, due to oscillation of the mechanical cutting blade; a reason why most modern gauged work cut mechanically is designed for slightly larger 3 mm joints that can accommodate them. This meant that we needed to finely 'humour' a number of bricks, by first checking them with the try-square, scribing discrepancies and then rubbing out these so each brick was perfectly square and could be laid in perfect 'face plane' with the same tight joints as the original brickwork.

The arches were set out and built to the profiles exactly as described earlier. The two Platt bands were laid upon lengths of timber batten, planed perfectly true, that were the same thickness as the intended projections (see Fig. 116). These were fixed into position so that the top of the battens allowed for the bed joint and would support the underside of the first course of each Platt band. The all-important centre line was measured, plumbed-up and drawn onto each batten, and the bonding was then marked out symmetrically either side. The prepared bricks, after dry bonding to check were all then dip-laid to line; and once the enrichments had dried, were rubbed-up to finish as previously detailed (Fig. 117). Upon removal of the battens each Platt band had perfectly level underside or 'eye-line', important because of the shadow created on the brickwork (Fig. 118).

Figure 118
The completely restored central bay to the east elevation (2003).

In my opinion I have been privileged to work on projects like this along with a dedicated team of my craftsmen, architects, surveyors and importantly a specialist consultant. What is of the utmost importance, and borne out from a case study like this, is the need to have people who have a deep knowledge and understanding of gauged brickwork, and who are willing to go the extra mile to achieve the best of results.

In this instance to achieve the result, we worked with the historic brickwork consultant and master bricklayer and developed an excellent relationship based on his pragmatic view of these works, and always when confronted with particular problems, possessed an answer based on his extensive knowledge and experience.

Finally it demonstrates that there are craftsmen out there who can undertake works of this nature and that these can be carried out and sympathetically executed to the highest of standards; particularly when there is the correct and respectful involvement of all parties concerned.

5

The Victorian and Edwardian Periods (1837–1914)

Introduction

Historical correctness should dictate that these adjoined periods terminate in 1910, with the death of King Edward VII, but these are generally accepted to extend to the outbreak of the Great War of 1914.

The accession of Queen Victoria in 1837, coincided with the dawn of a dramatic period of national inventiveness, development, and prosperity, unequalled in the history of the world. A long period of peace, following success in the Napoleonic Wars, allowed Britain to concentrate her energy and wealth on industry; it was her 'Golden Age'.

The architecture of previous centuries generally continued to evolve slowly along traditional lines, but this changed enormously, with attendant social consequences, with the huge material expansion facilitated by the discovery and use of steam, gas, and electrical power. In architecture the conflict between the traditional past and a new Industrial age, manifested itself in the so-called 'Battle of the Styles'. This was a period in architecture of revived vernacular styles often striving for a return to 'medievalism', rusticity, and other traditional building forms as a relief from what was seen as the hard functionalism of the machine age.

The fashion for stucco, especially during the Regency period (1800–30), saw standards of brickmaking, the quality of mortar, and the brickwork constructed, reach a nadir; encouraged by unscrupulous and largely unqualified builders. This was not resolved until the collapse of several buildings during the course of erection and the resultant Building Acts of the 1870s. Although the fashion for face brickwork returned after 1840, gauged work had been a major casualty.

Within architecture the Classical style dominated for public buildings such as libraries and museums, based on Greek and Roman originals. The Gothic Revival was foremost in the move against the prevailing use of this style, and later the hugely influential Arts and Crafts movement, founded by John Ruskin

(1819–1900) and William Morris (1834–96). Both were authors, artists, and philosophers strongly influenced by Augustus Pugin (1812–52) who, as a devout Christian and Catholic convert, advocated the strict design philosophy of the Gothic Revival.

Ruskin published *The Seven Lamps of Architecture* and *The Stones of Venice* between 1849 and 1853 arguing that the beauty of architecture was a result of sincere use of materials and honesty in construction. In this respect, Ruskin proposed that the right Gothic style was the north Italian or Venetian Gothic, and that the use of its polychromatic, multi-coloured masonry should be from the natural hues of the bricks and stones, not paint or other superficial applications.

Though there were elements of opinion in the Gothic Revival that preferred stone to brick, some proponents used brick, especially traditional handmade bricks to exploit the artistic possibilities of gauged work, as at The Midland Hotel, St. Pancras Station, London (1868–74) by Sir George Gilbert Scott (1811–78).

The vision of the Arts and Craft movement was a return to the virtues of freely expressed craftsmanship that were, it was thought, being destroyed by mass-production and the economics of capitalism. One answer was found in the so-called William and Mary and Queen Anne styles, popularised by architects such as Philip Webb (1831–1915), William Eden Nesfield (1835–88), Richard Norman Shaw (1831–1912), John James Stevenson (1831–1908), George Fredrick Bodley (1827–1907), Edward Robert Robson (1836–1917) and Basil Champneys (1842–1935). All studied the older English use of hand-made, mainly red, bricks and based their designs on traditional methods, in attempts to restore bricklaying as an art and prevent its demotion to craft status. They did so by the prolific use of gauged work to wonderful aesthetic effect; though by their direct control over the designs they unwittingly prevented their overall desire from being fulfilled.

From the 1870s until the end of the nineteenth century the Queen Anne heralded a golden age of gauged brick architectural detailing, particularly, though not exclusively in London. Once again gauged work was exploited for arches, aprons, niches, pilasters, volutes, pediments, oriels, vaults as well as carved work on capitals, cartouches, consoles, date tablets, friezes and scrolls etc; the craftsmen bricklayers relishing this long-awaited opportunity to display their finest cherished craft skills. The architect Sir Ernest George (1839–1922) used the Queen Anne style but added to the Flemish flavour of Norman Shaw's work that appeared after 1874 (Girouard, 1977, 224). George became the chief protagonist for a Flemish Renaissance style, also referred to as Pont-Street Dutch, using Flemish gables along with gauged work detailings in the Kensington and Knightsbridge areas of London.

Wonderfully ornate residences glorify our metropolis, such as the properties of the Metropolitan Board of Works estate of Chelsea Embankment, and Tite

Street, and Cadogan, and Hans Place Estates in Chelsea of Cadogan Square and Pont Street, London. Sadly, the master bricklayers who worked on these properties are unknown, lost in the anonymous economic changes that saw their employers, large building firms, take the credit for their work. The following companies are some of the most noted that worked on the above developments (Girouard, 1977, 228–9):

- Gillow and Company (contractors, Chelsea Embankment, 1876–78)
- Jackson and Graham (contractors, Tite Street, 1880)
- Kirk and Randall (contractors, Chelsea Embankment, 1878–79)
- Simpson and Sons (contractors, Cadogan Square, 1886)
- Trollope and Sons (contractors, Cadogan Square, 1876–86)
- Trollope and Sons (contractors, Pont Street, 1876–83)
- Thomas Pink and Son (contractors, Cadogan Square, *c*.1877–85)
- Thomas Pink and Son (contractors, Pont Street, 1876–77)

We must content ourselves that, at least, the fruits of the skilful labour of the master bricklayers in producing gauged work of the highest order – despite the best efforts of the German Luftwaffe and the equally destructive post-war planners and developers – are still to be seen and marvelled at.

Though less exuberant, the brick buildings of Bedford Park, London, many of which have charming gauged brickwork detailing, owe their origin to the aesthetic movement and ideals of Ruskin and Morris. Developed in three phases in the years between 1875 and 1886, when the buildings were to the Queen Anne designs of several leading architects like E.W. Godwin (1833–86) and Norman Shaw. A final phase between 1887 and 1914 saw the estate broken up and the land developed in a variety of ways. Gauged work was still being employed on brick-built buildings as, later, the fashion slowly changed to the less exuberant Edwardian style, for finishing simple enrichments to principal elevations. This lasted until the outbreak of the First World War in 1914 (Fig. 119).

The eclipse of gauged work was due to several contributory factors, the decline of the large town and country house, expensive handmade bricks (up to three times the cost of those made by machine) and the increasing cost of labour. Labour-intensive and highly skilled gauged work priced itself out of the builder and client's pocket. A major factor, however, was the 1914–18 war.

A huge number of Britain's finest craftsmen were lost to industry in the trenches, leaving an indelible mark on the quality of work that was to follow. A parallel can be drawn with the noticeable difference in standards of masonry work of medieval cathedrals and churches, left only part-completed when the Black Death struck. The loss of the finest skilled masons left their completion in the hands of semi-skilled people with neither the full knowledge nor skills

Figure 119

The end of an era – bricklayers and their labourers stand in front of recently completed gauged arches in Ashford (Kent), 1913. (Courtesy of Richard Filmer)

to continue the high quality of work. So it was after the Great War. It was impossible to fill, and quickly educate and train to the same standards, craftsmen to fill the huge void with so few young men remaining alive or uninjured. In the main, only the youngest apprentice bricklayers and their senior craftsmen – too old to fight – were left within the craft to learn from, and only a select few of the latter possessed the high-level skills, knowledge, and experience of quality gauged work. This was too great a blow for a bricklaying craft that, particularly in the last quarter of the nineteenth century, had invested so much in that fallen generation. It never recovered.

To give clarity to this loss, the census of 1911 gives 1,140,000 males as employed in building and construction. By 1921 this figure had dropped to 894,000 (Chadwick-Healey, 1971). Lloyd (1925, 27) gives union figures as '… there are now 36,000 bricklayers, as compared with 92,000 before the war…'.

Brickmaking

At the beginning of the nineteenth century the brickmaking process was still primitive. The urban pressure for quickly built homes for factory workers led to a massive demand for bricks. Between 1820 and 1850 over 100 brickmaking machines (Hammond, 1981, 14), and new-style, more efficient and controllable larger kilns, mainly using coal as the fuel, were patented to take advantage of this lucrative market (Hammond, 1981, 23–4). Many new brickyards were located close to the new rail network to gain quick access to growing towns and cities and meet this unprecedented demand. Mechanisation in brick production, with steam engines gradually replacing men or horses, allowed new (harder and less plastic) sources of clay to be exploited from greater depths (Woodforde, 1976, 121–2). As bricks were increasingly transported far and wide beyond their place of manufacture they generally carried the brickmaker's initials in the frogs as a means of identification.

To fully appreciate the huge demand for bricks during the last quarter of the nineteenth century, a report of a brickmaker's conference held in Southwark, London and reported in *The Builder* on 13th September states (1879, 1033):

> Some years ago a careful computation was made by Messrs Eastwoods & Co, of the quantity of bricks usually made to supply the markets of London and the metropolis. As near as could be arrived at at that time the numbers were found to be 600,000,000. But he had every reason to believe – and no doubt the experience of those concerned in the trade would confirm this – that in ordinary seasons the sale would be at 700,000,000.

A number of the larger traditional brickmakers with permanent brickyards and benefiting from rail access to London and other cities and towns began specialising in rubbing brick production. The majority of these, though not all, took extra care in the preparation of their own unique brickearth and clay, and in the firing of their bricks, to ensure a consistent quality of product essential for fine gauged brickwork detailing, by architects, and bricklayers. Searle (1936, 112) states:

> Cutters and Rubbers are bricks which can readily be cut or rubbed to any desired shape and are used for gauged work, arches, and where a few bricks of special shape are required. Such bricks must be made of a very mild loam and they are generally made of a mixture of washed earth and sand. Unless a sufficiently large proportion of sand is present the bricks would not 'cut' or 'rub' properly and they would be difficult to make into the desired shape.
>
> …They are dried and burned in the same manner as other bricks but care must be taken not to over-heat them or they will be useless.
>
> As few natural materials are suitable, alone, for the manufacture of these bricks, they are usually made of a clay which is carefully picked, and run through a

> wash-mill into pits, where it remains until by evaporation and settlement it has attained a proper degree of consistency. The clay is then mixed with sufficient sand to diminish the labour of rubbing the bricks to gauge, the proportion varying according to the quality of the clay, but often being equal to that of the clay.

Gwilt (1888, 526) records:

> The Red bricks derive their colour from the nature of the soil whereof they are composed, which is generally very pure. The best of them are used for cutting-bricks, and are called red rubbers … The Fareham Reds are noted bricks.
>
> The Ballingdon or Ewell deep black rubbing and building brick, probably so rendered by manganese, are soft in make and dead in colour.

There is no naturally occurring brickearth or clay that will fire black rubbers, so deliberate adulteration of the clay was most likely out of a need for use in fashionable polychromatic work.

The yellow, or white, coloured bricks capable of being cut and rubbed were the malm cutters out of the London stock range, or from the calcareous clay reserves in parts of Bedfordshire, Hertfordshire, Norfolk, and Suffolk where, as stated earlier, they were known as 'Clippers'. Some were calcareous Cowley, Essex, Kent and Surrey bricks, such as those mentioned in *The Building News* of 8th May (1896, 667):

> The Brockham Brick Company have some good samples of rubber, machine-pressed, and Gault facing bricks.

The malm or marl cutters, as referred to amongst brickmakers and bricklayers, were reserved for gauged enrichments. By 1850, however, the naturally fine, calcareous, malm clay was all but exhausted, so London Stock brickmakers had to specially prepare, wash, and strain their material in a creative process that became known as 'malming'; hence this definition of Malm cutters by Frost & Boughton (1954, 3):

> …are a good uniform brick, light yellow in colour, made from a specially prepared clay, and are of a uniform texture throughout …. Malm cutters or rubbers (seconds) are inferior to first-class malms … in respect to colour which is not uniform as in the former case.

London building supply merchants trading out of riverside wharves were advertising malm cutters and rubbers in publications such as *The Builder.* In 1853 these included Henry Dodd and Co. of Hoxton Brickfields, and a Mr Benjamin Gough. In 1858 Charles Richardson (later A. & W.T. Richardson) of Brunswick Wharf, Vauxhall, was advertising rubbers and cutters '…of the best quality'. Later in the period other building supply merchants advertised bricks for gauged work, such as F. Rosher & Co. of Old Jamaica Wharf, who sold 'Yellow Malm Cutters' and 'White, Black and Red Rubbers'.

Advising on the selection of rubbers suitable for gauged work from a general firing of bricks, Hammond (1889, 78–9) suggests that:

> … It is of very little use to look at the outside of a brick-stack if one is trying to ascertain the quality of the bricks …. The brick must be broken, or … sawn through with the saw, so as to examine the kind of earth of which it is made; for we frequently see bricks having a first-class appearance outside, and the inside when examined is found to be full of stones or clay that has never been properly worked up, much less washed; so that when the cutter begins to work he is sure to find one or the other defect just in that particular part which he wants to cut to the mould, and so the brick is wasted after a considerable time has been spent in squaring or otherwise preparing it for cutting, and the brick is not only wasted but the labour also.

He continues (Hammond, 1889, 79)

> There are a great many different kinds of bricks used for cutting, called 'rubbers'. Some of these have too much clay and others too much sand in composition. The first takes a great deal more labour in working than would be required if the sand and clay existed in proper proportions, because there is not sufficient friction when working the on the rubbing-stone or using the saw, and the latter is almost as bad in the too great freedom of its working; for where the brick has too much sand it is next to impossible to work the angles to the sharpness generally required for good gauged work, the excess of sand making the brick rotten, as it were, so that the angles will not hold. This is sometimes seen with good bricks, but it is when they have become exposed to the damp and then dried by the fire. This is often the case in the winter season.

There would have been quite a large number of small rural brickyards producing a variety of bricks capable of being rubbed. This is evidenced in a dated 1862 letter from the Beaulieu Brickworks, replying to a customer complaining about the non-delivery of arch bricks:

> …we do not keep Arch Bricks by us as they vary in taper, we make them to order generally … all our Customers use the rubber for the Arches as they can rub them to the taper they require them. You will find that all Brick makers make the rubbers for the purpose you require Arch Bricks … I should not of (sic) sent them had I not of (sic) been sure that you would of used them as other builders do. They never object to the labour of rubbing or cutting. (Cottingham, 1984, 15)

The following are among those companies marketing rubbers and cutters during this period:

- Allen's rubbers (Essex)
- Beart's white rubbers (Bedfordshire)
- Beaulieu whites (Hampshire)
- Chalfont red rubbers (Buckinghamshire)
- Collier's red rubbers (Berkshire)
- Cornard's rubbers (Suffolk)
- Cossey (Costessey) whites (Norfolk)
- Ewell rubbers (Surrey)
- Fareham reds (Hampshire)
- Kimber's rubbers (Hampshire)
- Midhurst rubbers (Sussex)
- Roshers red rubbers (Suffolk)
- TLB red rubbers (Berkshire)
- Wheeler's rubbers (Berkshire)
- Woolpit rubbers (Suffolk)

Allen's Rubbers

R.H. Allen of Ballingdon (Essex), made a deep black rubbing brick sometimes referred to in contemporary documents as 'black Suffolk rubbers' (this was due to the close proximity of the border separating Essex from Suffolk), as well as their dark and bright rubber range.

As Corder-Birch (1996, 446–7) records:

> On the Essex bank of the river Stour at Ballingdon were the large brickworks of Robert Allen and Sons who excavated the Ballingdon Cut to facilitate access to their works by barges from the river. The river Stour has been navigable since July 1713 … It therefore became one of the earliest rivers to be navigated … In 1859 Allen's were operating a fleet of 22 barges … Allen's Brickworks at Ballingdon had commenced in 1812 and they later owned another brickworks at Bures Hamlet. At their peak they were employing one hundred men in their brickworks.

Beart's White Rubbers

Robert Beart had huge rail-side brickworks exploiting the large reserves of gault clay at Arsley near Hitchin (Bedfordshire). Gwilt (1888, 526) states that his bricks were:

> …of the following qualities, ranged according price:- white rubbers; handmade moulded solid brick, equal to the best Suffolks.

Frost and Boughton (1954, 60) record that 'Beart's Patent Bricks' are:

> Made from a selected gault clay, They are hand moulded and kiln burnt, and of similar colour and texture to white Suffolks. They are generally known as white rubbers and used for similar purposes. They are made in two or three grades; the first or best quality for high-grade work. In actual construction a lime putty joint is suitable to the first grade of this brick….

Beaulieu Whites

These bricks were of a light straw colour, made from clay dug from the River Beaulieu near Southampton. The bricks for gauged work were more like cutters, being slightly harder than a rubber. According to Cox (2003):

> In about the 1840s, the Beaulieu brickworks at Baileys Hard, graded its bricks according to quality as best, seconds and thirds, while 'specials' were offered including splayed bricks, plinth bricks and 'saddle-back' copings. Rubbed bricks could also be supplied.

Chalfont Red Rubbers

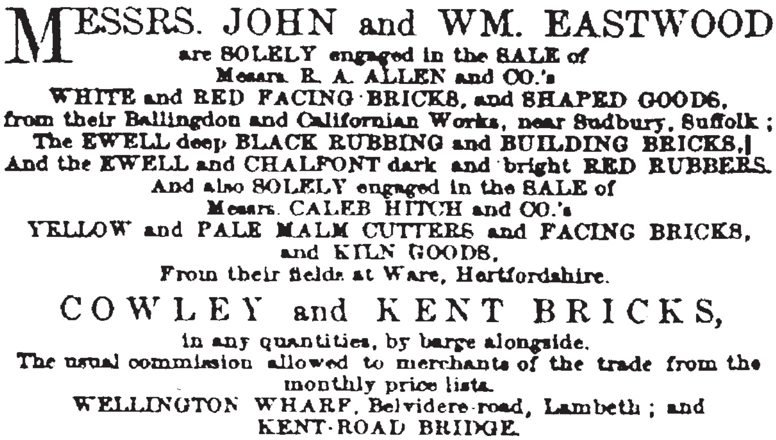
Two types of rubbers, one dark and the other bright red were referred to by George Gilbert Scott in *The Builder* of 5th July 1856 (1856, 364):

> A great deal might easily be done, not only with moulded but with cut bricks, of which some beautiful specimens might be found in the sixteenth century buildings about London. Bricks fit for this purpose could be obtained not far from the Metropolis, at Hedgerley and Chalfont.

In spite of research by the author, it has not proved possible to locate the exact brick yard or yards where the Chalfont rubbers were produced. It has therefore been impossible to verify whether this production was at Chalfont St Peter or Chalfont St Giles, although the latter area, only a few miles from the village of Hedgerley, appears the most likely. Gilbert Scott in the above quote of 1856 mentions both Hedgerley and Chalfont rubbers in the past tense. Yet Messrs John and William Eastwood advertised 'Chalfont Dark and Bright Red Rubbers' for sale amongst their list of buildings materials in 1858 (Fig. 120).

Certainly bricks capable of rubbing had been made in Hedgerley, near Windsor, for many years and are referred to as such by Nicholson (1823, 344). There is no reason to doubt that other suitable and exploitable sources of brickearth/clay were not also available in other parts of Buckinghamshire with prime access to the London market.

By 1881, trading as Eastwood and Company Limited, 'Lime, Cement and Brick Manufacturers and Merchants', are still advertising, 'Chalfont Red Rubbers' for



MESSRS. JOHN and WM. EASTWOOD
are SOLELY engaged in the SALE of
Messrs. R. A. ALLEN and CO.'s
WHITE and RED FACING BRICKS, and SHAPED GOODS,
from their Ballingdon and Californian Works, near Sudbury, Suffolk;
The EWELL deep BLACK RUBBING and BUILDING BRICKS,
And the EWELL and CHALFONT dark and bright RED RUBBERS.
And also SOLELY engaged in the SALE of
Messrs. CALEB HITCH and CO.'s
YELLOW and PALE MALM CUTTERS and FACING BRICKS,
and KILN GOODS,
From their fields at Ware, Hertfordshire.
COWLEY and KENT BRICKS,
in any quantities, by barge alongside.
The usual commission allowed to merchants of the trade from the monthly price lists.
WELLINGTON WHARF, Belvidere-road, Lambeth; and
KENT-ROAD BRIDGE.

Figure 120

Advert in *The Builder* for 'Chalfont Dark and Bright Red Rubbers', 1858. (Courtesy of Alan Cox)

sale, out of their four London Wharves. Gwilt (1888, 526), discussing the range of bricks available, also records:

> …and Chalfont, supply dark and bright, red rubbers….

It would appear that Chalfont rubbing bricks, like those from other small yards, probably fell from popular favour with the rise and intensive marketing of larger and more powerful companies, like Johnson's and Lawrence's high-quality 'Fareham Red' and 'TLB' rubbers.

Collier's Red Rubbers

S. and E. Collier (Berkshire) were established in *c.*1848 and had various pits around the Reading area, including Coley Park, Grovelands, and Norcot Hill. They produced a wide range of fired-clay products including terracotta, roof tiles, and ornamental finials, as well as ordinary red sand-faced, moulded bricks, and rubbing bricks that they marketed as 'Reading Red Rubbers'.

Cornard's Rubbers

From 1840 the Little Cornard Brickworks at Sudbury (Suffolk) was established by the Tricker family and, until the works closed in 1964, passed into other ownership several times (Blowers, 1987, 4–8). Working basic topmost clay, which contained a high proportion of flint that necessitated thorough washing and screening off into wash pits to mature over winter, they produced both red and white bricks. They also produced rubbers as purpose-moulded voussoirs in 303 mm, 355 mm, and 406 mm lengths. These required minimal rubbing to gain flat bedding surfaces and then cutting by what is termed 'topping and tailing' to suit the arch templet size and if necessary dummy joints cut-in if the arch face was to be bonded.

Cossey (Costessey) Whites

Costessey lies to the north-west of Norwich (Norfolk), the name being contracted by local pronunciation to Cossey. The pioneering female architect and wife of the owner, Lady Frances Stafford, started an estate brickyard around 1815 for the re-construction of Costessey Hall on a Tudor model (sadly demolished after the 1914–18 War). She worked closely with the leading antiquarian topographer, J.C. Buckler with the brickyard subsequently taken over by George Gunton.

Cox (2002) records that the works:

> …produced 'Cossey Whites', actually a light yellow, which were widely used around the Norwich area…. … In the later nineteenth century, Guntons produced 'Costessey ware'…. Described as 'fine moulded brickwork which can be rubbed and shaped into intricate patterns' and they were used for George Skipper's office, 7, London Street, Norwich in 1896, which has ornamental bricks and Costessey Ware panels.

Ewell Rubbers

The Ewell brickyard was probably at, or near, the site of the Nonsuch brickworks between London Road and Vicarage Lane in Ewell (Surrey). According to Cox (2002), the brickyard:

> Had its own clay pit and was in operation from about 1800 … Originally operated by Swallow and Stone then Stone and Swallow and eventually Stone and Company.

The company produced Ewell deep black rubbing bricks, as well as dark and bright red rubbers. With regard to examples of the use of their black rubbers, Cox (2002), states:

> In 1861 a house in Smithfield on the corner of St. John Street and Charterhouse Lane, London, the architect George Somers-Clarke employed Ewell black rubbers. In 1863 another building by Somers-Clarke, The Merchant Seaman's Orphans Asylum, Snaresbrook, used locally made red bricks which 'The Building' of 4/04/1863 p 242 described '… the fronts being relieved by black Ewell facing courses, and the window heads and other arches throughout are also of black Ewell cutters and red Ballingdon cutters'.

Fareham Reds

Fareham Reds were made in brickworks in the north-east part of Fareham in Hampshire, in the vicinity of Fareham Common and Fontley (also spelt

Funtley) where the railway arrived in 1841 so providing valuable access to London by way of Eastleigh.

There is little doubt that the Fareham Red was considered a premium rubber during all of the Victorian period, as Walker (1885, 1761) emphasises:

> Fareham rubbers for gauged-work also stand first in quality, though they are not extensively used, as they are dearer than the other varieties in the market.
>
> Of red bricks Fareham Rubbers are the best; they are of a close, firm texture, will carry a sharp arris, and weather well; in colour they are cherry red.

The phrase 'carry a sharp arris' is worthy of greater exploration, as its meaning is frequently overlooked. Historic rubbers, dating from the fifteenth to the nineteenth centuries, are seen to be of close-textured body when cut. Most are easily cut and rubbed to give sharp arrises that will hold; directly as a consequence of their integral material and manner of manufacture.

By 1860 excellent rail access existed eastwards too along the south coast to Brighton and the 'Direct route of Portsmouth to London via Guilford'. According to Cox (2002):

> …in the 1860s and 1870s that 'Fareham Reds' came to prominence, to such an extent that Sir John Summerson suggests that 'Fareham Reds' seem to have been among the factors responsible for the change in the colour of London streets from brown to red in the 1870s. This type of brick was produced by William Cawte … listed [in the 1860s] at Furze Hall, Fareham, as a brick and tile maker.

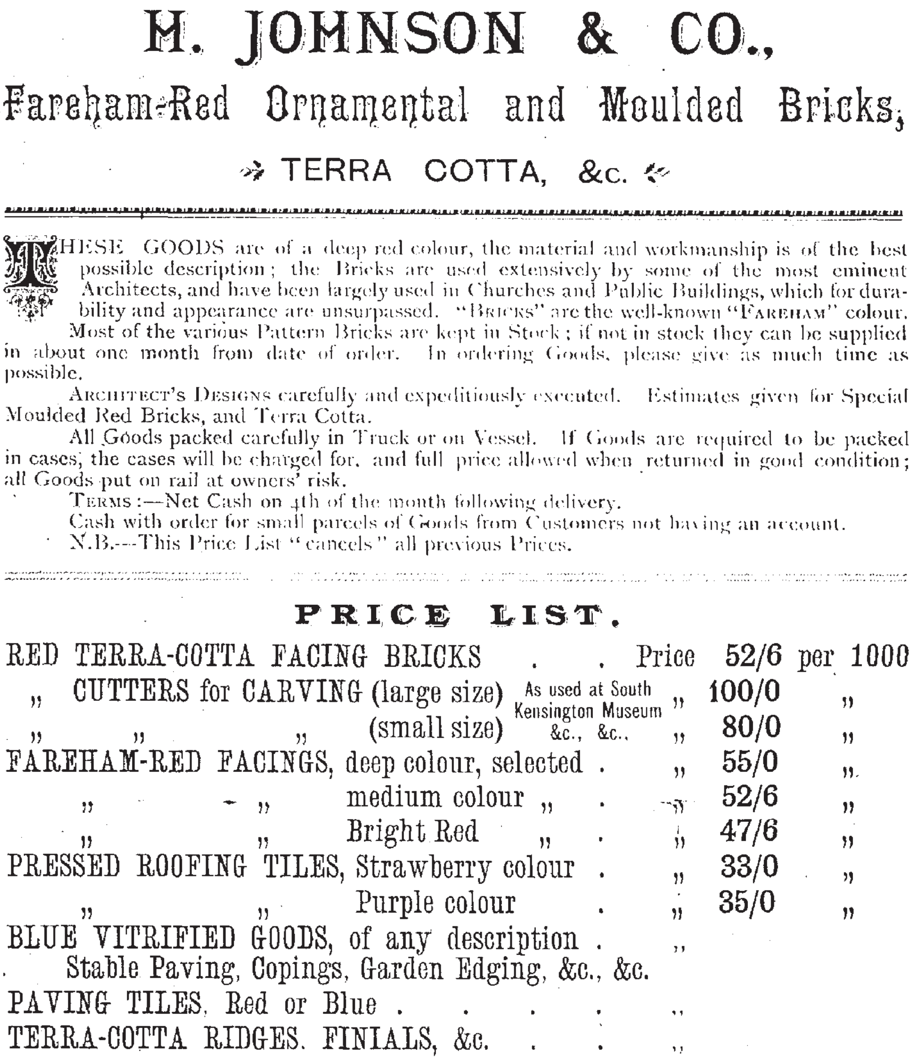
On the subject of brick prices, *The Building News* of 8th March 1872, records (1872, 189):

> Fareham Red Rubbing and Facing Bricks. – Price of the facing bricks in London is 63s. a thousand, 49s. Loaded in trucks at Fareham. Red Rubbers, £6 per thousand.

At about this time, Cox (A Cox, 2002) records:

> …Cawte supplied Fareham Reds for two other major London public buildings. In 1871 he opened a new field adjoining his existing one … to manufacture the 25 million bricks used in the construction of St Thomas's Hospital. And although G.E. Street's Law Courts (1874–82) is stone-faced to the Strand, Fareham Reds were amongst the large quantity of bricks employed throughout the building.
>
> Fareham Reds were quickly taken up for more modest buildings in London. In 1873 the architect Richard Norman Shaw used cut and gauged Fareham Reds for the front of the offices in Leadenhall Street, in the City. He again used them for the Queen Anne Style Clock House, No. 8 Chelsea Embankment.

By the 1880s H. Johnson and Company owned the firm, their postal address being given as 'Lausanne', Fareham (Hampshire) and their manufactory address as Funtley (Fig. 121).



H. JOHNSON & CO.,

Fareham-Red Ornamental and Moulded Bricks,

TERRA COTTA, &c.

THESE GOODS are of a deep red colour, the material and workmanship is of the best possible description; the Bricks are used extensively by some of the most eminent Architects, and have been largely used in Churches and Public Buildings, which for durability and appearance are unsurpassed. "BRICKS" are the well-known "FAREHAM" colour.

Most of the various Pattern Bricks are kept in Stock; if not in stock they can be supplied in about one month from date of order. In ordering Goods, please give as much time as possible.

ARCHITECT'S DESIGNS carefully and expeditiously executed. Estimates given for Special Moulded Red Bricks, and Terra Cotta.

All Goods packed carefully in Truck or on Vessel. If Goods are required to be packed in cases, the cases will be charged for, and full price allowed when returned in good condition; all Goods put on rail at owners' risk.

TERMS:—Net Cash on 4th of the month following delivery.

Cash with order for small parcels of Goods from Customers not having an account.

N.B.—This Price List "cancels" all previous Prices.

PRICE LIST.

RED TERRA-COTTA FACING BRICKS . .	Price	52/6	per 1000
" CUTTERS for CARVING (large size) As used at South Kensington Museum &c., &c.,	"	100/0	"
" " " (small size)	"	80/0	"
FAREHAM-RED FACINGS, deep colour, selected .	"	55/0	"
" " medium colour " .	"	52/6	"
" " Bright Red " .	"	47/6	"
PRESSED ROOFING TILES, Strawberry colour .	"	33/0	"
" " Purple colour .	"	35/0	"
BLUE VITRIFIED GOODS, of any description . Stable Paving, Copings, Garden Edging, &c., &c.	"		
PAVING TILES, Red or Blue	"		
TERRA-COTTA RIDGES, FINIALS, &c. . .	"		

Figure 121
Advert for H. Johnson and Company, manufacturers of Fareham Red Rubbers, *c.*1880. (Courtesy: Hampshire Record Office)

Red cutters for carving were sold in two sizes, large at 100.s per 1,000 and small at 80.s per 1,000; and it is indicated that these were used for that purpose at South Kensington Museum, among other notable places.

The emphasis on two sizes is of interest as it is during these years that many rubbers began to be consistently produced to larger sizes than standard bricks. This was almost certainly a direct response to the prolific architectural use of carved enrichments, ensuring adequate 'tailing-in' of projecting elements to the background masonry and reducing unnecessary joints. It was also a response to the move towards the use of the bow-saw to cut and shape the rubbers within profiled cutting boxes, as described later in this chapter.

Praise of the Fareham Reds for their consistent and inherent qualities was widespread during these late Victorian years, especially in the architectural and building press. *The Builder* of 2nd September 1871 reported that gauged Fareham reds were being first rubbed smooth on a revolving table (1871, 689). Clearly this was a builder's development to speed up the traditional process of initial preparation of squaring, whereby the rubbing brick was held stationary as the rubbing stone revolved. It then relates how these rubbers were set closely in 'fine stuff' on South Kensington Imperial College (now part of the Victoria and Albert Museum). Both the small and large rubbing bricks, for carving, were also used on the original part of the Victoria and Albert Museum.

Towards the close of the century a Mr Asher Barfield took ownership of the company. Fareham Reds gradually began to fall from favour, *The Building News* of 27th December 1895 commenting they 'were expensive in the labour of cutting' (1895, 918). This was towards the end of a prolific period in the use of gauged work, however, and competition from other companies producing quality rubbers was peaking.

Kimber's Rubbers

An advertisement in, *The Architect, Engineer's and Building Trades' Directory* of 1868, states (1868, 239):

> Thomas Kimber, Ramsdell near Basingstoke, Hants. Celebrated for upwards of a century for roofing tiles, paving ware, clinker and rubbing bricks, etc'.

Midhurst Rubbers

In 1887 the Midhurst, Sussex brickmakers, Tallant Brothers advertises, 'rubbing bricks equal to Fareham ware' (Beswick, 2001), from their Pitsham and Henley brickyards (Fig. 122). Rubbers are still being produced at Pitsham today by W.T. Lambs, but the clay is brought in from further afield.

Roshers Red Rubbers

An advert appeared for F. and G. Rosher, Lime, Cement, Brick, Tile and Slate Merchants in *The Architect* of 3rd July 1869. (1869, x) describing them as:

> Rosher, Lime, Cement, Brick, Tile and Slate Merchants, where one can obtain from their London Wharfs, White, Black and Red Rubbers.

The Builder of 23rd December 1893, however, describes them as (1893, xxii):

> Roshers Brick, Tile and Pottery Company. Works: Henley Road, Ipswich, Are the only Makers of the Highly-Esteemed R R Red Rubbers.

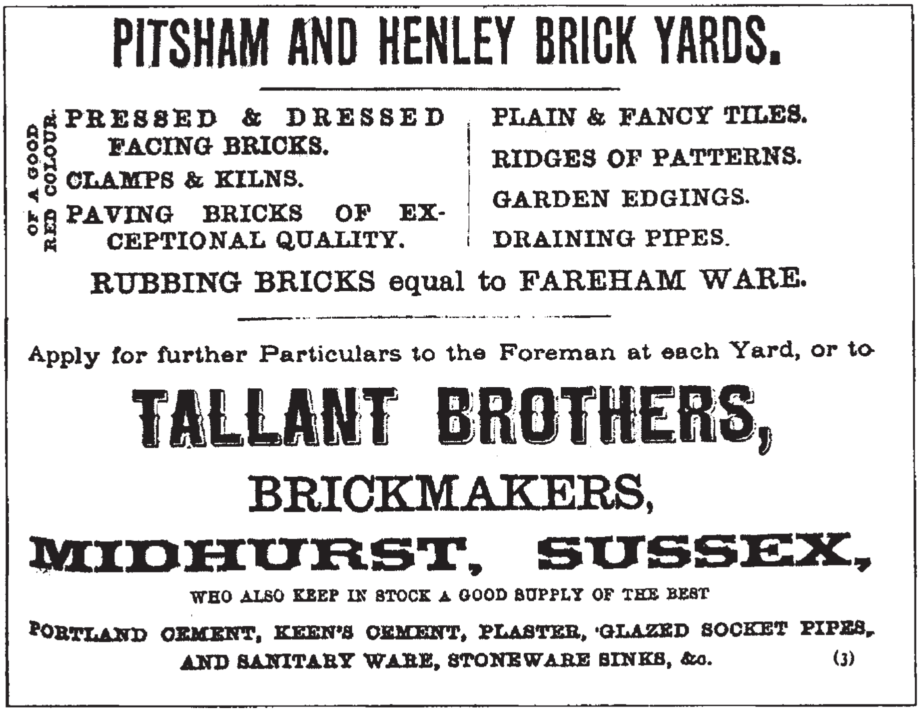


Figure 122
Advert from Brickmaking in Sussex, for Sussex brickmakers Tallant Brothers 'rubbing bricks equal to Fareham ware' from their Pitsham and Henley yards, 1887.

TLB Red Rubbers

The TLB rubber was produced by Thomas Lawrence and Sons of Bracknell (Berkshire), hence the initials that were always stamped on to the flat beds of the rubbers, or in the frogs of all their other bricks. They were considered second only to the Fareham Red, as Walker (1885, 1761) states:

> Next in quality come the Berkshire Builders and T.L.B. Rubbers, Made by T. Lawrance [sic] Bracknell, Berks.
>
> No. ones T.L.B.s are good bricks, though less firm than Farehams, but of an even texture; they are divided by colour into two classes – Cherry-red and orange tint. The orange is generally used, as they contrast well with the red building bricks, but will not carry so sharp an arris or weather so well as the darker bricks.

As can be seen in their trade price list of 1898 (Fig. 123) there were three different types of TLB rubber. In ascending order of quality these were the 'Orange Red', 'Cherry Red' and 'Rich Dark Red', sized at $9\frac{3}{4}$ ins × $4\frac{5}{8}$ ins × $3\frac{1}{8}$ ins (247 × 118 × 80 mm). Of interest, their prices are not quite double those of their handmade facings. The 'Large Rubbers' listed beneath their main bricks were significantly bigger and more expensive, being specially prepared for use mainly on carved gauged work.

Figure 123

Wholesale trade price list of Messrs Thomas Lawrence of Bracknell, Berkshire, 1898, with types, sizes, and prices of their rubbing bricks. (Courtesy: Berkshire Record Office)

WHOLESALE TRADE PRICE LIST OF FACING & RUBBER BRICKS

Loaded into Railway Trucks

At BRACKNELL STATION, S.W.R.

The Bricks marked * can also be loaded at Wokingham Station, S.E.R.

			£	s.	d.	
No. 1	Selected	Orange Red Facings, Hand-made, at	2	9	6	per 1000.
„ 2	„	Cherry Red „ „ „	2	10	6	„
„ 3	„	Rich Dark Red „ „ „	2	12	0	„
„ 4	„	Orange Red Hand-made Pressed Facings - - - „	2	19	6	„
„ 5	„	Cherry Red ditto - - „	3	2	6	„
„ 6	„	Rich Dark Red ditto - - „	3	5	0	„
„ 8	„	Orange Red Rubbers $9\frac{3}{4} \times 4\frac{3}{8} \times 3\frac{1}{8}$ „	4	7	6	„
„ 9	„	Cherry Red „ „ „	4	7	6	„
„ 10	„	Rich dark Red „ „ „	4	7	6	„
„ 12	„	Orange Red Facings, Hand-made „	2	6	6	„
„ 12 x	„	Cherry Red „ „ „	2	8	6	„
„ 12 xx	„	Rich Dark Red „ „ „	2	11	6	„
„ 13	„	Orange Red Facings, Machine-made	2	0	0	„
„ 13 x	„	Cherry ditto „ „	2	0	0	„
„ 13 xx	„	Rich Dark Red ditto „ „	2	0	0	„
„ 16	„	Grey Headers and Stretchers of an unusually bright colour „	2	10	0	„
„ 17	„	Machine or Hand-made Paving Bricks - - - „	2	10	0	„

Seconds suitable for inside walls and other rough work at Market Price.

APPROXIMATE WEIGHTS OF ABOVE BRICKS:—Hand-made Bricks, 53 cwts. per 1000; Machine-made ditto, 61 cwts. per 1000; Rubbers, 82 cwts. per 1000.

LARGE RUBBERS,	$12\frac{1}{2} \times 4\frac{3}{8} \times 3\frac{1}{8}$	at 14/6	per 100.	Weight, 11 cwt.
„ „	$14\frac{1}{2} \times 4\frac{3}{8} \times 3\frac{1}{8}$	„ 19/6	„	„ 13 „
„ „	$12\frac{1}{2} \times 7\frac{1}{2} \times 3\frac{1}{8}$	„ 28/6	„	„ 17 „
„ „	$9\frac{1}{2} \times 9\frac{1}{2} \times 3\frac{1}{8}$	„ 27/6	„	„ 15 „

NOTE.—Instructions are given Railway Co. to cover all trucks containing Rubbers with Tarpaulins, for which they make an extra charge of 1/- per truck.

ALL BREAKAGES IN TRANSIT AT PURCHASER'S RISK.

Experience gained in working both with original Cherry Red and orange TLB rubbers substantiates Walker's viewpoint regarding the vulnerability of some of their arrises. This is due to the open, almost aerated, texture of the bricks, particularly the orange rubber. One had to exercise great caution with the latter in handling them to prevent losing a prepared arris. This was particularly true of TLB 'seconds' that were sold too.

According to Dumbleton (1990, 7):

> The firm claimed to have made bricks since 1860, and in 1886 gained the only gold medal for bricks at the Architectural and Building Trades Exhibition. Their circular of 1893 shows that by then they had works at Swinley, Easthampstead, Warfield and Pinewood making 12 million bricks a year.

TLB rubbers were made at two of several brickyards Lawrence operated on the geological junction between the Bagshot sand-seam and London clay. The main yard was the Warfield Brickworks, the second – evidently only in production to meet demand between 1891–1910 – was at their Pinewood works.

Dumbleton (1990, 14) describes how the rubbers were made from a Swinley Clay at Warfield:

> Rubber bricks. Special clay from Swinley was mixed with water in a wash mill, a cylindrical tank with radial rotating rakes. The slurry, free from any stones, then flowed down a wooden sluice, through screens to remove roots and other debris, and into the settling ponds called rubber bays. After some months the clay was dry enough for use. The rubber bricks were made like ordinary bricks, in steel-lined 9, 12 or 14 inch moulds, but had no frogs and were stamped T.L.B. with a hand stamp.

In 1988 Walter Spencer, then 93 years old, wrote a personal account for the British Brick Society of his father's long years working at the Swinley yard for Thomas Lawrence Spencer (Spencer, 1988, 20–22):

> (Jan 1) … I thought that you might be interested in some facts relating to the old brickyard owned by Thomas Lawrence ….
>
> T L B bricks were famed in their day, and the 'Rubbers', a slightly bigger and better quality brick, were used to build the forts outside Portsmouth Harbour ….
>
> …Another brick yard was opened about half a mile from the old yard, on discovering that more 'Clay Bays' had been found with clay of a much more refined quality. The yard was called 'Klondyke' and the celebrated TLB RUBBER was produced here. These were slightly larger bricks and were more smoothed faced.
>
> …The site of the Brick Yard is now entirely obliterated and except for the undulations of the 'clay bays' cannot be traced. It was situated on the left of the Ascot to Bagshot road just before the gradient to Tower Hill commences and covered over a square mile of land….

In respect to the manufacture of TLBs nothing would be added to the clay before moulding, except a handful of soft sand thrown over the rubbers after they were made, and prior to being put in the drying sheds. After the normal drying period they would be placed in coal-fired rectangular down-draught kilns, because as Dumbleton (1990, 14) correctly states:

> Down-draught kilns are more economical in fuel than scotch kilns, and produce a more uniform product.

With regard to the numbers of rubbers placed amongst the standard bricks in the two kilns for firing, the following ratio was given as:

> …'20,000 ordinary bricks and 12,000 rubbers and the other 30,000 ordinary bricks and 15,000 rubbers…' (Dumbleton, 1990, 14)

The rubbers would be placed in a certain position and level within the kiln to protect them from the main heat behind the standard facing bricks. The rubbers were fired at a temperature of 900°C (about the heat at which vitrification starts to occur), for approximately five days, although this would be dependent on outside weather conditions. After the firing the kiln would be opened and the bricks left inside until cool enough to handle. The cooling period varied and was also dependent upon the weather conditions and the position of the kiln. The bricks would then be graded upon being drawn; the expected percentage loss was 4 per cent on average and the shrinkage about 2 per cent.

Wheeler's Rubbers

Wheeler Brothers, formerly Wheeler and Sons, of Coley Kiln in Reading (Berkshire) were brick and tile makers. They produced fine orange red rubbers that have been identified as being used for some of the gauged enrichments of the arches and quoins of St Pancras Chambers (London) (1866–68). It is possible that they also supplied similar bricks for the same purpose for use on the East Side buildings and elsewhere at St Pancras.

Woolpit Rubbers

There were numerous small rural brickyards across Suffolk, such as The Woolpit Brick and Tile Company. *The Builder* on 14th April, 1883 (1883, 498) says:

> …of Woolpit, Suffolk, and Moorgate Street, some very good dark and light red facing bricks, red and white rubbers, hard red facings and red moulded bricks. They will all bear inspection.

The Builder of 5th September (1879, 24), stated:

> Suffolk white bricks contain a large proportion of sand, hence their suitability for rubbers.

Gwilt (1888, 526) records:

> The Suffolk bricks, called white Suffolk's or 'Clippers', are of two or more qualities, expressly made for facings, and are expensive; the best are rarely obtained in London, being sold in the locality of their manufacture… The works supply superior white and red (kilnburnt) Suffolk facings, splays, door-jambs, coping bricks, stable clinkers, &c dark red facings, rubbers, splays, paving bricks, &c; bright yellow malm facings and cutters of best quality.

The Introduction of Scientific Testing

By the end of the nineteenth century, improved methods of brickmaking and the rapidly changing technology of brick construction meant that architects and engineers demanded information on how masonry, including individual materials, would perform by quantitative testing. Rubbing bricks were no exception. *Rivington's Notes on Building Construction* (Rivington, 1901, 112) gives the defining characteristics of good rubbers:

> A really first-class rubber will not be easily scored by a knife even in the centre, and the finger will make no impression upon it…Such a brick will be of uniform texture, compact, regular in colour and size, free from flaws of any description.

Rivington also recorded 'the sizes and weights of the best-known varieties of British bricks'. This included the Fareham Red rubber, the dimensions of which are given as, 10.9 ins × 4.8 ins × 2.9 ins (277 × 119 × 74 mm), and its weight recorded as 8.8 lbs (3.9 kg). This is as opposed to the standard Fareham Red facing brick with dimensions of 8.5 ins × 4.15 ins × 2.6 ins (216 × 107 × 66 mm) and a weight of' 6.3 lbs (2.85 kg) (Rivington, 1901, 113). One can determine from this that the Fareham Red rubber was oversized, particularly in its length, but less dense than its facing brick counterpart (0.058 lbs/in^3 compared with 0.069 lbs/in^3).

Since water is one of the main decay agents in brick, knowledge of the presence and movement of water within a brick is very important. Rivington recorded information on water absorption by different varieties of brick, including a malm cutter, which was shown to have the highest absorption recorded, at 22% (Rivington, 1901, 114).

Rivington also considered the comparable compressive strength of rubbing bricks with other bricks. The results of testing showed that the rubbing brick was, not surprisingly, weaker than the other bricks tested, failing at four tons (Rivington, 1901, 115), which was significantly lower than the other types of brick tested. This was further substantiated in the results from similar tests on the crushing strengths of various types of brick, undertaken a few years later (Mitchell and Mitchell, 1904, 327–8) (see Table 3).

The low crushing strength demonstrated by rubbing bricks is due to a combination of factors – their fine washed structure, low-fired temperature, and characteristic large voids volume, typically around 35%, which defines their porous nature. Yet it would be wrong to categorise these soft bricks as being constructionally weak and non-durable in the context they were used. Historical use has proved that cut and rubbed and gauged brickwork, properly detailed, will last as long as standard facework. This is due, in part, to the soft lime mortar that was used with these bricks. Structural engineer Lachlan McDonald writes:

> In Victorian brickwork red rubbers were commonly used to form arches with panels of brickwork over. The construction involved the use of lime mixed with fine sand to reduce shrinkage. The joint width restricted to around 2–3 mm maximum for gauged arches, and as fine as 1 mm, depending on the available budget and skill of the craftsman; and up to 6 mm in ashlar work. Despite the low compressive strength of the mortar and the brickwork, it is a general view that if constructed with thin joints this brickwork performed well; even if it was significantly overstressed by modern standards.

The soft lime mortar can distribute the forces within the brickwork over several courses, with much more efficiency than a modern hard cement mortar (L McDonald, 2002). Additionally, due to the plastic nature of the mortar, small movements can be accommodated in the joints without cracking the bricks, and cracks within the lime mortar itself, following movement, are often re-sealed due to the so-called 'autogenous healing'. Although this mechanism is not well understood, it is likely to involve continuous carbonation, or re-carbonation, of deposits of lime out of solution, or free lime. Furthermore, the porous nature of both the bricks and the mortar is more favourable to water movement, allowing wetting and drying-out to occur, leading to less trapped moisture than occurs with cement construction. This improves the weathering characteristics of the brickwork.

John Addison (2006), another structural engineer with vast experience on traditionally built brick and stonework, has this to say about the overall strength of gauged work:

> The ideal brick, from a structural point of view, is one which has the usual 102 mm (4.ins) thickness but blessed with unlimited dimensions. This mega-brick could match the height and length of your wall and you would need no joints

at all! Think hard on this. You only have multiple joints in brickwork because of how brickwork through the basic brick size has evolved down through the ages. Think also of a column of stone (few joints), or of iron (no joints), also of concrete blocks (again fewer joints), and pre-cast concrete wall panels. You will see how joints have begun to disappear.

The 'infinite brick' concept by itself is obviously absurd, yet serves to illustrate one way to avoid worrying about the influence of joints. This is very desirable when estimating the magnitude of direct load that completed brickwork can stand. In the real world of brickwork, however, the way one can get to perfection in jointing, is to go for the thinnest joint you can make, by first shaping the most accurate brick, which is perfectly possible with a top craftsman cutting and rubbing bricks post-fired. Then to mix a screened slaked lime mortar, of the appropriate class for function, with the right amount and micron size of sand, that is used to fill the bed and cross joints completely between the dampened bricks, let it all set and stand back and admire the finished result! Built by craftsmen who are fully competent the result will be strong, robust and durable as historic examples have shown.

Experience and numerous scientific tests down the years have demonstrated how little influence the compressive strength of mortar has on the weight carrying ability of brick walls, this being dictated more by the crushing strength of the brick itself. One just needs to study the modern 'Structural Code for Masonry' to confirm the lack of effect of mortar mixes for normal situations in practical situations of brickwork. This should eliminate concern over a moderately weak brick, thin joint and modest mortar concept, and worry over replicating the details found with this type of gauged brickwork during repair and restoration work, once you know how.

I have been fortunate in my career to have met numerous and diverse situations in old and historic buildings. This has shaped my view of what factors are important in Building Conservation. This may seem extraordinary, but tests carried out by Professor A.W. Hendry in Edinburgh in the 1970's, showed that masonry made with joints of only sand with no lime, or Cement, binder, could stand up and be counted.

Finally, on the question of loading capacity, it is a fact that most traditional buildings experience no greater stress than about 0.8 N per sq. mm in the wall construction that is relatively insignificant compared to their crushing strengths. When even 3 N concrete blockwork is considered to be loadbearing then the softer rubbing brick does not necessarily imply an unacceptable weakness. Converting the figures for the crushing strengths of red rubbers, in Table columns 3 and 4 in the chart, Mitchell & Mitchell, (1904, 327–28) the structure first cracked at a brick stress of 3.5 N/sq.mm then crushed at 6.6 N/sq.mm. From this you could say the controlling stress is 3 N/sq.mm. Column 4, where it states, 'red rubbers three in a column, bedded in putty', shows the weakest crushing strength as 2.4 N/sq.mm. This is pretty good. After all, timber has a good crushing strength and you can cut it with a knife! Thus the soft rubbing bricks with small joints of overtly weak lime putty:sand mortar can perform magnificent tasks in buildings. The evidence is not only out there in the buildings but can be easily numerically substantiated in the professional design standards.

Table 3 Crushing Strength of Bricks (UNWIN), Mitchell & Mitchell, 1904 (Single bricks. Faces made smooth and parallel by plaster of Paris).

Description	Dimensions	Cracked at tons per sq. ft.	Crushed at tons per sq. ft.	Colour	Remarks
London Stock max. London Stock min. London Stock mean	9′2×4′×2′8 8′8×4′0×2′5 9′0×4′2×2′6	– 84 –	185 89 121	– Yellow Error! –	Twelve from Different localities
Aylesford common	8′9×4′4×2′7	48	183	Pink	
Aylesford common	8′9×4′4×2′7	111	228	Pink	
Aylesford pressed	9′1×4′3×2′7	71	141	Red	Frog
Grantham wire-cut	9′2×4′2×3′2	–	83	Red	
Leicester wire-cut	8′9×4′5×3′2	228	246	Red	
Leicester wire-cut	9′1×4′2×2′8	115	229	Red	
Leicester wire-cut	4′4×4′2×2′7	225	365	Red	Mean of 7 half bricks
Gault wire-cut max.	8′9×4′3×3′0	119	198	White	
Gault wire-cut min.	8′7×4′1×2′7	89	145	White	
Gault wire-cut mean	8′8×4′2×2′8	–	178	White	
Arlesley white max.	9′1×4′2×2′9	–	207	White	
Arlesley white min.	8′8×4′1×2′7	50	107	White	
Arlesley white mean	8′9×4′2×2′7	–	161	White	
Arlesley white wire-cut	9′0×4′2×2′7	151	239	White	
Coventry wire-cut	4′5×4′4×3′0	–	256	Red	Half brick
Fletton	8′6×4′2×2′7	137	203	Pink	
Fletton	8′8×4′1×2′7	126	169	Pink	
Fletton	8′6×4′2×2′7	199	239	Pink	
Glazed brick wire-cut	8′8×4′4×3′3	69	166	White	Frog

Table 3 **Continued.**

Description	Dimensions	Cracked at tons per sq. ft.	Crushed at tons per sq. ft.	Colour	Remarks
Glazed brick wire-cut	8′9×4′4×2′9	166	174	White	Frog
Kentish stock max.	9′3×4′4×2′9	107	127	Yellow	
Kentish stock min.	9′1×4′3×2′8	30	54	Yellow	
Kentish stock mean	9′2×4′4×2′9	–	82	Yellow	
Staffordshire blue, Staffordshire blue max. Staffordshire blue min. Staffordshire blue mean	 9′0×4′5×3′2 8′9×4′1×2′7 9′0×4′2×2′9	 763 152 –	 807 296 564	 Blue Blue Blue	 Nineteen half bricks
Stourbridge max	9′0×4′3×2′8	161	242	Yellow	
Stourbridge min	8′8×4′3×2′8	157	209	Yellow	
Stourbridge mean	9′0×4′3×2′7	–	300	Yellow	
Red rubbers max.	10′1×4′9×3′4	–	93	Red	
Red rubbers min.	9′9×4′8×3′3	36	67	Red	
Red rubbers mean	10′0×4′9×3′4	–	77	Red	
Red rubbers three in column, bedded in putty	9′0×4′5×8′0	–	25	Red	

Victorian and Edwardian Bricklayers

The high level of building activity during the mid-eighteenth century had seen the complete disappearance of the craft guilds, and a rapid decline in the time-honoured hierarchy of master, journeyman, and apprentice. By the beginning of the Victorian period, master bricklayers were relatively rare in London. Big businesses sprang up regulating wages and conditions of work, changing building from a craft-oriented industry to one of general contracting, a contractor estimating for a whole job. This had early consequences in quality of craftsmanship for the embittered workers who had now lost control of their work, prices and traditions.

Despite hostility, the time-served craftsmen worked on the prestigious contracts or on the parts of a building requiring knowledge, experience and skill, but the rest of the trade was being flooded with cheap semi-skilled labour, content with lower rates than craftsmen bricklayers. The Statute of Apprentices

(1563) was not being enforced, indeed as stated earlier it was abolished in 1814, as it was seen by government and employers as outdated and not suited to the new market place. The prevailing spirit of 'laissez-faire' meant that the building industry was not investing in its future, with provision for apprenticeships, and although a seven-year apprenticeship was theoretically operational, it could in reality be as short as four or five years.

A correspondent in *The Builder* of 18th December 1847 (597) picked up this concern:

> On more than one occasion we have mourned over the decay of skill amongst our operative bricklayers…. Bricklayers are no longer animated by the right spirit; pride in their work they have none; anxiety to excel exists no longer.
>
> …The men themselves are scarcely to blame: they have not had fair play. There are few apparent inducements for good work or superior skill; rapidity and bad work are what their masters have desired, and the result is, that men capable of executing good work are with difficulty to be found…

The Tylers and Bricklayers Company managed to recoup many of the financial losses of the eighteenth century, and this money was used wisely to keep a close alliance with the craft it represented. Although its powers of search and craft supervision had long since lapsed, it concentrated much of its effort in supporting the building trade training schools. From the 1870s, to ensure a future supply of much-needed bricklayers skilled in the craft, the company gave a £25 premium to master bricklayers willing to take apprentices (Bell, 1938, 57). This sponsorship succeeded in salvaging many skills, badly needed for the next century that might otherwise have been lost.

In 1878 the City and Guilds of London Institute was established by the Corporation of the City of London (the 'City') and certain of the London Livery Companies (the 'Guilds') for the advancement of technical education. In the 1890s, by examinations of apprentice and journeymen, it was hoped to bring skilled recruits to bricklaying. The Tylers and Bricklayers Company, in a substantial grant to the City and Guilds, helped to support the project by giving £20 towards medals and prizes to encourage industrious study.

Despite these commendable efforts to raise craft standards and pride, there remained much concern about the true benefits to the bricklayer on site. This was particularly true for those needing to be highly skilled and educated in order to set out and produce the quality gauged work then being designed, yet have the craft protection the guilds once offered.

The emergence of newly legalised trade unions in the 1870s meant that overall conditions began improving for building craftsmen and some sense of craft pride returned. The Operative Society of Bricklayers was formed in Manchester in the early 1800s (Postgate, 1923), their aim being to align themselves to the best qualities of the old guilds, rooted in traditional crafting skills, sound technical knowledge, and pride. In 1863 the Society commissioned the Royal Academy artist A.J. Waudby to design a membership certificate (Bellamy, 1986) (Fig. 124). Study of this most attractive certificate allows one to see how the members wished to see their craft displayed and how an emphasis was placed on gauged work. It portrayed scenes of a 'cutter' at work in the cutting-shed and a bricklayer setting an arch.

Figure 124

The Operative Society of Bricklayers membership certificate by A.J. Waudby, 1863. (Reproduced by kind permission of Coalbrookdale Library, The Ironbridge Gorge Museum Trust)

That gauged brickwork was considered the supreme test of mastery within the craft is confirmed by Noble (1836, 28):

> At a former period, it used to be the pride of the bricklayer to produce a specimen of his skill, in the formation of a Roman Doric column and entablature, or some other elaborate form, in gauged brickwork: but it subsequently ceased to meet the eye of the architect, and gave place to rapid, coarse, and too often imperfect execution; result of new system of operative task work.

Demand for quality handcrafted brickwork, begun in the period of the Gothic Revival, was explored to new and exciting creative possibilities by the so-called Queen Anne Style, leading to a renaissance of the use of gauged brickwork. This was especially so in wealthy, vibrant, and hugely influential London.

Master bricklayers possessing skills and knowledge of gauged work provided the main route for the chosen apprentices to learn from inside the cutting shed and on site, but the Industrial revolution was also introducing new materials and associated techniques beyond the traditional knowledge of the masters. This resulted in a need for bricklayers to have broader skills and underpinning knowledge. By the third quarter of the nineteenth century, under the 1889 'Technical Instruction Act' it became possible for indentured apprentices to attend state-funded technical colleges. At first these apprenticeships were under the auspices of the Board of Education (Rivington, 1901, VII) and later the City and Guilds of London Institute (CGLI). In this environment the more able student could gain the theory, technology, and practical tuition to supplement site work, enabling him to study and produce gauged work to the most exacting of standards.

The duration of apprenticeships was generally accepted as four or five years but could still be as long as seven, being dependent on one's experience, especially if one came from a family of bricklayers; and of course the level to which one was to be taught. The boy's parents or guardians generally paid a fee, prior to indenturing, to the master, or more commonly by this period the company, to whom he was 'bound'. It is important to acknowledge that, as there had been in earlier periods, there were some women employed as bricklayers too, albeit as a very small percentage of the total number nationally. Nineteenth-century occupation tables of the census figures for great Britain give 107 women out of a total of 39,806 bricklayers, or 0.3%, in 1841, and by 1891 that figure had dropped to 0.2%, or 66 women out of a total of 130,446 bricklayers (Clarke and Wall, 2006, 40).

At these new colleges qualified lecturers were chosen for their craft skills, technical competence, wide experience, and ability to convey their subject in an erudite manner. Most were site men (some from the army's engineering corps), formerly employed as foremen bricklayers, general foremen, or clerks of work. Attracted to teaching by their love of the craft, lecturing now offered better conditions of service and workplace, status, and well-motivated and disciplined students; all characteristic of the prevailing social attitudes of late Victorian England.

An assessment of what was being taught to apprentice bricklayers about gauged work in the technical colleges of the late Victorian period, can be gleaned from the syllabus and examination questions of *The City and Guilds, Subject 57, Brickwork*. The following questions are taken from the Ordinary Grade (as opposed to the advanced Honours Grade) from 1897 to 1899 (Richards, 1901, 126–31):

1897 Arches – Names of the different kinds and mode of construction. Bond in arches, and description of their various parts, such as soffit, skewback etc

1897 Draw to a scale of 1″ [inch] to 1′ [foot] the elevation of a camber or straight arch, 14″ [inches] on the face and 9″ [inches] soffit, for a 3' [foot] opening.

1897 Brick – cutting (A) Setting out work in detail from architectural drawings, and obtaining the templets, moulds etc., e.g. arches moulded and plain, cornices, caps pediments, pilasters, aprons, and gauged work generally. (B) Cutting and finishing any required piece of gauged work from templets and moulds supplied.

1898 Draw to a scale of ⅛ [one eighth] half the elevation of a moulded segment arch for a 3′ [foot] opening. The moulding to be 2¼″ [inches], the face of arch 12″ [inches], the rise 3″ [inches], and the soffit 4½″ [inches]. Also show four top courses of the reveal and skewback in Flemish bond.

1898 Annexed (Fig. 218) is the plan of a 1½ brick wall in English bond, with a Gauged pilaster projecting from it. Draw the alternate courses to a scale of ⅛ [One eighth]

1899 Draw to a 1″ [inch] scale the elevation of an equilateral or Gothic arch, 12″ [inches] on face, for a 3′ [foot] opening, showing in the arch two ways of filling in [tympanum].

1899 To a scale of ¾″ [three quarters of an inch] to 1′ [foot] draw the elevation of a plain [un-moulded] segmental arch, 14″ [inches] on the face, for a 2′ [foot] opening. The rise to be 12″ [inches].

Finally, from *The City and Guilds, Subject 57 – Brickwork 'Honours Grade'* (Richards, 1901, 132):

1900 To a 1-in [inch] scale and for a 3-ft. 6 in opening, draw the elevation of a gauged arch 14 ins [inches] on the face, with a projecting and

> moulded key. The arch is to have a 15 in [inch] rise, but to spring from a level bed similar to a semi, and the soffit and reveals are to have a 2¼ in [inch] moulding.

To support lecturers and apprentices there were several books on brickwork featuring small sections, or chapters, on 'gauge work', as it was often being referred to through to the 1880s, such as Hammond (1875 and 1889) and Walker (1885). Many were written by lecturers intending them to also be also of assistance to site bricklayers.

In the shires, traditional craft apprenticeships continued to be highly prized and viewed as the best possible avenue to learning, though there were no colleges to support this. H.W. Masons, General Builders, Undertakers and Monumental Masons, of Newport Pagnell (Buckinghamshire) have retained their Silver Street premises since 1764. The master bricklayer, Henry William Mason (1873–1952), grandfather of the present owner and craftsman bricklayer Mr Roy Mason, followed a long-established custom of being apprenticed at 14-years old to a master at another family company. In this instance, it was the highly respected firm Marriott's of Rushden (Northamptonshire), who worked not only locally but also in the capital. At Marriott's, he was introduced to the cutting-shed and gauged work. Upon qualifying as a journeyman in 1893, he was put to work in London to gain additional knowledge and experience of high-level craft skills such as gauged work. This enhanced the quality of building work that Henry Masons and Sons could then offer their clients once he eventually returned to the family business. Amongst the city craftsmen he was recognised as a very knowledgeable and talented bricklayer and on 21st October 1893, he was admitted to the Operative Bricklayers Society's (OBS) Harrow Road branch. His membership certificate, number 21382, survives today in the ownership of his grandson (H Mason, 2003).

Changes in the Cutting-Shed

Early Victorian cutting-sheds were still erected on site, but as these became more congested, particularly in the city, they were increasingly kept in the builders' own yards. The finished cutter's work would be dry-assembled in numbered order and carefully packed into protected casing for delivery for on-site assembly. When the fashion for enriched gauged work returned in the second half of the nineteenth century many craftsmen remained solely in the workshop to cope with this demand, so becoming experts at producing all forms of enrichments. In the small towns and rural areas, however, the bricklayer would continue to set his own cut work. The tools and techniques of the cutter (the term 'hewer' by then being rarely used) were still those of the Georgian period.

The tools and implements used for making gauged arches, only a decade before the accession of Queen Victoria in 1837, are detailed by Pasley (1826, 240–41) as:

> 1. A banker or bench, on which the bricklayers prepare their bricks.
>
> 2. A camberslip or ruler, curved in the proportion of about 1 inch in 6 feet. This marks the moderate curvature usually given to the intrados of flat arches over doors and windows…
>
> 3. A large board, for which an old door is frequently used.
>
> 4. A lath is used for describing semicircular or segment arches, with a nail driven through one end for the centre, and a pencil at the other end of it.
>
> 5th. The instrument called a trammel for describing elliptical arches.
>
> 6th. A mould. A piece of wood 15 or 16 inches long, cut on each side to correspond with the radiating joints of the proposed arch…
>
> 7th. A pair of steel compasses.
>
> 8th. Rules, such as by carpenters are termed straight edges.
>
> 9th. A small square with a brass blade.
>
> 10th. A small level [this should be bevel?] with a brass blade for marking bricks that are to be cut obliquely, which is also necessary for the joints of groined arches…
>
> 11th. Templets, which are rectangular pieces for the purpose of marking the lengths of the several arched bricks. A long templet is used for marking those bricks which appear as stretchers; and a shorter one for marking those which appear as headers, in the face of the arch.
>
> 12th. A small tin saw with a wooden back and handle, …to commence the cutting of a brick, in order to prevent it from splintering.
>
> 13th. A brick axe to complete the cutting begun by the saw. It has an edge at each end, like a very large chisel, with a round stem in the centre for grasping it. It is used by striking down over:
>
> 14th. A chopping block.
>
> 15th. A rub stone, to give the bricks a smooth surface, after being axed. This is a thin round stone fixed on the banker.
>
> 16th. A float stone. This is a stone convex on one end, to rub bricks to a concave form when necessary, as in niches, &c.

In so many respects these tools had changed little from the time of Moxon, Neve and later Nicholson. It is likely that the slow pace of development in gauged work was not just conservative practice in the cutting-shed, but due to its fall from fashion in the late eighteenth and early nineteenth century as Pasley (1826, 221–2) indicates:

> Formerly it was customary to have ornamental fronts of brickwork, which were prepared by cutting and rubbing the bricks, and when it was the fashion to build with red bricks, the ornamental parts were usually of a deeper red than the rest of the wall, and the bricks selected for this purpose bore a higher price, and were termed red rubbers.
>
> In this manner, brick pilasters, with friezes, &c., were made, and it was also customary to rusticate brick piers, or the coins of buildings.… In the present day, the practice of using brick ornaments of this description is almost obsolete, …

The large brick axe still remained the main cutting tool and studying Pasley's description (point 13) it is evidently the large axe detailed in Chapter 4. Study of the membership certificate of the Operative Society of Bricklayers for 1863 and their emblem of 1869, both by A.J. Waudby, one sees the brick axe represented several times.

In the 1863 certificate it can be seen on the coat of arms held above the shield and amongst a collection of the bricklayer's tools at the bottom. It is to be seen in the depiction of the cutting-shed, incorrectly spelt Guage [gauge] Work, where it leans against the chopping block where the cutter works a brick (Fig. 125). In the later 1869 depiction of the cutting-shed two craftsmen are shown at work cutting Gothic arches, one at the rubbing stone and the other at the chopping block. In all of these pictures one can truly assess the size of the large brick axe in contrast, not only to the other tools, but also to these craftsmen (Fig. 126). This size is further emphasised within the drawing of the coat of arms in the 1869 certificate in which it can be clearly seen held aloft in the hand.

During the late eighteenth and early nineteenth century another of the dramatic changes, as a result of the Industrial revolution and growth of mechanisation, was the emergence of specialist tool factories gradually replacing individual handcrafted tools forged by the builder's own blacksmiths. Toolmakers from Birmingham and Sheffield began to make and advertise high-quality craft tools in their pattern books, such as in the plate from that of R. Timmins and Sons of Birmingham, engraved *c.*1820 showing an itemised plate with the large brick axe for sale (Fig. 127). This 'Brick Axe' being sold at 8 pence per LB; weight being an important factor in its downward impulsion and clean cleaving of rubbing bricks without undue effort, as described earlier.

The Waudby depictions of a cutting-shed are of singular interest as they provide a rare glimpse into this normally secretive workplace. Also one can see

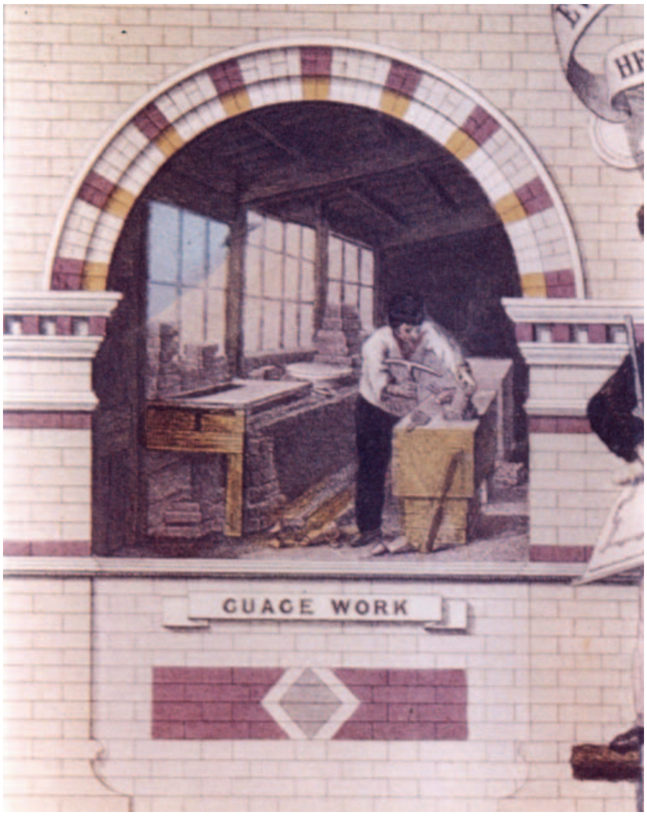


Figure 125

Large brick axe lies against the chopping block in A.J. Waudby's 1863 depiction of a craftsman in a cutting shed preparing gauged work. (Reproduced by kind permission of Coalbrookdale Library, The Ironbridge Gorge Museum Trust)

Figure 126

Depiction of a cutting-shed, where two cutters are preparing the voussoirs for gauged arches, the large brick axe again lays against the chopping block and is also held aloft in the coat of arms, by A.J. Waudby 1869. (Courtesy: The People's History Museum, Manchester)

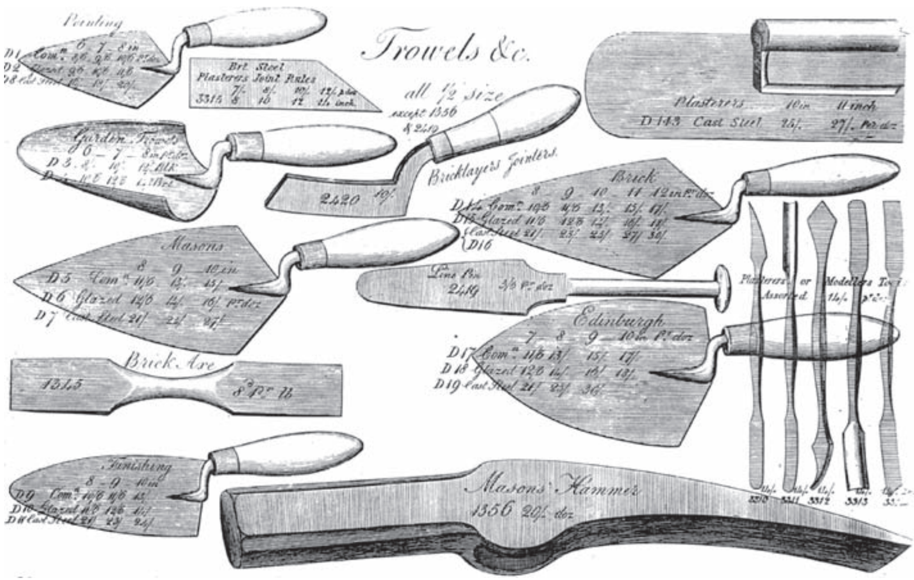


Figure 127

R. Timmins and Sons of Birmingham, engraved *c.*1820, showing an itemised plate of Mason's and Bricklayers tools; with the large brick axe. (Courtesy of Richard Filmer)

the then common arrangement of cutting at a chopping block, away from the banker upon which rests the rubbing stone and bedding slate.

The chopping blocks depicted are sturdy – not unlike a butcher's block – unable to move or vibrate. Waste from brick cutting is shown at the cutter's feet, both from the brick axe and the club hammer and bolster; seen in the pictures. The cutter is using a wooden hafted tool, most likely a later form of scotch, as discussed below, to chip the brick to shape, as it is securely hand-held in a suitably shaped wooden seating or 'cutting block'.

The cutting block would be made of a hardwood, such as elm, to be robust enough to endure the long-term abuse it would be subject to. In design it could be an arrangement of two blocks, screwed to a base and fixed to support a brick in an angular position. Alternatively, it could be a solid timber block cut to an angle of between 45–60° to the vertical, to create a 90° seating to the incline. Both allowed the brick to rest securely whilst being worked. They could also be in two sizes, a smaller one for holding the brick lengthways, or a larger version to hold the brick on end. This piece of equipment facilitated greater precision, as it prevented the brick moving as cutting blows were struck and thus prevented disfiguring chipping and rounding of the all-important sharp arrises. This invariably occurs if bricks move during cutting and shaping due to the abrasive action of the small particles of resultant waste that collect and get under it.

Waudby's certificates and emblem paintings are also important as time capsules, for they show a brick axe in the cutting-shed at a time when it was beginning to fall from popular use. This point is emphasised in the answer to the question from a Mr Clarry, 'What is a Brick-Axe?'

The Builder of 26th June 1880 responded (1880, 808):

> Sir, – if 'Clarry' had put that question to a bricklayer thirty years ago he would have smiled at his ignorance. Well, sir, a brick-axe is, or was, an iron tool, like the ends of two crow-bars joined, flat at each end, and round at the centre, for the hand to hold it, with about 4 in. of steel at each end, and its length was about 2 ft.6 in long, according to fancy or a man's ability to use it. The axe was made to cut gauged brickwork after the bricks had been marked to the mould, as described by John Philips in some of your former numbers, some years back, and excellent letters they are, and well worth a bricklayer's time to read them. The brick-axe is not used now*, as an iron or steel cutter is used to cut the bricks, it being struck with the club-hammer. This gives much less trouble. It required some practice to use the brick-axe with skill, and it was much harder work.
>
> George Brown, Bricklayer.
>
> *We saw it in use not long ago in Islington. – ED.

Regrettably, despite an exhaustive search by the RIBA library on the author's behalf, back through all the volumes of *The Builder* from 1880 though numerous letters by John Phillips were found regarding other subjects, letters that related to the use of the brick axe were not located.

The iron or steel cutter struck with the club [lump] hammer, referred to in Mr Brown's letter was the bolster or boaster. Any craft tool and the established practice of its use rarely fall completely from use inside 30 years. Older craftsmen tend to stick to familiar tools, equipment, and craft techniques that have served them well down the years, and resist change. Thus the Editor in his footnote, and Waudby in his drawings, are correct in what they saw.

As Richard Filmer (2007) relates:

> The tool is not a common entry in tool catalogues, e.g. in the W. and C. Wynn of Birmingham, catalogue, of 1820, show no less than six patterns of brick hammers, ranging from 14s.0d. (70pence), to 27s.0d. (£1.35p.), per dozen, but no sign of the brick axe whatsoever.

Certainly by the 1870s Sheffield tool catalogues were neither displaying nor selling the large brick axes, only advertising the smaller versions for use as 'brick cleaners'. The emphasis had moved to the brick hammer, with its adze-like blade as mentioned by Nicholson in 1823, or the 'scotch' (or 'scutch') to finely cut, dress and finish the brick true to the desired shape, particularly if it was to be cut-moulded.

The brick hammer was certainly well established by the end of the eighteenth century, while the scotch became particularly popular from the mid-nineteenth century. Both of these hafted tools replaced the smaller brick axe for fine trimming to shape, as the axe required greater skill and experience to use with accuracy. The introduction of high-quality mass-produced masonry cutting tools with steel blades, like the brick hammer and scotch, were not only easier to use but would not have needed sharpening so often and have been capable of cutting and shaping some of the harder bricks appearing with mechanised brickmaking.

The scotch consisted of three distinct parts: stock, blade and wedge and could be bought already assembled as a mason's cutting tool. Alternatively one could just buy the handles or replacement blades, which were typically sized at 12 × 1¼ ins (305 mm × 32 mm); though frequently old files were re-worked into scotch blades because of the suitability of their superior steel. A hardwood wedge secured these (Fig. 128). The origin of the term 'Scotch' is obscure, although it is known to be of late medieval origin and means, 'to make an incision, cut, score or gash'. To 'scutch' is to strike, whip or slash.

The scotch is similar to a 'millers bill' or, more correctly, the 'mill-bill and thrift'. According to Richard Filmer (2006):

> 'In the re-issued Elwell catalogue, probably originally produced in about 1870, shows what we would now call scotch handles, which were then catalogued as mill bill handles …'

The mill-bill is an edge tool of high-carbon steel, pointed at each end and wedged into the handle or 'thrift' (being removable like the carpenter's iron in a plane) and held secure by a leather tongue; rather than the timber wedge of the scotch. The bille and thrift is used for dressing and cutting the furrows in millstones. Richard Filmer and Kenneth Major of TATHS have stated (2001):

> …the brick scutch was also used by mill-dressers for 'stitching'. This is the process of producing grooves – often twelve to sixteen to the inch [25 mm], – rather like a file, on the 'lands' between furrows. Obviously this was a better tool to use for this particularly fine work, and was also presumably rather easier to sharpen than the mill-bill. The metal, of course, was subject to a very severe hardening process.

Stonemason carver, Piers Conway, who noted the similarity, has also commented on this fact (2002):

> I watched a programme on the restoration of a mill in which a chap was re-cutting the old millstone, (a trade in itself), and he was using a traditional dressing axe

Figure 128

Bricklayer's Scotch resting against a cutting block.

> called a 'Thrift' with inter-changeable mill-bills and picks. This implement was very similar to your [Gerard Lynch] Victorian 'scotch' and may well be the missing link from old stone working traditions from the earlier brick axe.

The influence from stonemasonry once again appears, albeit in an obscure manner, in the bricklayer's cutting-shed. Study of the type of cutting tool being used by the cutter in the Waudby plates is almost certainly a later style of scotch hammer, with a fixed double-edge blade fixed to an ash handle, and more commonly termed a 'Scutch'. This style was still to be seen in the *d.*1938 Marples catalogue, displayed under the 'Shamrock Brand' of 'Mason's Tools' as a 'Double-Edge Scutch Hammer, 14 inch [355 mm] Head'. It is shown alongside the traditional scotch, though by then even this tool was also being termed a scutch too.

The changes that were taking place in the cutting-shed of the second half of the nineteenth century reflected standards being set for brick enrichments by architects following the Gothic and Queen Anne revival styles, keen to emulate the high levels of past masonry craftsmanship.

Study of contemporary cut brick arches reveals there were two accepted classifications – 'axed' or 'gauged'. The term 'axed' (from the use of the brick axe), retained even when the hammer and bolster along with the scotch or scutch were substituted, is still used today. Hammond (1875, 24–5) details these two classes, defining 'axed' arches by the standard of the late Victorian period:

> These are used very much in the present day, on account of their taking less labour, as it is thought. But it is an inferior sort of work at the best, and often costs as much as gauge-work by the time it is finished.
>
> The bricks of these are simply axed down to a given size, and nothing but the soffits are rubbed; and this is done after they are brought to the required bevel with the hammer boaster and scotch; they are then set in cement, with a joint about three-sixteenths of an inch in thickness, and afterwards pointed.

One can determine that, despite being then set with narrow joints of only three-sixteenths of an inch (5 mm) in thickness, it is considered inferior to gauged work. The use of a cement mortar for such work was not uncommon on some of the big city sites, especially from the 1860s, but it was not remotely approaching the high strength of its modern ordinary Portland cement (OPC) counterpart (P. Livesey, 2003):

> The 'Portland cement' of 1850 was a different animal to that of 1900, which in turn was totally different to that of today.

Hammond's pointed finish for a contemporary axed arch would have been 'tuck pointing', as discussed earlier; but always using thinner ribbons than that normal for surrounding standard facework. This was important for creating the illusion of the gauged arch it was intended to replace and imitate.

Hammond (1875, 25–26) defines contemporary gauged work and its preparation as:

> …all kinds of work that is cut and brought down to a given gauge upon the rubbing-stone; such as all kinds of arches, mouldings for external cornices, architraves to doorways and windows, eaves, &c., and is considered the most important branch of the trade.
>
> For this purpose a shed should be built to protect the bricks that are to be cut from the wet, and also large enough for the workmen to erect their benches and chopping-blocks to suit their own convenience. They then require the rubbing stone and a bedding-block. The former ought to be in the form of a circle, and not exceeding 14 inches in diameter; for if it is, it will be very likely to rub out of level on the face, that is either hollow or cambering; and even with this size it will

> be found necessary to turn it round in its bed about once a day when in use, for if the stone is un-level the bricks will assuredly be the same, making very bad work.
>
> The bedding-block is square and of a perfectly smooth surface. It is used for the purpose of scribing and fitting the bricks to the moulds, and is usually made to the size of one course of the arch, if double-faced; if not, about 14 by 18 inches.

The importance of keeping the rubbing bricks dry is correctly emphasised, as they will neither rub-up on the stone nor cut with ease if they are damp. Also Hammond's overall description ties in well with Waudby's depiction of a cutting-shed. The bench (banker) and chopping-blocks, which Hammond describes, are shown, as are the rubbing stone and bedding-block (slate) on the banker. The cautionary note to check that the rubbing stone does not rub hollow illustrates the huge volume of work being undertaken at that time. The favoured source for rubbing stones during this period being the 'Park Spring' quarry in Yorkshire, near Leeds (Richards, 1901, 45). The 'bedding-block' is yet another craft term for the 'bedding stone', or 'bedding slate', which is a straight piece of marble of sufficient size for checking the flatness of the bed of the 'squared' rubber and permit it to be scribed accurately to the templet that is placed against it.

'Squaring', as briefly discussed earlier in Chapter 3, is the craft term for bringing the bed, stretcher face and sometimes a header face of a rubbing brick square to one another in that order on the large rubbing stone. Initially the bed face with a slight hollow is placed down on the stone, as this is easier to rub flat. The brick, held at either end, is rubbed in a circular motion finishing by rubbing away from the craftsman as the brick is lifted to periodically check the bed with the blade of the try-square until it is flat along and across its entire surface. A stretcher face is then selected and rubbed on the stone with the bed facing away from the craftsman. The two faces are then checked for square to one another with the try-square, placing the stock against the prepared bed; similar to the preparation of timber by a joiner. Any inaccuracy is determined by light under the blade of the try-square as it is drawn along the stretcher face towards the craftsman, identified and it is then re-rubbed and checked until the try-square is in perfect contact with both faces. If a header face has to be squared, the same process is repeated until the try-square rests perfectly from both the bed and stretcher faces to the header. The brick is now 'squared' and ready to be scribed and cut to shape.

Regrettably, Hammond does not describe the tools employed for cutting the gauged work. He does, however, provide a valuable clue as to how the bricks were being prepared for gauged mouldings (1875, 42–43):

> In many places this is done by simply making a template the form of the brick required, and marking the brick, first on one side and then on the other, and

> so cutting or rubbing it down to these marks. But for moulding birds' mouths, splay, bulls' noses, and, in fact, almost any kind of work, it will be found much better if a box is made that will hold three or four bricks, either flat or on edge, as they may be required, taking care that the ends are both alike, and the exact shape of the brick required. If this method be properly worked it will be found very accurate, and done with a great deal less labour. The boxes for this purpose are usually covered with tin or sheet-iron to protect the wood from wearing away while working the bricks; if not, the moulds are very apt to get out of their proper shape and so lead the workman wrong.…

In this passage Hammond describes the use of boxes termed 'cutting' or 'moulding' boxes, shaped to profile so that the 'squared' rubbers can be placed in and worked to shape; as opposed to using a single templet. There can be little doubt that shaped moulding boxes had been in use for a very long time in the better cutting-sheds pre-dating the introduction of the bow saw. Through careful study of Waudby's depiction of gauged work a large selection of profiled cutting, or moulding, boxes can be seen on and under the banker, and upon the window cill of the cutting-shed.

Given the tools that Waudby's cutter is employing, however, the boxes would be used only to scribe the desired profiles on the squared bricks. Then, after their removal and 'axing' or 'scotching' to size and shape, they would be replaced to their original positions within the moulding box for precise finishing by abrading. Working between the opposing profiled sides, using various large files, rasps, and other abrasives, would control this, hence why Hammond states the edges of the box are covered with tin, or sheet-iron, to stop wear while working the bricks, thus preventing distortion of the finished bricks.

Practice proves that it is not possible, nor indeed practicable, to use a brick axe or scotch to cut rubbers to shape whilst positioned within a cutting, or moulding, box, as the arrangement does not facilitate this. The two profiled ends are unable to control the cutting tools, essential with the cutting-box method, and the debris created quickly clogs the box. With these cutting-tools the boxes can only be used for both scribing the rubbers and assisting final finishing, as described above. This advanced greater accuracy of both scribing the prepared, or 'squared' rubbing brick to the desired shape, over the earlier method of working to a free templet placed alongside the brick, both resting on the bedding slate; as well as accurate finishing between the profiled sides of the moulding box. This was and remains similar to a technique used by craftsmen cutting and rubbing gauged work in Flanders, as discussed earlier.

In order to use the cutting or moulding box correctly, therefore, demands a tool that can be used across the full width of the box along the opposing profiles, reducing the rubbers to almost perfect size and shape in one pass.

The answer is provided in a description of the practicalities of cutting gauged-work by Walker (1885, 83–84):

> [Figure 129] …shows the kind of box that is used for cutting moulded bricks to any required section – in this case an ogee. The box is generally made to hold two headers or one stretcher. The brick or bricks, having been squared and rubbed down to the required thickness, are placed in this box and with the bow-saw roughly cut out, and then rubbed down to the section of the box with a rasp, and sometimes a piece of straight gas-pipe to form the hollow members, the bricks being very soft. … The cross piece or pieces on the top of the box are omitted for the sake of clearness.

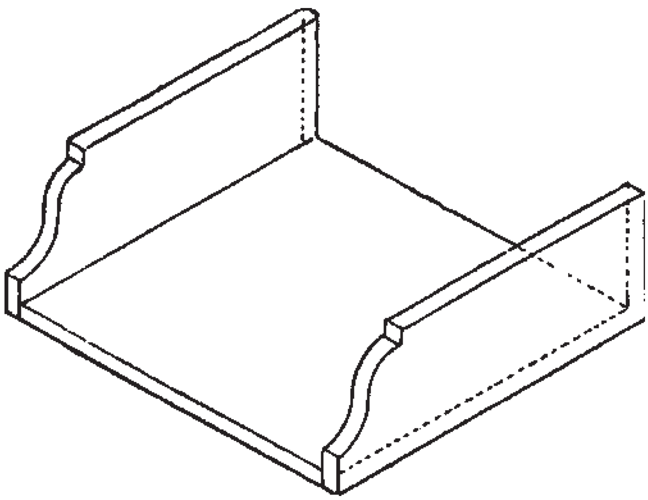


Figure 129

Drawing of a timber cutting box for an Ogee moulding.

Walker's terminology indicates the bow saw, generally then a craftsman-made tool, was, by then, a familiar tool in the cutting-shed. The 'cross piece', generally termed the 'bridge', spreads the pressure of the vertical strut clamping down the rubbers within the box, wedged between it and an overhead beam above the bench. The bow-saw technique made cutting easier, especially with the washed rubbers by then readily available, increasing accuracy and facilitated precise finishing. It also largely removed the need for reverse templets to check and finish; except for internal curved mouldings and stopped returns that cannot be cut in a box, but only by the older techniques of hand-cutting and abrading.

Hammond, in his above description, simply assumes the reader knows the wire-bladed bow saw is the tool used for cutting, and indeed later he states (1889, 21):

> It is the practice now to do everything possible in a good red brick cutting with the bow-saw…

He also discusses the dramatic effect of the bow saw within the cutting-shed:

> There is nothing connected with cutting that has caused a greater revolution during the last few years than the bow-saw. Whether for boxing mouldings of any description, reducing bricks for ashlar or arches, cutting scrolls, and every kind of work, the bow-saw is the most convenient invention. In fact the cost of labour connected with gauged work has been reduced vastly by its use, and a short description may be found useful here for those who have not been in the habit of using it.... The upright sides should be about 16in. long, and 1½ by ⅞ in. in section, and the crosspiece a, [Figure 130], about 2 feet in length, the same thickness as the upright sides. This is morticed loosely into the latter, and held in its place by means of a screw, but not tightly. This completes the woodwork....

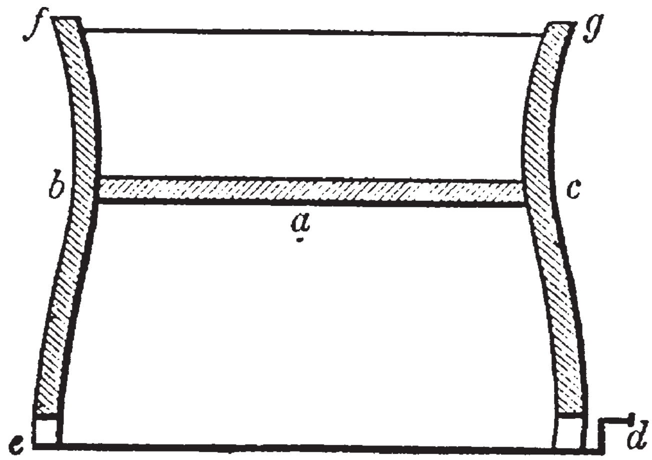


Figure 130

Drawing of a bow saw with a winch to twist the wire blade.

Hammond (1875, 43) mentions three or four bricks being placed in the box for cutting, which is revealing. The historic rubbing bricks would have to be soft and easily cut, otherwise one cannot cut that many in a cutting box together with the bow saw. When cutting along a box, the blade naturally rides up higher inside the brick the further it is away from the controlling sides of the box where the cutter's hand pressure is at its strongest. Indeed with modern, harder, rubbers one is limited to a box holding only two bricks, and sometimes only one. To overcome this the cutter is forced to ease off the pressure occasionally, allowing the blade into the central section of the bricks to catch up with the depth of the sides. This was not so common with the older types of traditional rubbers, such as the original TLBs, which the author's years of practical experience confirm, cut more easily and quickly.

The bow-saw blade for cutting rubbers in a cutting box was steel wire, looped and twisted so its entire surface area became plaited, and thus serrated, providing a 360° cutting edge. This was a development of the small bow with a single wire used for cutting away surplus clay off the top of the box by some brickmakers during moulding. Historically wire could be made by two methods (Trew, 2006, 1–7). From ancient times till 400 AD the 'slit and hammer' method, cutting narrow strips from thin sheet metal was employed. Towards the end of the last period to 1100 AD metallurgy and the drawing of wire through die plates of various materials developed, but quality and quantity of wire made little progress. With the invention of steam engines in the eighteenth century the process of drawing was mechanised and made easier, utilising rollers to both pull and smooth the wire, making it more consistent in quality. Despite this progress, it was still expensive to produce and the quality of the metal was inferior so that wire breakage was a continual problem. The first breakthrough came in 1856 with Henry Bessemer's development of the converter which, with further improvements ultimately led to high-quality steel during the 1860s. The next breakthrough involved the mass extrusion, or drawing, of wire, as Delbert Trew (2006, 5) in his article 'The Making of Wire' states:

> Steel history states the Washburn & Moen Manufacturing Company is responsible for many innovations in the manufacture of wire. By 1870, the company had developed a continuous wire rod mill allowing for unlimited production of wire and had begun development of automatic reels needed to speed up production.

This could facilitate the quality and quantity of relatively cheap wire, sold in rolls, that could supply the lengths required on a daily basis for a busy cutting-shed, which is why we only begin to read of the wire-bladed bow-saw method after this time.

The size of wire these brick cutters preferred, according to Richards (1901, 45) was No. 18 gauge, this size, in England, being the B.W.G. designation, which meant Birmingham Wire Gauge and which was later superceded by Standard Wire Gauge or S.W.G. A drawing of a bricklayer's bow saw, but then termed a 'frame saw', is described and illustrated by Audel in Volume 1 of his North American craft book, 'Audels Masons and Builders Guide' (1924, 101–2):

> The saw consists of a frame holding the blade which is of twisted soft steel or malleable iron wire (No. 16 B. w. g.).

Making a Twisted Wire Blade

The method of twisting wires varied, as would the wire diameter, 21 mig (metal inert gas) welding wire gauge being favoured by the author, as a thinner wire gives a finer cut. Some craftsmen cut two separate lengths of wire (typically the length of the bow saw plus about 200 mm) and tie them off at either end.

Alternatively (and more commonly) one simply loops a similar double length of wire and then, bringing the ends together, tie them. The wire is now ready to be twisted to form a blade.

To twist the wire, to form the serrated blade, there were again several methods. The first involves tying one end of the wire to the handle of a galvanised pail and hooking the looped end over a nail in a crossbeam in the cutting-shed roof. One then spins the pail until the wire is twisted sufficiently. Hammond (1889, 92–3) describes another method of twisting the wire:

> Take a piece of wire, say 40 feet, double it, and hook one end into a hook or nail, and pull the doubled wire out straight; pass the other end through a piece of gas barrel and fasten it round a piece of wood (about ¾-inch diameter) in the middle. Then, holding the piece of gas barrel with the left hand, and keeping the wire straight, turn the wood round until the wire is sufficiently twisted. It can then be coiled up ready for use.

A variation on this uses a carpenter's brace into which a hook is located to receive one end of the wire. The other end of the wire is looped around a bent nail, or hook, fixed to a vertical post and the brace wound until the wire has the number of serration's required per inch or mm length of wire. This twisting technique would not have been unknown, as it was a traditional country practice used to make hay or straw ropes (see Fig. 131).

Figure 131
Making a twisted wire blade using a carpenter's brace.

Some craftsmen would prefer to create one long length of wire, as described by Hammond, from which they would cut to length to fix on the bow saw, whilst others would prepare a large number of short lengths of twisted wire blades ready to fit the saw. Irrespective of this, the manner in which one twists the blade will determine the number of complete twists, or serration's, per given length of wire that permits the blade to cut more easily and with fewer passes through the brick. This, in turn, means that cutting is less stressful on the wire which because it thins through repeated abrasion at the centre of the blade length, breaks less often. The hardness of the rubber, occasional inclusions within it and even the manner of how the cutter uses the bow saw, all play a role in how long a blade will last. To gain a well-twisted wire it is important to keep the brace pulled tightly to strain the wire during twisting. One must always conclude this twisting action by turning the brace backwards several revolutions so that the tension created in the wire is released, otherwise the blade will spring dangerously; and this would be even more acute on a long length of wire.

Hammond (1889, 91–3) provides variations on making blades and types of bow saws used (see Fig. 130 on page 280):

> …Some prefer to have the wire twisted before it is fixed to the frame; others to fix it in the frame and twist it there.
>
> If the latter way is adopted there must be a small winch attached to the bottom of the frame at d., and a small shaft running through the latter, with a hook to receive the wire. This wire is then fastened to a nail or screw at e, brought under that end, and fastened to the hook of the shaft running through the end d. Then if a plain piece of 3⁄16 wire is made to run through the top f g, and fastened with a nut or thumbscrew, the winch can be turned and the wire twisted and tightened at pleasure.
>
> If the wire is twisted before it is fixed in the frame, the tightening is done by a piece of strong string and windlass (such as carpenters tighten their bow-saws with), or by means of two small rods of iron, each running half-way across from f to g, with a thread worked on them in the centre where they meet and so loosened or tightened by means of a 'union;' and this method, if properly constructed, is not to be despised…

Tensioning the Twisted Wire Blade in the Bow Saw and Cutting Bricks

With the wire twisted to suit the cutting required it was then only left to attach it to the bow saw and to tension it sufficiently to enable it to perform as a blade. This basically involved drawing the tops of the two handles inwards so their ends, to which the blade is attached, move further apart thus tensioning the blade. There were three main methods employed do this. The first involved a simple twisted cord that is looped around the tops of the opposing handles, which is then tensioned with a wooden 'toggle' that is placed and turned between the two lengths of cord at the centre of the saw. Once sufficiently tensioned the toggle is slid downwards so that it is prevented from un-winding by the centre bar of the saw. The final two methods involve threaded steel rod placed across the saw and through the tops opposing handles. The first and most simple method had a nut and washer fixed at one end with a washer and wing nut at the other, which was turned along the threaded bar to tension. The final method utilised two lengths of threaded steel bar that were fixed at the top of the handles, but deliberately left short of uniting at the centre. There these ends were threaded into a metal 'turnbuckle'. To tension the blade the turnbuckle was rotated which caused the two threaded bars to draw inwards along with the tops of the two handles. When a blade snapped and needed replacing, then the bow saw had to be released from tension and wound tight again once the new blade was fixed. Overnight the bow saw was always 'slackened-off'.

Figure 132
Author using a wire-bladed bow saw to cut a moulded detail.

With two bricks rubbed on bed and stretcher face square to one another and scribed to the templet, they would then be placed with their rubbed beds to the baseboard and scribed faces to the sides of the cutting box on the bench; and wedged ready for cutting. A small batten called a 'bridge' would then be rested centrally on top of the bricks to spread the pressure of a timber strut, cut to length and pinned from the roof or ceiling of the cutting-shed onto the bridge. Some cutters liked to work with the cutting box placed sideways to them and use the bow saw from left to right or vice-versa (Fig. 132). Others preferred to position the cutting box so that the cutting box faced them and work the bow saw towards them. Whichever, it was important the cutter used the saw so that he did not force the twisted wire blade down over the protective metal-edged tops of the cutting boxes as this would quickly wear both. Once the brick was cut through the top surface of the cut brick would be carefully rubbed smooth and flat to the tops of the cutting box, with a large flat file or length of batten; being careful to prevent 'ragging' the arrises, or edges, of the bricks.

Lloyd (1925, 73) also states:

> Recently the hack-saw…. has superseded the tin saw for making incisions, and has displaced the scutch for some brick-cutting. It is also used for cutting soft bricks.

Although a hacksaw could substitute a 'grub saw' it is no match for the wire blade because it keeps its direction better when cutting through the brick than a blade, which tends to twist during the sawing action and therefore does not give such a precise cut. A hacksaw blade, if utilised, is limited in use to only straight cuttings, lacking flexibility to follow intricate mouldings.

It is obvious for all accurate cutting of bricks to shape for enrichments there was a need for precise measurements for lengths, widths and gauge, hence the mention of various instruments for measuring in Pasley's above list of tools and equipment. The cutter would obtain these specific measurements from the full-size drawing, double check them individually against the overall element and from them make accurate, labelled timber 'controlling rods' which could then be utilised as necessary to set down all of these sizes prior to cutting and abrading. This way there was no need to keep reaching for the ruler. Mouldings were traced from the full-size drawing onto paper and were then usually given to a joiner to make the various templets and associated cutting boxes.

The last quarter of the Victorian period saw all the basic essentials of improved rubbers, layout of cutting-shed, alternative craft tools and the rubbing and cutting techniques, for producing gauged work, firmly established and lasting up to the present. For these reasons many modern commentators mistakenly cite the bow-saw method as the only way to execute gauged work, based on contemporary craft books. This includes the description of gauged work by Richards (1901, 45–6):

> GAUGED work consists in rubbing and cutting to any required shape specially made bricks, or 'rubbers,' as they are technically termed. This class of work is usually done in what is called a cutting shed, provided with a bench about 2′3″ [675 mm] high and 2′6″ [750 mm] wide.
>
> The tools and appliances required are a rubbing stone (Park Spring, for preference), circular in shape, and 14″ [353 mm] diameter; a bow saw fitted with twisted annealed wire No. 18 gauge, parallel file 16″ [454 mm] long, small tin scribing saw, square, bevel, straight pieces of gas barrel for hollows in mouldings, etc., bedding slate to try the work for accuracy, straight-edges, compass, setting trowel, putty box, boaster, club hammer, and scotch (the three latter for axed work), reducing boxes for thickness and for length, moulding boxes, boxes with radial sides for obtaining the wedge-shape voussoir according to the template…

Long gone from this description is any reference to the use of the brick axe and a separate chopping block. Richards (1901, 49) describes in his contemporary definition of 'axed work':

> Axed Arches – Axed arches are really roughly cut gauged arches with a 3⁄16″ [4 mm] mortar, instead of a 1⁄32″ [0.8 mm] putty joint. Therefore the mode of obtaining the template and the system adopted for gauged aches generally, applies equally well to axed ones: the only difference being that when the bricks are hard, the brick will have to be scribed each side to the template and across the soffit with a tin scribing saw, and cut off to the scribed lines with a boaster (sometimes called bolster) and club hammer upon the banker, and the remaining material between the scribed and boastered lines neatly axed off with a scotch (sometimes term scutch).

One must also remember that not all bricks used for gauged arches were as soft or cut as easy as rubbers, so the cutting box and wire-bladed bow-saw method would not always be appropriate for them. Malm cutters and Suffolk clippers sometimes responded better to fine 'axing' and abrading to achieve the required precision; though, by the end of this period, their popularity was waning against the fashion for orange/red-coloured rubbing bricks. The plate of an Edwardian bricklayer's tools given by Mitchell and Mitchell (1906, 86) (Fig. 133) shows the scutch, chopping block, wire bow saw, and moulding box, or 'brick mould' as it is termed in the plate, that allowed for the cutting of both rubbers and cutters.

Certain brick companies, such as Johnson and Lawrence, produced their rubbers to larger sizes, as discussed earlier, which made them better suited for the cutting box and wire-bladed saw method. Oversizing had sometimes been resorted to historically for certain architectural requirements and cutting certain moulded returns, possibly when the bricklayer was also the brickmaker and able to make a positive case for doing so. During the nineteenth century the reasons were different, as Walker (1885, 62–3) states:

> Rubbers are purposely made much larger than the ordinary building bricks to allow for cutting and gauging them four courses to the foot [305 mm], though as a rule they will not hold out or bed more than 11½ inches with close joints. T.L.B.'s as they come from the brickfield measure 10½ × 4⅞ × 3⅛ inches.
>
> They are also obtainable 12 inches long, but this length are only required for Camber arches, or Gothic arches whose bed joints radiate from the centre…in which so much of the brick is cut away to form the long bevels on the soffit and crown, that the ordinary sized bricks will not "hold out" to the required lengths, and have therefore to be lengthened, where necessary, by forming the long 'stretchers' out of two three-quarter bricks…

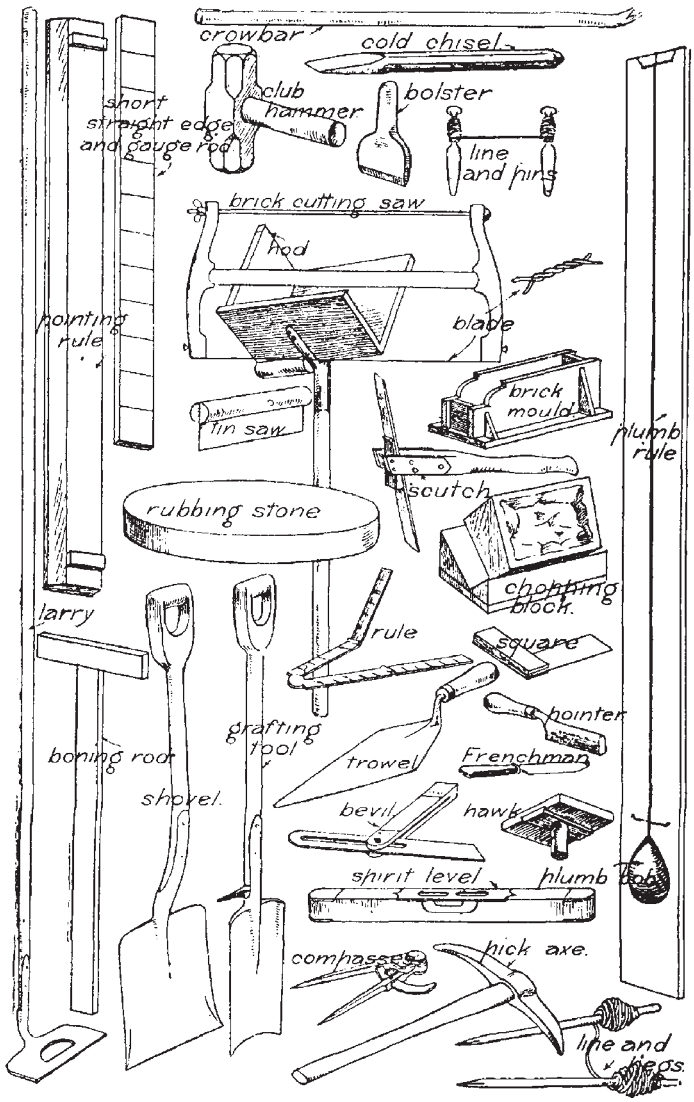


Figure 133

Bricklayer's tools from Mitchell's Building Construction and Drawing, 1906.

Johnson's Fareham rubbers, intended for carving were oversized, as can be seen in the poster of Johnson of *c.*1880 (refer back to Fig. 121, p. 253), the bricks being priced 20/- [£1.00] more per 1,000 than for the smaller size rubbers.

Even the smaller sizes of rubbers, however, could be larger than the Royal Institute of British Architects (R.I.B.A) standard face brick, as can be seen in the sizes being offered by Lawrence for their TLB rubber range in 1898:

- 12½ × 4⅝ × 3⅛ ins – (248 × 118 × 80 mm)
- 14½ × 4⅝ × 3⅛ ins – (368 × 118 × 80 mm)

- 12½ × 7½ × 3⅛ ins – (318 × 191 × 80 mm)
- 9½ × 9½ × 3⅛ ins – (242 × 242 × 80 mm)

The smallest rubber was still larger than the typical contemporary face brick, then generally 9 × 4½ × 3 ins (229 × 115 × 76 mm). As stated above the largest rubbers were generally intended for use as either long voussoirs on deep-faced arches (especially the long springers in a camber arch), but they were also utilised for deep 'tailing-in' on cut-moulded oversailing courses, as headers, as well as for some carved enrichments. Being of a thicker gauge also meant that certain architectural features such as ashlared pilasters could be cut and rubbed to be laid with fine putty joints yet keep gauge with the standard walling. Most other companies continued to make their rubbers to the standard size. This also remained true of malm cutters, the production of which ended with the rapid decline of London Stocks due to competition from the Fletton industry at the close of the nineteenth and early twentieth century. Several companies continued supplying rubbers as green-moulded (over-sized) voussoirs requiring only rubbing to create flat surfaces with sharp arrises, 'topping and tailing' (cut to the required intradosial and extradosial bevels from the drawing); and the dummy joints correctly applied with the saw to create the desired face bond.

Dry-bonding Gauged Work Prior to Building

In all quality gauged brickwork once all the cutting work was finished, and while the bricks were still dry, the enrichment would always be set out first by dry-bonding, using appropriately sized purpose-made spacers for joints. Gauged work, during the late nineteenth century, according to Walker (1885, 61), was set with, '…a white putty joint, which should not exceed the thickness of a new sixpence'. More commonly called a 'tanner', it was 1⁄16 ins (1.5 mm) in thickness, and used as a quick measuring gauge by rolling it along and between the setting-out line as the templet was adjusted to allow for the joint.

Once satisfied as to accuracy of fit and bonding then, depending on the nature of the enrichment, profiles and/or templates would be carefully positioned and onto these all setting-out marks transferred to erect lines, for guiding level, plumb, gauge and, where appropriate, radial alignment of the brickwork. This prevented the disheartening and messy taking apart of any part of the newly laid brickwork upon an error being discovered, which could both damage the bricks having been dampened prior to laying, and made any adjustment to individual bricks virtually impossible.

Once the accuracy of fit had been determined then the bricks were dusted clean and, in order of setting, lowered into a small tank of clean water that would be positioned next to the dipping box. To set, or lay, gauged work the rubbers needed to be soaked, but not saturated, a judgement that came with experience, but in essence they would be left under water until the water stopped bubbling and making a 'sizzling' sound, which varies with the density of the rubber. Left too long and the dipped rubber would not pick up the mortar to form a joint, yet if removed too early and dry it would pick up too much mortar that would stiffen before the brick was bedded into position.

Lime-Putty Mortar and its Preparation

To produce joints of such fine measurements the substance of the bedding material must be reduced to a very fine state of division. In normal gauged work slaked lime, known as putty, mixed with silver sand are the materials employed.

Precision in the cutting of gauged arch voussoirs, allowing them to lock together in a very accurate and close-fitting manner, provided strength for the element, so a low strength mortar, based on a non-hydraulic chalk-lime binder could suffice. Generally, though as Hammond (1875, 45) emphasises 'Gauged arches, as a rule, are set in grey lime putty, brought to the consistency of cream'.

Hammond's old term of 'grey lime' refers to the feebly hydraulic class of lime, a highly workable lime capable of an internal set and long-term carbonation. Sometimes written as 'greystone', 'grey chalk' or 'stone lime', it was the favoured building lime, especially in the city, since the seventeenth century. Walker (1885, 14) emphasises the correct choice of building lime, warning:

> Mortar used by the bricklayer is made either from stone lime, lias or Portland cement ….Chalk lime should not be used, as the only setting that takes place in it is the formation of a surface crust, bearing a small proportion to the bulk…. Stone or gray chalk lime, as it is sometimes called, is generally used…

In reference to setting gauged work, Walker (1885, 63) states:

> Stone lime should be used for setting, as chalk lime is not fit for out-door work.

Putty for gauged work would normally be prepared in a galvanised tank by part filling it with clean water (fit for drinking) and gradually adding lumps of fresh quicklime to slake it. In the initial stages the water would bubble and boil furiously; this reaction being slower with greystone limes than the purer chalk, or high-calcium, limes. The whole mass stirred continually with a Larry (a special tool like a hoe) until it was a thick creamy fluid. The slurry would be passed into another tank at a lower level through a finely meshed sieve. Richards (1901, 39) states 'the joint should be ⅓₂″ [1 mm] only in thickness, hence the sieve should be at least 400 to the square inch'. Once this phase was completed the putty was covered with water and left to stand for several days to mature and ensure that there are no unslaked particles of lime.

Matured putty was then screened, through a fine meshed sieve, into the dampened 'dipping box', or 'putty tub' being 'an oblong wooden box, about 2 ft. by 1 ft. 9 in. deep, for the setter to dip that side of the brick where the bed-joint is required' (Hammond, 1875, 45). Then, depending on the specified joint thickness, a ratio of appropriately sized silver sand added and both thoroughly whisked together to achieve the desired consistency. The top of the mortar, or 'fine stuff', would then be levelled of flat ready for laying to commence. The dipping box was usually positioned at waist height in front of the work to make dipping the rubbers easier.

Setting gauged work on site required great care and skill so as not to spoil the preparation of the enrichment that had been undertaken in the cutting-shed. Hammond (1875, 44) states:

> … it must be remembered that, after the work is cut, there is almost as much skill required in setting it. For it very often happens that a vast amount of labour and skill is expended upon work while in the "cutters" hands, and directly it is taken on to the building the beauty of it is all destroyed through the carelessness of inability of the setter…

Gauged work, especially that designed with very thin joints was sometimes set with grey lime putty only, but not always; as Lindsay Brayley (1945, 66) suggests '…a little sand may be added to prevent excessive shrinkage on setting'. Historical texts, in discussing the setting or laying of gauged work, tend to emphasise the class of quicklime required, its preparation to a putty, and that the rubbing bricks are laid with a 'putty joint'; a traditional craft term that is still commonly used today; but which can be misleading. The same term is used in 'Tuck pointing where Richards (1901, 39) states a jointer inserts, '…a white or black putty joint about ⅛" wide…' There is no mention of the silver sand necessary to make the fine mortar that this 'ribbon' would certainly have needed. Discussing 'Axed Work' laid with a ⅜" (5 mm) 'butter joint', Hammond (1875, 460) states it, 'Is usually set in Portland cement; and this is sometimes mixed with a little putty to make it work better.' Hammond takes it as granted the reader understands the need for sand at that joint thickness, again he is merely stressing the binder for the mortar.

Grey lime putty could be used neat for fine joints because of its strength, but, as stated above, some craftsmen still preferred to add a very small proportion of fine silver sand to it to give it body and prevent shrinkage. As such it was prepared like a plasterer's setting coat; indeed it was sometimes referred to by their craft term as a 'fine-stuff'. As in all things there were vernacular practices and individual craftsmen's preferences combined with years of experience of knowing how to make allowances for the unique nature and working characteristics of a particular lime in its preparation. Some slaked grey limes, even after running through the final fine-meshed sieve into the dipping box, could be a little gritty and this performed as the aggregate. As lime mortars expert Bob Bennett states:

> Grey Lime was a relatively impure material as it contained tri-calcium sulphates and silica. Further random contaminate could also be found in the form of wood or coal ash from the old brick or stone kilns and, occasionally, small traces of alumina have been identified. I believe that these impurities contributed to the performance of grey lime in two ways. Firstly, some of the contaminates act as pozzolans when into pure, non-hydraulic lime mortars. Secondly, Grey lime mortars were mostly prepared in a 'pan-mixer' with rollers, which crushed any large particulates to a predetermined fine size, coincidentally acting as an aggregate.

Lime is usually the 'binder' in a mortar, the sand being the 'filler', so as the joint size of gauged work thickens the ratio of sand has to increase. On an ashlared joint of 5–6 mm (¼ in) the ratio is likely to be 1:2 or 1:3. Without the sand there would be a loss of mechanical strength, an increased likelihood of cracking and crazing across the joint width during drying-out; and long-term failure. Apart from these structural considerations sand compared to the binder was, and remains, very cheap and thus keeps material costs of any mortar down.

This problem of craft terminology, relating to lime putty, leading to confusion with modern readers, was raised with master plasterers Alex Hyland from Scotland and Jeff Orton from England. Both agree this misunderstanding occurs in plastering too in respect of the final 'setting coat' of fine stuff that is often wrongly being thought of as consisting of lime putty alone. As Jeff Orton states:

> The overall thickness of the final setting coat, like the joints on gauged work, can be from approximately 1⁄32″ to 3⁄16″ (1 mm to 5 mm) according to the type of finish…
>
> The proportions of lime to sand can vary between 3 parts lime to 1 part of sand, to 1 part of lime to 3 parts of sand, or any combination in between. The mixes containing more lime than sand are the softest, and are used on ceilings etc. The mixes containing more sand than lime are the hardest, being used for walls and areas likely to suffer from knocks and abrasions. The more sand the mix has in it, the better the process of carbonation has in taking place, along with the presence of moisture in the atmosphere, consequently the more durable it will be. In some areas of this country it is not uncommon to find crushed limestone, sieved and used as an aggregate instead of fine sand, but this does not always show-up in analyses, just that it all is calcium carbonate.
>
> Miller (1897, 97) states that in America they call this setting coat the 'Putty Coat', and later in his book he had this warning about using lime putty on its own (Millar, 1897, 100):

> 'In some districts common ceilings are finished with a thin coat of neat lime putty; but unless the putty is made from grey limestone, or is of a hydraulic nature, the work is more or less weak, and in most cases practically useless'.

Jeff Orton continues:

> In mentioning hydraulic grey limestone Millar is mainly emphasising its strength compared to the chalk lime and not necessarily advocating it to be used neat.
>
> A limewash is one of the rare times that lime putty can be used on its own, with considerable success, but it has to be very diluted with water, until it is no more than the consistency of milk.

He concludes:

> The problem is both one of misunderstanding craft terminology and that those writing on aspects of the building crafts did not always explain every detail, they took it for granted the reader had an inkling of knowledge on the subject, unlike some of today's readers. From approximately the middle of the nineteenth century, Portland cement made such huge strides forward, particularly in the civil engineering side, that specifications were changing very quickly, and today people read into the evidence, both written and in practice, and form opinions without enough research.

Setting the Gauged Work – Ashlar, Arched, and Carved

Walker (1885, 63) describes laying or 'setting' once the rubbers have been soaked – but not saturated – to remove their excessive porosity:

> …the joint is taken up by absorption by holding the bed of the brick in contact with the putty, which must have the proper consistency and be kept in a small putty-box made with a level top, so that the setter can rest or steady his arm upon it while 'dipping' his brick. Before putting the brick in place, the putty is scraped off the middle of the 'bed' that it may set or joint more evenly. The joint should not be touched after the brick is 'bedded' but should be left full like a small bead. Stone lime should be used for setting, as chalk lime is not fit for outdoor work.

To dip a brick properly, the bed of the brick, starting from the back edge to avoid staining the face, would be 'floated' onto the flattened surface of the mortar and levelled out so that a full joint was picked up (Fig. 134). The rubbing brick would then be dextrously lifted and turned towards the bricklayer, to keep the face clean and allow any dripping to occur at the rear where it is of no aesthetic consequence, and the joint quickly trowelled full and flat up to the lead arris. Where cross-joints were being applied as well as the bed joints, then the cross-joints would be dipped first, then the bed, and both quickly trowelled to ensure both united fully; preventing any hollows in the joints that both weakened the brickwork and demanded unnecessary pointing-in afterwards (see Chapter 6, Fig. 166).

Figure 134
Dip laying an ashlar rubbing brick in preparation for setting into position. (Courtesy of Gerald Edkins)

Setting, or laying, gauged work always involves dampening all surfaces being built on, each of the dip-jointed bricks then being placed with a sliding motion into position; a final tap with the brick hammer or rubber-headed hammer to consolidate this process. As each of the bricks are laid a small bead of putty should exude from the joint face (Fig. 135) and it was always considered best practice to leave this until the joint had stiffened, to then cut it off flush with a sharp knife as the work is initially cleaned down (Fig. 136). Any attempt to do so when first laid would result in smearing the facework with wet mortar. In setting each and every brick the bricklayer would be checking position and alignment against the lines ranging from the profiles.

Figure 135
Setting the ashlar rubbing brick into position. (Courtesy of Gerald Edkins)

Figure 136

Trimming the excess bead of mortar from the facework. (Courtesy of Gerald Edkins)

For completed arches, accepted best practice was to pour a stronger hydraulic lime:silver sand grout into 'joggle-joints' (cavities cut, or filed, into the opposing beds of voussoirs) once the arch was 'turned', to increase its strength. Later in the period Portland cement, that was much weaker than its modern counterpart, was increasingly preferred for grout due its to speed of set and strength. Grouting with Portland cement was also sometimes employed at the rear of gauged brickwork to be carved *in situ*, as Walker (1885, 63–4) indicates:

> If the work has to be carved deeply, it is best to build it all 'headers', and 'grout' it in solidly at back with Portland cement, that the bricks may not break up or get disturbed under the chisel of the carver.

Generally, where strength of the bedding matrix was important (such as for door reveals, on projecting oriels, or *in situ* carved enrichments), a different mortar was necessary. The historic hot or cold cements could be used, indeed they were still in use in France during the nineteenth century, as Burnell (1874, 94) states:

> The French plumbers unite the glazed pottery tubes they employ for the distribution of water, with a hot cement made of resin, wax, and lime; or with a cold cement composed of quick lime, cheese, milk, and the white of eggs.

The use of either type of 'cement' was, however, fast declining instead, as Walker (1885, 64) explains:

> A composition of whitening [whiting] and patent knotting is more frequently used than lime-putty for bedding or setting work intended to be carved, and for ornamental key-blocks made up of two or more bricks. It will be found most convenient to put such keys or blocks together in the cutting-shed, and take them upon the building to be set as one piece of work. These remarks apply equally well to the niche hood in every particular.

'Whitening' or 'whiting' is simply finely crushed chalk. The need for a shellac-based medium, such as 'patent knotting', is emphasised by Richards (1901, 86–7) with regard to carved gauged work:

> Gauged brickwork is a most admirable material for carving, the soft effect produced being quite equal to that of modelling.
>
> The bricks, having been perfectly squared and the projection arranged, are set in a mixture of dried or baked white lead and liquid shellac; being at the same time rubbed together to form a tight joint. Carved brickwork may in this manner be made to stand out in relief as much as 18"; but when this is the case the work should be arranged from a model, the different projections being taken from this and the work set accordingly…

White lead or whiting give body and pigment to the finished joint and appear similar to one of lime putty and silver sand. Shellac sets hard, imparting the desired strength to such a mix, being defined by Jennings and Rothery (1936, 35):

> Lac is a natural resin which exudes from a number of trees…. Stick lac is crude resin. Seed lac is the first result of refining the crude resin. Shellac is the usual commercial form; it is received in thin sheets…

Information provided by Hillary Miller, laboratory technician at Liberon Waxes, indicates that commercially produced shellac really began in the Victorian period as 'the industrial revolution of the early nineteenth century ensured an increasing need for gum lac as a colouring dye and an adhesive'.

Bricklayers of this period were quick to realise the potential of shellac to firmly unite their rubbing bricks. The occasional need to glue bricks together led to the craft term of bricks being 'shellaced'. Where the glue joint between bricks was not going to be seen, then just pure liquid shellac was used, in this instance the method then was:

> To shellac rubber bricks together, the liquid shellac is poured into water and gently stirred about to remove the greater portion of the spirit [methylated]; the shellac, very like curds in appearance, is then smeared upon the dusted surfaces of two bricks, the latter rubbed together to make a tight joint, and left to set. (Richards, 1901, 85)

For an ornamental 'blocked' keystone – of three or five voussoirs joined together – the rubbers would be dusted, dampened, and then set with white lead or whiting and shellac. These would be laid individually to the designed bond on the bedding, or 'surfacing', slate and quickly tied-off with wire or string; with appropriately placed thin timber 'packings' either side to protect the vulnerable arrises. Once fully set and dry, the 'block', or 'lump' would be placed in the appropriately profiled large moulding box, and then cut and rubbed to shape using the wire-bladed bow saw, and finished with chisels, files, and other relevant abrasives. Sometimes niche heads were built inside the cutting-shed, also some flat or camber arches were bench-constructed, in whole or part, by this method for placing into the opening on-site (Mitchell and Mitchell, 1906, 71):

> The voussoirs are jointed together on the surfacing slate, either into the complete arch or into convenient sections the back of the joints being grouted with Portland cement. In setting the arch it can be placed en bloc on the turning piece and between the skewbacks prepared to receive it, or if large, the various sections are jointed together on the turning piece, in which case the exact position of each brick must be marked thereon.

This block or lump method was also used to cut and shape, by turning in a box (as if on a lathe) bonded gauged vases for use on classical gables and pediments. It was a method also employed to shape the block into a sphere or globe to a pier capping. A good example of this is on the gated rear entrance to Emmanuel College, Parker Street (Cambridge) (1894), designed by the architect J.L. Pearson (1817–97) seen in Fig. 137.

Figure 137
Gauged pier capping with globe, Emmanuel College, Cambridge (Cambridgeshire), 1894.

When using white lead or whiting with liquid shellac in the form of patent knotting, the former is always added to the latter, stirring continually to a cream-like consistency. Traditionally this was done on a slate or stone slab until fully integrated, and trowel-applied to the prepared rubber. The brick would then be laid to position to exude a thin bead of joint, allowed to dry sufficiently, and then neatly cut off flush without staining the work; in readiness for full rubbing-up once the work dried.

The former Hornsey Road Baths, London (1894), designed by A. Hessel Tiltman (1854–1910) is built in the Queen Anne style of red brick with dressings of gauged work and cut stone. There are superb examples of *in situ* carved gauged work with two griffins (Fig. 138) and two lions either side of the large gauged arched vehicular entrance and a large carved cartouche in one gable when the building was extended in 1914.

Figure 138
An heraldic Lion of carved gauged work, Hornsey Road Baths, London, 1894.

Where *in situ* carving work was to be undertaken as part of an overall enriched detailing Walker (1885, 83) explains:

> It is the work of the bricklayer to cut and form all kinds of mouldings, dentils, entasis, columns, flutings and such-like members in gauged work, leaving the more intricate, such as design and foliage, to be executed by the carver.

By the second half of the nineteenth century city trade carvers, who could work in brick, stone or wood, were commonly employed by large companies like John McCullock of Kennington, London, rather than be self-employed. The trade carver Mr Heam, who carved all the decorative gauged work on the block of offices erected at the corner of Chancery Lane and Southampton Buildings, London, in 1879 was one such person (Fig. 139).

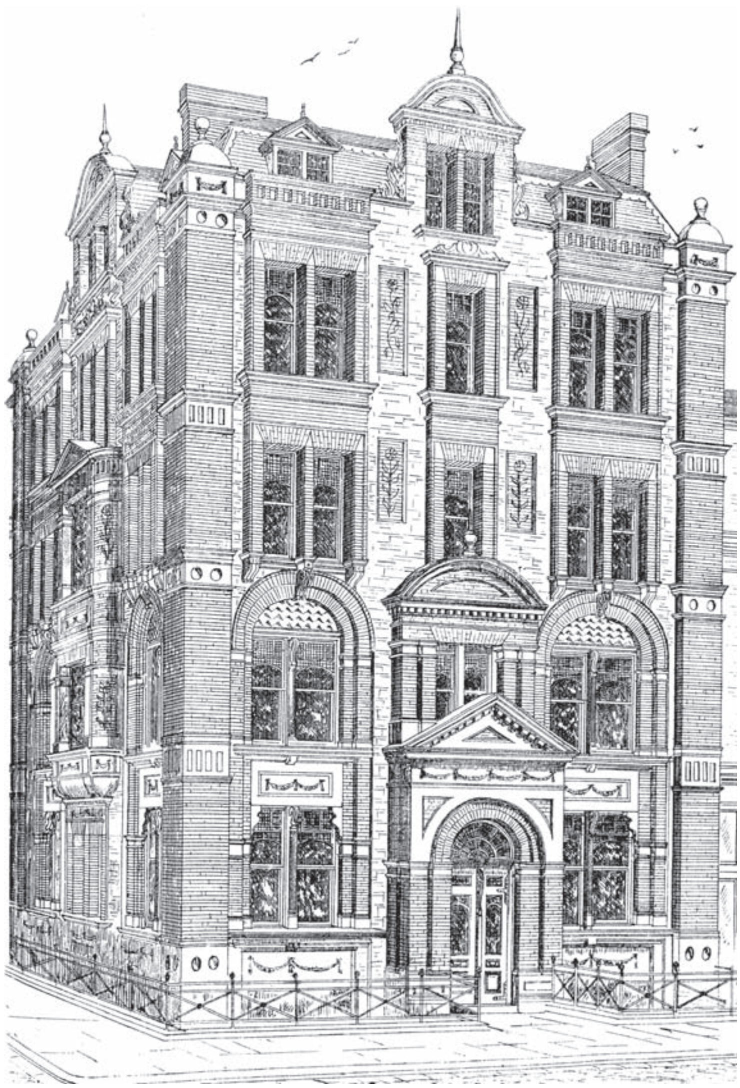


Figure 139

Drawing from 'The Architect', of the offices at the corner of Chancery Lane, London, displaying carving skills on gauged work panels by Mr Heam, 1879.

McCullock's craftsmen carried out much of the exquisite *in situ* carved gauged work on the many Queen Anne styled properties around Chelsea and Cadogan Square as well as the stylistic development (humorously titled 'Pont-Street Dutch' buildings) of the later period around the Kensington and Knightsbridge areas of London. 'Pont-Street Dutch', supposedly based on Flemish Renaissance architecture, was fashionable in the 1880s, making much use of panels of gauged brickwork, elaborate gables and strapwork. One of its most successful protagonists was Sir Ernest George (1839–1922).

According to the London Post Office Directory of 1885, John McCullock was an architectural modeller working out of 384 Kennington Road, where they were in 1890; but then listed as an architectural sculptor. In the 1899 edition, the listing is for J. McCullock Ltd, Sculptors and Modellers, Monumental Masons, Woodcarving etc., at a new address of Harleford Mews, Magee Street, Kennington Park. Perhaps as a reflection of the architectural changes following these years, the company is listed as J. McCullock Ltd, Fibrous Plaster Decorators in the edition of 1910.

Measuring Gauged Work

With regard to measuring gauged work at the beginning of the nineteenth century Pasley remarks that ornamental parts of the work are, like the earlier periods, charged extra and by different methods to standard walling and lists them. Removing that not related to gauged work, his list reads (Pasley, 1826, 251–52):

> 3rd. Gauged and rubbed arches. These are measured in superficial feet, according to the area of the figure contained between the intrados, the extrados, and the extremities of each.
>
> 4th. The points of groined arches. These require bricklayers of more than usual skill, and are very troublesome. They are measured by the lineal foot.
>
> 6th. Rubbed splays. These imply the fitting of the brickwork over the extrados, and on each side of the skewbacks or gauged arches, and all other oblique work…to be cut but rubbed.…it is measured by lineal measure along the outline of all the curved or oblique lines.…
>
> 8th. Rubbed splays to angles. Rubbing as well as cutting is necessary when those splays appear on the outside of an ornamental brick building, as in angular bows. These angles may of course be salient as well as re-entering, and are also measured like the former, by the lineal foot, but are paid at a higher rate.
>
> 12th. Cornices or other mouldings set in putty. These are charged by superficial measure, not by taking the net height, as it would appear in the elevation of a building, but by straining a line over all the projections, and into all the cavities, so as to embrace the whole outline of those mouldings, as they appear in profile.

Hammond (1875, 114) is typically succinct on the same:

> All gauge-work is measured by superficial measurement (unless otherwise specified); and every part that is exposed to view is taken in the dimensions.
>
> Skewbacks, birds'-mouths, splays, beads, &c., are generally measured by the run. But if measured as gauge-work, it is usual to ply the tape or a piece of string, close to every part of the brick that is moulded, and afterwards measure it to get the whole of the girth of the work, and this is multiplied by the length for the contents.
>
> Arches are also measured by the girth multiplied by the length.

This practice of measurement for gauged work remained essentially the same throughout the period. A factor never mentioned, but with a large impact on price, was fineness of the joints – the tighter, the more expensive – as the cutting, preparation, and setting all had to be of the very highest order.

The Use of Gauged Brickwork in the Revivalist Styles

On the use of gauged brickwork in the revivalist styles, Walker (1885, 14–15) comments:

> Owing to the revival of the Queen Anne style of architecture, brickwork now occupies the foremost position in building construction…. Our popular architects delight to revel and indulge their fancies in red brickwork, as evidenced in several public buildings of recent erection.

Walker (1885, 79), elucidating still on the proliferation of ornamental brickwork and defending it against its critics, suggests:

> Ornamental brickwork in this country has reached its greatest height in connection with the Queen Anne style of architecture, as elaborated in the present day. The oriel windows of the Tudor, the ornamental gables and picturesque chimneys of the Elizabethan, are all merged into it, and with such a profusion of carving as to be unprecedented in any former age…

Walker is writing during the height of the High Victorian period when London was a mass of building activity. Many architects were designing wonderfully crafted brick façades, allowing master craftsmen the opportunity to display their skills in a manner not truly seen, or indeed desired, since the late seventeenth century. Combined with the rapid developments in associated building technology – such as the use of brick reinforcement – there was an unbridled renaissance of gauged work.

This enthusiasm was fuelled by a conjunction of events such as the philosophy of the Arts and Craft movement, dedicated and innovative architects, the rising pride of city craftsmen and movements towards formal craft education, and the entrepreneurial self-belief of the late Victorians for high standards and discipline. All was financed by the wealth of the British Empire and continued on into the Edwardian period, until cruelly terminated by the devastating effects of the First World War.

It was through the early Gothic Revival movement that the craft of bricklaying received its much-needed boost as the fashion for fair-faced brickwork returned, and with it gauged work detailing. The Midland Hotel, St Pancras Station (1868–74), by the architect Sir George Gilbert Scott (1811–78) presents neatly cut-moulded voussoirs to the series of arches of gauged work.

The use of Gothic vaulting was also re-introduced and there is an excellent example of gauged vaulting, with stone ribs, to be seen in one of the entrances to the Law Courts on 'The Strand' in London (1882), designed by George Edmund Street (1824–88).

To truly assess how gauged brickwork was developed and used in a more novel manner during this period, one really has to look at buildings constructed in the so-called Queen Anne style, which was suited to gauged enrichments. Within this style proliferated all manners of arches, aprons, pilasters, columns, pediments, and niches, and a use of carved work, to an extent not seen before or since.

Not everybody was at ease with this Victorian version of Stuart brickwork, or fully understood the capabilities of rubbers to be perfect for post-fired working to shape.

The Building News of 27th October stated (1871, 311):

> Much as we admire it, we cannot help considering rubbed brickwork to be false in principle. There is no doubt that rubbing has been resorted to in some of the most beautiful work we posses; and we must admit the new buildings at South Kensington are most excellent examples of the judicious employment of red bricks. But we are convinced that as bricks are necessarily moulded in the process of manufacture, it is a mistake to tamper with and shape them after they leave the kiln. It is really doing the work twice over to cut them into fantastic shapes, as has been done in the window shown by Mr. Wm. Cawt, of Fareham, when they might have received these forms in a quarter of the time while the clay was in the plastic state. Besides, mortar joints are on no account to be despised, and 'improved' down to the thickness of a mere sheet of paper, as we see here. We should say, by all means use the brick with the natural surface it receives in firing, and give it a plain, honest bed of mortar. This has been done in the Albert Hall and in the new Exhibition buildings, and we venture to assert that the effect with gray mortar is better than the rubbed work at the Museum, which looks as if the joints had been ruled on with a drawing-pen.

Another aspect of this displeasure with gauged work can also be read in *The R.I.B.A. Journal* of 8th December 1892 (1892, 88) (this was repeated in *The Builder* of 26th January 1895):

> …much of the modern brickwork in imitation of the Queen Anne style fills me with horror and detestation. When I see pilasters tacked on to a front which not

> only have an exaggerated entasis at their sides, but come bellying out in front like the sails of a ship, they remind one of the fable of the frog and the bull, and the bricks seem swollen with conceit at having attained to a form utterly foreign to their nature. And it is this, rather than the ugliness, which I so strongly object to. Brick is a hard material moulded and baked in a kiln, and moulded bricks seem to me perfectly legitimate; but surely the original baked surface is the most fitting to resist the weather; and if you go and rub and cut all the surface off, and then give the material a shape and form utterly foreign to its nature, you are completely reversing the practice of the Mediaeval builders, who have left us the most magnificent examples of their skill, and who invariably gave to each material they employed the ornamental treatment that it was best fitted to receive…..

Clearly these writers knew nothing of the prolific practices of the medieval hewers, or of the finest Stuart and Georgian bricklayers, and their legacy of magnificent post-fired enrichments, or that baked rubbers differ from well-fired bricks.

The differences in this revivalist fashion were not only the stylistic and design conundrum and use of traditional enrichments, but also the impact of changing technology behind their constructional use. This is immediately apparent in the quality of rubbers over their seventeenth- and eighteenth-century predecessors, giving features a much more homogeneous appearance in both colour and texture. It is especially noticeable on high-quality work where colour-matched rubbers could be insisted on, ensuring no variation in quality, texture, or tone; this can cause the gauged work to appear less organic and sincere than the best work of the earlier periods it seeks to emulate.

Over-sized rubbers also have a dramatic impact, as architectural features are being formed from individual units much bigger than was typical before. Arches of this period are frequently set-out to a larger brick gauge at the extrados due to different setting-out techniques employed from earlier periods and less voussoirs in an arch face of comparable span to one from the previous periods; creating a rather heavier appearance. On flat or camber arches, for example, travelling the dividers along the length of an arc drawn from the striking point, rather than along the extrados could set out voussoirs. This arc could either be drawn above the arch commencing from the top of a skewback, or alternatively from the extrados of the key brick at the centre line, and drawn down and the across the arch face to the skewback. Either of these methods resulted in individual voussoirs that get increasingly wider along the extrados from the keybrick to the springing brick at the skewback. This method was not possible given the thinner gauge of bricks from earlier periods. Oversized rubbers, however, could facilitate certain detailing more easily than smaller bricks, such as the rusticated semi-circular arch as at Eastney Barracks in Portsmouth (Hampshire). Here, the oversized voussoir bricks of the arch extrados were capable of being cut to special individual shapes in order to link the varying radial lines with the horizontal offsets of the blocks, or rustications (Fig. 140).

Figure 140

A rusticated semi-circular gauged arch at Eastney Barracks, Portsmouth (Hampshire), 1871, showing the aesthetic effects of larger rubbing bricks.

Carving gauged brickwork, as discussed earlier, was also benefiting from new techniques in washing and screening the brickearth and clay, making rubbers cleaner-bodied and more homogeneous, so allowing easier and deeper carving with sharp arrises and greatly reduced unwanted inclusions spoiling the carver's work. This facilitated a plethora of brick carving, on all forms of architectural features, to unprecedented levels, such as that displayed at Newnham College, Cambridge (*c.*1875) (Fig. 141) and the exquisite bullseye arched windows to Holywell Hill in St Albans (Hertfordshire) (1911) (Fig. 142).

Figure 141

Exquisite carved gauged work at Newnham College, Cambridge (Cambridgeshire), *c.*1875.

Figure 142

Carved bullseye arched window, Holywell Hill, St. Albans (Hertfordshire), 1911.

The Use of Reinforcement in Gauged Work

The early nineteenth-century development of reinforcing brickwork by laying lengths of tarred and sanded hoop-iron into the beds of every fourth or fifth course was also used on some gauged work, facilitating certain architectural uses not previously possible. In such instances the rubbers had channels rubbed into their beds to accommodate the reinforcement and not interfere with the tight jointing. The row of cut-moulded gauged consoles, constructed of TLB red rubbers and supporting verandas, at R. Norman Shaw's (1831–1912) Albert Hall Mansions, in Kensington, London (1892), are a reinforced deceit; otherwise they could not accommodate the loading they carry (Fig. 143).

Former English Heritage architect, Mike Stock, tasked with the repair of consoles damaged by the expansive effects of rusted reinforcement (Fig. 144) records (Stock, 2002):

> The 'brick' corbels supporting the lower balcony are false, however, and the support for the balcony slabs is vertically separated pairs of wrought iron or rolled steel joists embedded into the elevation, with brick packing between the two joists. The composite brackets were then encased with gauged TLB rubber work, which incorporated hoop-iron cramps in the approximate locations shown on the sketch [Figure 137]. Poor detailing of the balcony 'drip' allowed water to run over the balcony front and into the joint between the underside of the balcony, and the top of the brackets. This resulted in corrosion of both the supporting

Figure 143

Console revealing rust damage from reinforcement to gauged brickwork, Albert Hall Mansions, London, 1882. (Courtesy of Mike Stock)

> joists, and the upper cramp, with inevitable oxide 'jacking', causing serious damage to the gauged work, as can be clearly seen [Figure 136].
>
> A further problem noted was that the calcium of the limestone balcony was taken into solution by the aggressive acid atmosphere. Re-crystallisation of the sulphate salts within the face of the soft rubbers was causing serious blistering and exfoliation of the brick face too.

The architect George Devey (1820–86) utilised reinforcement in the form of 12 mm diameter iron rods passed through holes drilled through the lengths of cut-moulded stretchers, on the deep overhanging cornices, at Minley Manor in Aldershot (Hampshire) (1886–87) (Fig. 145). This technique only became visible as a result of water ingress from downwash, through defective cross-joints in the projecting cut-moulded reverse-ogee course directly above, and the resultant expansive effects of rusting on the internal reinforcing rod leading to the loss of part of a brick face.

Figure 144

Drawings depicting the hidden ironwork within a gauged console, Albert Hall Mansions, London, 1882. (Courtesy of Mike Stock)

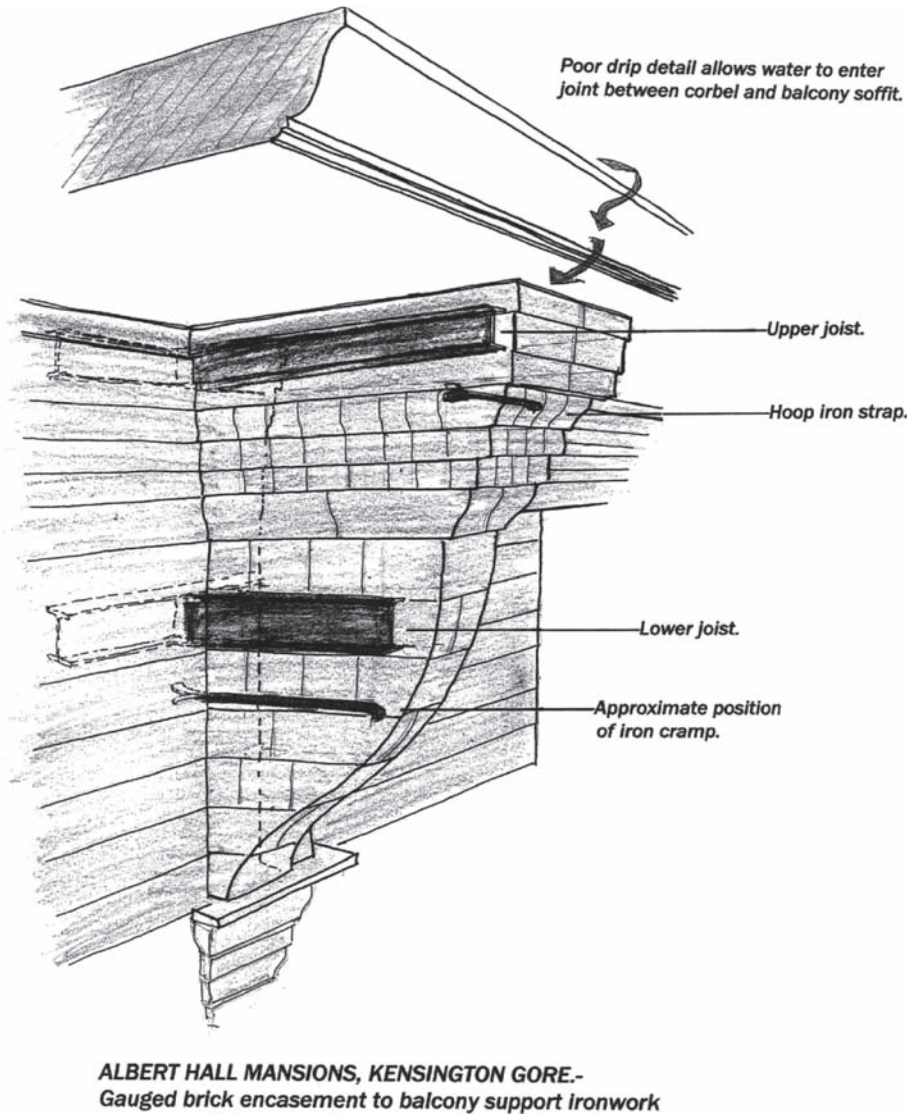


Figure 145

Iron reinforcing rod hidden within a gauged cornice exposed due to the expansive effects of rusting blowing some brick faces, Minley Manor, Aldershot (Hampshire), 1886–87.

Summary

The gauged work of this period, particularly during the second half of the nineteenth century, was greatly influenced by advances in technology. Developments in the washing and screening of brickearth and clay led to the manufacture of cleaner-bodied rubbers, fired in improved and more controllable kilns, and distributed to a wider market, via the national rail network. The introduction of the twisted steel wire blade for cutting rubbers within profiled cutting boxes increased both accuracy and speed. A wider range of products to fix and support the finished gauged work than was previously available led to new architectural uses. The fashion for gauged enrichments returned in a highly adventurous manner due to various architectural revivalist styles that benefited from the national desire to educate building craftsmen to undertake handcrafted work of the best quality.

Case Study: 'Weavers House', New Wanstead, London, E11

The Building Surveyor's Perspective

By Chris Billson FRICS, Chartered Building Surveyor

I am a Chartered Building Surveyor with over forty years of experience of working on existing buildings. In 1997 I was appointed by one of the oldest of the City Livery Companies to prepare and implement a programme of restoration and repair to one of their Grade II listed Almshouses, Weavers House, in East London. The statutory listing for Weavers House is Grade II. It records that Joseph Jennings built it in 1859 in a Jacobean style with a two storey central block and symmetrical flanking wings. It goes on to describe that the building was constructed in yellow stock bricks with painted stone dressings; all under a slate roof. Although this description does not go into finer points of detail, the arches over many of the windows and doors are constructed of 'Malm Cutters'. These were made from a special type of brick earth and considered to be the 'rubbers' of the London Stock brick range.

One area of repair identified as being necessary was to dismantle and rebuild a segmental gauged arch over a window built in these Malm cutters. The main contractor appointed to carry out the overall programme had been assured by his sub-contractor that they possessed the knowledge, skills and experience of traditionally constructed brickwork including the use of non-hydraulic and hydraulic lime mortars and the execution of gauged brickwork. I was also assured that they were capable of following my instructions for the reconstruction of this arch. Unfortunately they were not and the arch when rebuilt was unsatisfactory (Fig. 146). Furthermore despite having errors in setting out and workmanship pointed out to them, the main contractor and his sub-contractor were adamant that the completed work could not be improved upon.

Figure 146
The poorly rebuilt gauged arch of Malm cutters, 'Weavers House', Wanstead, London, 1859.

I therefore considered that in order to progress matters the best way forward, without getting involved in a contractual 'wrangle', would be to engage the professional services of someone who was an acknowledged authority on traditionally constructed brickwork. This had to be someone who, if called upon to do so, could demonstrate in a practical way how the condemned work was incorrect and who would therefore command the respect of the main contractor.

I have always had a fascination of historic buildings, traditional materials and practices, with a particular interest in brick built properties. I have been a member of the British Brick Society (BBS) for many years and of the RICS Conservation Group since its inception. Through both of these bodies I have been able to avail myself of many informative publications, articles and papers and attended various CPD courses to study these subjects and to make use of the knowledge thereby gained for the honest and faithful repair and restoration of traditionally built structures. This has had the added benefit of allowing me to meet some of the leading authorities in the fields of restoration and conservation.

Such a person was known to me, as some years previously I had met Gerard Lynch 'Head of Trowel Trades' at Bedford College – a fellow BBS member – as a result of attending a CPD course, 'Introduction to Gauged Brickwork', in the summer of 1990. I remembered that he had identified a significant deficiency in the College part of brickwork apprenticeships and had pioneered the re-introduction of traditional craft knowledge and skills alongside the modern emphasis. Furthermore his book 'Gauged Brickwork: A Technical Handbook', clearly written by a master craftsman, had been published in May 1990 and was receiving acclaim from leading figures and heritage bodies involved in historic buildings and their repair. I knew therefore that he had not only the technical knowledge when it came to gauged brickwork but also possessed the ability to consolidate that knowledge into practice since he had been a 'time-served' bricklayer before moving on to academia and consultancy work. By 1992 Gerard had returned to contracting on historic brickwork and employed a team of highly skilled craftsmen. However, due to the developing demand for his professional opinions, lectures and writings he established himself as a full time consultant. I therefore asked him to visit site to pass an opinion on the work that had been condemned.

Following his inspection, in early 1998, he prepared a detailed report, including rule-assisted drawings that compared an identical gauged segmental arch that was of the same size and which had been built at the same time as the one that had been rebuilt but was the subject of dispute. This report set out clearly those areas where the work was deficient. The geometry and setting out was incorrect. There had been no preparation of the Malm cutter voussoirs prior to relaying the arch, inferior quality lime had been used in the mortar, and poor bricklaying meant that there were mistakes not only in the laying of the arch but also in the surrounding standard stock brickwork too. He then proceeded to detail precisely what would be necessary to rectify the numerous defects.

After studying this report the main contractor acknowledged that rebuilding of this arch was not the work for an ordinary bricklayer but required a person with a 'special touch'. It was therefore agreed, with the main contractor, that I would 'nominate' bricklayers who possessed these skills and who would be retained to dismantle the incorrectly rebuilt arch and reconstruct it correctly. Unfortunately Gerard was not in a position to help me within the rapid time frame necessary due to his commitments, but kindly provided the names of two skilled craftsmen, Richard Keech and Scott Williams. Both were time served apprentices of his from his time at Bedford College and had benefited from being taught traditional skills including gauged brickwork by him and been part of his contracting team and subsequently set up their own specialist sub-contract company. Therefore he was confident that Richard and Scott would be able to dismantle the incorrectly reconstructed arch and rebuild it correctly and to the exacting standards of workmanship required.

The finished result of this exercise is now a structurally sound arch and a piece of brickwork that equals a mirrored 150-year-old example at the opposite end of Weavers House in terms of workmanship and materials. Clearly the reconstruction of this arch was a complex task requiring a great deal of understanding and sensitivity on the part of the bricklayers who were responsible for its execution. Had I not had access to a knowledgeable and experienced consultant and skilled bricklayers like Richard Keech and Scott Williams, the likelihood of me being able to demonstrate to the main contractor and his sub-contractor that their work was incorrect and the workmanship unacceptable, was remote. They would almost certainly have maintained a position that, *'Bricklayers able to produce what I was demanding are no longer available in the building industry today'.*

The Bricklayer's Perspective

By Richard Keech, craftsman bricklayer, Brogborough, Bedfordshire

As an apprentice bricklayer at Bedford College I, along with my colleague Scott Williams, were among one of the first students introduced to the art of gauged brickwork whilst studying under Gerard Lynch. In my four years spent at college selected students, including Scott and myself gained valuable knowledge and experience from his hands-on approach in cutting, rubbing, and setting gauged brickwork. After completing my apprenticeship I set myself up as a sub-contractor. A little while later, he left the college to pursue his work as a contractor, consultant and author. He had great confidence in my abilities at carrying out gauged brickwork and I had the honour to work for him, along with Scott on several repairs or restoration contracts, and he kindly recommended us for other contracts, involving historic brick buildings including tuck pointing and gauged brickwork.

The original gauged arch, of buff coloured malm cutters, had failed and several of its voussoirs had loosened and some standard brickwork above it. This had been taken apart and rebuilt by the brickwork contractors undertaking other works on site. These did not have the required experience or skills in this type of traditional brickwork and the standard of the rebuild was not accepted. In their attempt to rebuild the failed arch, the bricklayers only added to the problem; even damaging some arch voussoirs. Additionally, the majority of the re-built London Stock bricks over the arch, due to the excessive damage they sustained, and having been laid in hard cement mortar, could not be re-used.

It was essential to provide a safe and comfortable working environment. An aluminium tower scaffold was erected of two sections. The first section nearest the wall was positioned just below the height of the arch, to be in a comfortable sitting position when laying the arch voussoirs and make laying them that much easier. The second platform at the rear of the tower was on the next level up to provide a bench for us to systematically layout the arch on as it was taken down and prepare the voussoirs at a convenient height. The top and three sides of the tower scaffold were covered with a protective tarpaulin to create an environment that was both dry and 'out of the wind'; allowing work to proceed in inclement weather.

We then took detailed measurements of the gauged arch and the surrounding face brickwork feature of a projecting three course platt band directly above the crown of the arch, as it was before any taking apart. This was clearly impossible with the original arch as it was incorrectly rebuilt. This particular building was symmetrical in design with an identical window opening at the opposite end with an arch of the same span, rise, bonding detail, etc; and this was used as a datum point for all measurements. All the surrounding face brickwork measurements where also checked against the second arch, such as gauge height to Platt band and the measurement of its projection from the face line. Photographs were also taken before any remedial work commenced, which are very useful for a number of reasons. Firstly as a reference to the original arch when rebuilding. Secondly in any contractor/client dispute after the work is complete, and finally for our portfolio of work.

Measurements were double-checked, photographs taken, then face brickwork above the arch was carefully taken down. This area consisted of some of the projecting Platt band up to the stone cill of the first floor window opening. This was laid in an approximation of English bond with an oversized header on the header course, centralised below the opening. The header courses mainly consisted of ‘snapped headers’ with less than a quarter being full tied-in headers. Regretfully the majority of these bricks had to be discarded due to previous damage and replacements were found from a local reclamation yard in Bow, East London. These were very slightly oversized to the originals, but the closest match that could be obtained, so they were decided on and laid with slightly tighter joints to compensate; and the appearance was most satisfactory.

On a large sheet of 18 mm plywood we set out the geometry of the arch. We drew a horizontal ‘springing line’ and marked off the width of the opening. By geometry we then established a vertical centre line at 90 degrees to this, something Gerard was always keen to stress the importance of, both in setting out and constructing an arch. The ‘rise’ was then measured on top of the springing line onto the centre line, to true underside of the segmental arch – with no allowance for the ‘blocked’ key bricks – and a line was then drawn from this down to the ‘springing point on either side to form a chord. By geometry we then bisected the chords with arcs scribed above and below them, allowing us to scribe straight lines through the bisected arcs terminating on the centre line, to establish the ‘striking point’, or radial centre of the segmental arch. The arch could now be drawn and the voussoirs marked.

From the detailed measurements and drawing of the arch, a timber centre was constructed from 18 mm WBP plywood for the structural formwork. The positions of the key bricks were drawn and then the centre was then cut out. To allow the projecting key bricks to step down, small cut-outs of the correct depth were required to be accurately set out into the top of the centre. Flexible 6 mm WBP ply was then wrapped around the top of the centre at a width of approximately 100 mm. Finally another length of 18 mm plywood was cut and fixed to the bottom of the centre for rigidity to take the weight of the large span arch. All was fixed with glue and screws. The completed centre was then positioned under the arch on vertical timbers against the reveals and strutted firmly with a diagonal timber bracing. The use of appropriately sized 'folding wedges' enabled the centre to be adjusted tightly up to the soffit of the arch to secure the brickwork during disassembly and support the existing voussoirs.

The poorly re-built arch was carefully taken down, working from the key evenly either side out towards the skewbacks, and the voussoirs, some of which were badly damaged and chipped, were laid out in order of laying on the elevated bench on the scaffold. The lime mortar was removed from each voussoir by gentle scraping, and these were then lightly re-rubbed on their faces to remove 150 years of grime and recent staining as well as determine those which could be salvaged. Thankfully, as Gerard had predicted, they re-rubbed quite easily on the large rubbing stone.

Some were too damaged and matching replacements were sourced from 'Solo Park' in Cambridgeshire. The new replacement bricks were rubbed square, scribed to templet and cut to the voussoir shape. The final task in the preparation of all the voussoirs was to set out from the templet the positions of the 'dummy' or false joints to the centre of alternate voussoirs, creating the appearance of two headers and thus a bonded face. These were cut in to a depth of 5 mm with a 1 mm-hacksaw blade.

We now prepared the existing brickwork and re-checked the position of the centre. We positioned two horizontal timber beams or 'profile trees' above the arch, one directly underneath the Platt band and the second one just above it. The lower one was to line-in the first third of the voussoirs either side of the arch that could not be guided from the main profile due to the projection of the remaining Platt band. The centre line of the opening was plumbed-up using a large spirit level from the timber centre and marked on to both profiles. It was also transferred down onto the diagonal strut bracing the two centre supports; and deliberately positioned to be at the correct measured distance down from it for a nail to be fixed for the radial 'striking point'. With two lines fixed to a nail on the striking point and on up to the profile trees, a joint width back from the springing brick positions, the skewbacks could be cut to the right bevel and laid with bond to both horizontal and radial alignment.

The intradosial lines, previously set out and drawn onto the top of the centre for each voussoir, were now transferred across the full width of the timber centre using a try-square to ensure all the voussoirs would be set square and parallel over the arch. These positions were then extended up onto the profile trees, the first 5 voussoirs on either side on the lower profile trees and the remaining voussoir positions onto the upper profile. To secure these radial lines small panel pins were nailed into the profiles by the side of each mark,

Figure 147

The re-rubbed gauged arch, dry-bonded in position and with the profile trees erected and set-out ready for rebuilding to commence, 1998. (Courtesy of Richard Keech)

and this technique was repeated on the soffit marks of the arch centre. With all voussoirs ready for re-laying they were dry-bonded on top of the centre, using cut lengths of dpc to space out the 1 mm joints; yet another technique learned from Bedford College (Fig. 147). A check was made to make sure that the top of the key bricks lined through precisely horizontally to facilitate a standard bed joint to the underside of the Platt band. Satisfied that all our setting out and preparations were sound the dry-bonded arch was then disassembled and laid out in the order of laying onto the elevated bench ready for laying.

Two horizontal lines maintained the arch face to the surrounding brickwork during re-building, one positioned near the bottom of the arch, the second just down from the crown, to prevent the arch twisting across the opening. Two further lines from the profile trees to the striking point guided the radial positions of each voussoir correctly.

We soaked the porous ‘cutters’ in water, to a point just short of saturation, reducing their suction, giving additional time to position them and improving the overall bond strength. The laying mix for the arch was prepared using matured slaked lime putty passed through a fine-meshed screen and then mixed with silver sand with just a drop of boiled linseed oil. All of these ingredients were mixed by hand-whisk until a smooth, creamy, consistency was obtained, and then placed into a dampened ‘dipping box’.

The laying process itself was simply a matter of giving each voussoir another quick dip, or ‘dock’, into the bucket of water, waiting for any residual surface water to run off, and then carefully dipping the voussoir into the prepared lime putty mix within the dampened dipping box. Great care is taken dipping voussoirs to make sure that only the bed of the brick takes-up the joint and none rides-up and over the arrises staining brick faces. A small leaf towel helped ‘ease’ the mortar forward and tight up to the face arris. The voussoir was then carefully laid into position and radial line on the arch centre using a very small sliding and rubbing action, against the previous and dampened voussoir to gain a good bond and the 1 mm joint required (Fig. 148).

Figure 148
Re-building the arch by placing the voussoirs to the lines ranging from the profile tree and those set out on the centre, 1998. (Courtesy of Richard Keech)

After each voussoir was laid the line was moved onto the next pins, ready for the following voussoir to be laid. This was repeated until the centre 'key bricks' were reached. For the final key voussoirs the dipping mortar had to be applied to both bed faces of the voussoir and they were then carefully slid down tightly into place. A traditional thin-bladed bricklayer's jointing tool, the thickness of the arch joints, was then used to fully compact the bed joints either side of the key voussoirs. This was also used to lay-in the mortar into the 'dummy joints', guided by an appropriately positioned timber pointing rule.

The next stage was re-building the standard brickwork over the arch. A mortar mix to match the original was specified based on a blend of fine and course sands and hydraulic lime. The bricks were dampened and laid to line, gauge and bond of the surrounding original brickwork. For the long extradosial cut up to the arch a neat and even joint width was obtained by setting out accurately and using a bench-mounted disc cutter, a fairly quick process only involving two courses. The extrados of the arch in reality cut into four courses of facework, but the top two ran in line with the central projecting key block, so no cutting was required for them; other than cutting to length. The Platt band was built directly over the crown of the arch. This consisted of three projecting courses of London Stocks that ran straight over the arch and this was a simple job of 'lining-in', to established bond, between the existing brickwork on either side. The final lining-in of the remaining brickwork was completed.

Once the face brickwork was completed. The specified joint finish was carried out on stiffened mortar to produce a finish, to match the aged appearance of the original surrounding brickwork. Once all had set sufficiently the arch centre was carefully removed by gentle easing and then removing the folding wedges and the timber struts. The underside, or soffit, of the arch was then tided-up by rubbing-up the soffit and, where necessary, pointing the joints with the thin bladed jointing tool. Finally the connecting mortar joint between the rear of the arch soffit and the half-brick recessed brick reveals and window frame was pointed with the lime-hair mortar that was then trimmed plumb to a consistent 20 mm width to produce a neat bead, or 'fillet'.

As this work was carried out during the months of March–April the odd cold snap could still occur during the construction, so each day's work was covered each night using hessian sheets, bubble wrap, and polythene. When the brickwork was finished it was again covered but left with a slight gap to permit airflow to aid drying, and left for a period of two weeks, which was long enough to be well out of any frost periods. The covers were then fully removed and the arch face was very lightly rubbed-up with the hand-held 'float stone' to bring the work to a bright-unified finish. This completed the re-building of the gauged arch (Fig. 149).

Figure 149
The fully restored gauged arch and surrounding standard face brickwork, 1998. (Courtesy of Richard Keech)

When carrying out repairs or restoration it is important to employ someone that has the required depth of craft skills, knowledge and experience; and who has confidence in their own abilities. It is also vital that these craftsmen know and fully recognise the limits of their abilities. Of course, to a degree, one can only increase experience by trial and error, but gauged work is not a place for this, that should be done in a college. Gauged work demands a high-level of competence as it was, and remains, the pinnacle of my craft, therefore one must be taught its skills and knowledge fully before attempting to repair or restore original work. I was indeed fortunate to learn not only the skills and knowledge of traditional craft practices from an acknowledged master, but also his excellent ethos too.

It is vitally important that someone leads such work with the relevant depth of skill and knowledge required to successfully complete a given task, and not by someone just 'having a go' because they are a bricklayer. In this case study it is clear that because of someone 'having a go' they cost others a lot of money and time to put right their inferior work. The building also suffered because of the unrecoverable damage caused to original materials, creating an unnecessary need to source replacements. By employing well-taught, skilful, experienced and knowledgeable craftsmen the buildings of our past can be repaired and restored to a high standard so that they compliment the original and survive well into our future.

Unfortunately this situation is unlikely to improve unless there is a realisation within the Construction Industry that to become a 'craft' bricklayer requires intellectual as well as practical skills which can only be acquired from tutors who possess both of those attributes themselves. Furthermore the various bodies responsible for the repair and restoration of older brick structures should not delude themselves in thinking that the current NVQ courses will remedy the problem. A six-month course administered by lecturers who do not themselves possess the practical skills that they are supposed to be teaching is not the answer to the problem. Unless all that are involved with brickwork from the operatives to the clients acknowledge the dire straits we are in, regarding the diminution of a craftsman bricklayer, the seed-corn skill base able to pass on their knowledge will be lost forever within the next fifteen to twenty years.

6

1918 to Present

Introduction

This period has witnessed remarkable developments and scientific achievements providing fresh approaches to architecture that utilise new constructional materials and methods so creating styles of their time. This has partly resulted from the collaboration of architects and engineers in resolving building problems. Previously:

> Designers who thought in terms of technology became the engineers; those who thought in terms of academic aesthetic formulae became the architects, and no love was lost between what soon became the two opposed modes of thought. (Penoyre and Ryan, 1958, 155)

Their collaboration and the new technology they had (and continue to have) allowed them to break away from applied period styles that had become the accepted meaning of architecture, as Penoyre and Ryan continue:

> … these men reverted to first principles and a dogmatic adherence to the functionalist ideal, believing that if a thing was truly fitted to its purpose it must necessarily be beautiful.

A new philosophical background underpinned architecture of the twentieth and early twenty-first century, and thereby the new breed of craftsmen, with an emphasis on putting forms into shape. It can be argued that this movement re-vitalised architecture, producing our modern streetscapes, but overlooked principles of form, proportion, and texture, was the result of a singular concentration on functionalism. Traditional materials such as brick, stone, and timber, continued to be used, but usually with different applications, and in conjunction with new materials – plastics, rubber, and aluminium – alongside steel and concrete.

These materials were produced in whole or part in highly automated factories. Their individual properties were better understood and their performances under loading and climate calculated so that no more material than necessary was used. This final point is of significance, as it led to standardisation that is normal today. The consequence of all this was, and remains, the loss of superfluous ornamental architectural decoration and the demise of associated crafting skills. In terms of structural brickwork, gauged work was dismissed as an unnecessary and highly expensive extravagance.

Brickmaking – A Changing Rubbing Brick

The two kinds of brickmaking – traditional hand-made and mechanically produced – have continue to co-exist throughout this long period although the latter has expanded rapidly at the expense of the latter. This has had inevitable effects on the production, quality, and variety of rubbing bricks available.

Many rural brickyards did not re-open after the First World War, despite the recovery of building activity. Almost all the traditional brickyards who made their own rubbing bricks gradually scaled down production, or stopped altogether, due to the huge reduction in demand for decorative brickwork. The construction industry in general, however, grew rapidly, assisted by large amounts of government aid intended to help house returning soldiers and to revitalise industry. The brick industry was prosperous during this period, and saw substantial re-investment. Many large firms replaced steam power with electricity, and the introduction of petrol lorries for brick deliveries meant not only the beginning of the end for the horse and cart but also less reliance on the railways.

The Second World War once again brought the closure of brickyards, but thankfully, the government and the brick companies had learnt from the First World War and developed a financial scheme to ensure funding for re-opening after the cessation of hostilities. It was at this time the Brick Development Association (BDA) was formed to administer these funds, its objectives being the research and education in the correct use of brick. Despite this help, many small firms were not to re-open and in 1946 there was estimated to be 1,350 brickworks employing 40,000 workers, yet through mechanisation annual brick production continued to rise (Brick Development Association, 2003).

The decline in demand for rubbing bricks throughout the 1950s and on into the 1960s led to a dramatic reduction in the numbers of brickyards making them (albeit on an occasional basis to cater for a particular order) to just a handful. The main company supplying the wanted demand was Thomas Lawrence of Bracknell (Berkshire).

To encourage better constructional use of their rubbers and make up for the lack of on-site workshops and skills of setting out and cutting of arches, Lawrence offered a cutting service supplying camber, segmental, and semicircular arches for on-site assembly. From measurements supplied by the architect or builder, they would draw the full-size arch, obtain templets, and cut the voussoirs using an electrically powered bench-mounted ‘Clipper’ disc-cutter and rub mouldings within profiled boxes (Fig. 150).

Figure 150

Cutting gauged voussoirs by bench-mounted disc-cutter at Lawrence's Warfield works (Berkshire) in the early 1950s. (Courtesy of Michael Dumbleton)

These arch sets were numbered in order for laying and packed for site delivery (Fig. 151). Lawrence continued to offer oversized bricks for bespoke cutting but increasingly it centred on an orange rubber sized to one format of 250 × 120 × 80 mm (9¾ in × 4¾ in × 3⅛ in), as opposed to the wider range of sizes once offered.

By 1967 there were only 531 brickworks, the biggest loss was in traditional brickmaking, which continued to decline, as the small yards were unable to compete with the more cost-effective big companies.

At Lawrence's works in 1978, annual production had dropped to around 250,000 bricks plus 25,000 rubbers; mainly the second quality orange type. The demand for rubbers, being mainly used on repair and restoration work and very occasionally on new-build, had significantly dropped, so they were now only placing 2,000 within a kiln setting. In 1981 The Brick Development Association awarded a certificate of merit for craftsmanship for the re-building of a niche within a garden wall at Hampton Court Palace using TLB rubbing bricks. Thomas Lawrence finally ceased production in 1984, not only of their prized TLB rubbers, but completely. The company was refused Local Authority permission to extract the prized clay for rubbers from the company's land opposite to their works, vital for continued production. Thus it

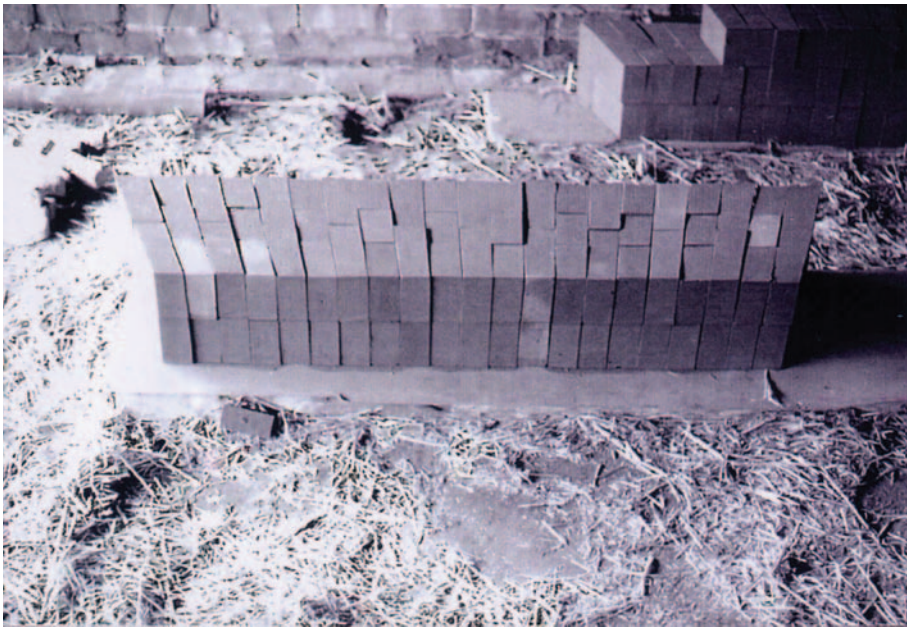


Figure 151
Disc-cut gauged arch sets of TLB rubbers ready for packing and delivery at the Warfield works of Thomas Lawrence (Berkshire) in the early 1950s. (Courtesy of Michael Dumbleton)

was that a highly respected brickmaker who supplied quality rubbers that were a significant part of the best of English gauged work for over a century ceased to exist at the stroke of a planner's pen.

Those who taught the author the skills of gauged work would remark that the qualities of the post-war TLBs, though still very good, were not that of the rubbers made in the pre-war years. Having on many occasions removed, re-worked and replaced Victorian and Edwardian red and orange TLBs, this view is considered well founded.

The prestigious 'TLB' trademark was purchased by the long-established traditional brickmakers W.T. Lamb and Sons, incorporating it into their existing rubber production at their Pitsham Works, near Midhurst (Sussex). Lamb and Sons also produced a yellow gault rubbing brick complementing their range, at their Faversham works in Kent. They produced a TLB red rubber in several sizes and types – firmer bodied bricks termed cutters, primarily intended for machine-cut work, and the 'TLBHCP', a softer rubber for traditional bespoke work and for carving. The latter was originally developed for the repair and restoration of the Hampton Court Palace cut-moulded chimney stacks; hence the added initials 'HCP'.

Hyett (1992, 11) explains the difference in the formulation of both of these types of rubbers in relation to the eventual choice for re-building an ornate Hampton Court Palace chimney stack:

> …we found that the least expensive method of procurement was to use a general TLB brick, the mechanical properties of which allow it to be substantially cut off

> site. The general TLB is very similar in appearance to the specially formulated TLB HCP bricks in current use at the Palace for chimney repairs, except that the ratio of washed clay to sand is reversed from the proportion 25% clay/75% sand (TLB HCP) to 75% clay/25% sand (TLB). This reversal of the ratio of the constituent materials gives a stronger brick, more resistant to attack by wind and frost and to arris damage. Whilst not so easy to hand-cut using a bow-saw, the stronger bricks could be squared in the dry state using diamond tipped saws, roughly shaped by grinding, reduced to template by hand-finishing and hand-rubbed/stoned after construction….

Writing in *Renovation* of June 1988, the architectural historian Dan Cruickshank describes how Lamb and Sons had developed their services for the client, specialising in supplying bricks for gauged work (Cruickshank, 1998, 1–5):

> Lamb's bricks and arches division undertakes to produce full-size working drawings, based on the architect's specification and requirements…. This service is especially valuable if the arch or detail is a repair for an historic building, for many mistakes in specification can be made by architects untrained in the traditions of rubbed and gauged brick construction.
>
> The bricks to form arches, when the geometry has been agreed, are cut by machine saw with each brick being dimensioned according to a template derived from the full size working drawing….
>
> However, moulded bricks – ovolo or scotia for entablatures or stringcourses – are still ground and rubbed, though the process is also now mechanised. But where tradition remains firmly unaltered is in the size and quality of the bricks used for cutting and rubbing….
>
> The precision of the cutting allows for very fine joints in the manner of eighteenth century brickwork although Lamb's recommends 5 mm or 3 mm joints.

The latter remark regarding joint size is revealing. The lack of 'squaring' across the rubbers, to ensure surfaces exactly at 90° to each other before cutting, and the inability of machines to cut to precise tolerances with mechanised blade oscillation, makes close jointing virtually impossible. It further recognises that most site craftsmen were insufficiently skilled to set-out and work to former tighter tolerances.

From 1987, the author, as Head of Trowel Trades at Bedford College of Higher Education (BCHE), established contact with Robert Lamb, the owner of W.T. Lamb and Sons. Over-sized rubbing bricks and pre-cut arch 'sets' were generously provided to support the author's efforts to re-introduce gauged work back into the curriculum. Mr Lamb expressed deep concern over the dearth of skilled bricklayers to do justice to his company's products and very much welcomed the initiative.

During the same period respected traditional brickmakers Bulmer Brick and Tile Company Limited, based near Sudbury (Suffolk), began exploring the potential of reviving production of rubbers. The owner Mr Peter Minter subsequently provided trial rubbing bricks for use at Bedford College in an arrangement that benefited both parties. The apprentices learned how to cut, rub and set enrichments (see figures 164 and 165) and Bulmer Brick and Tile Company Limited gained vital and on-going feedback on various test rubbers regarding hardness, inclusions, workability, and suitability of purpose.

The only other traditional brickyard making rubbers at that time was the Aldeburgh Brickworks of W.C. Reades (Suffolk), mixing their Chillisford clay with their own loam sand prior to over-wintering, for both standard bricks as well as rubbing bricks.

By the end of the 1980s there were only 205 brickyards, employing less than 12,000 people (Brick Development Association, 2003). A growing emphasis on environmental issues, with vastly decreased fuel consumption and waste emissions, was met with computer-controlled gas and oil-fired kilns and re-cycling of combustion products within the firing. The Brick Development Association (BDA), through its advisory centre and well-researched publications, supported these developments and promoted better use of well-detailed imaginative brickwork and more aesthetically pleasing ranges of facing bricks and associated green-moulded specials were introduced. By 2002, brickyard numbers had declined further to 116, owned by only 45 companies employing 6,692 people (Brick Development Association, 2003).

The revival of interest in English gauged brickwork in the 1990s offered a glimmer of hope to the traditional brickyards, unable to compete with the financial and marketing resources of the larger brick companies. Those with the correct raw materials could concentrate on providing their unique type/s of rubbing bricks for the growing and relatively lucrative market in the repair and restoration of traditionally constructed buildings. In addition, the numerous extensions and new-building erected in conservation areas required complementary designs, materials, and practices that reflected their original surrounding properties. This proved moderately successful, though the on-going problem of sufficient skilled and knowledgeable bricklayers to do justice to the bricks produced was, and remains, a serious and constant concern.

Modern Rubbing Brick Production

Rubbing bricks for use in cut and rubbed and gauged work must have specific physical characteristics to suit that purpose. Their properties and qualities in general should also conform to the requirements of BS EN 771-1:2003 *Specification for Masonry Units: Clay Masonry Units*, the European harmonised standard published by the British Standards Institution (BSI). This replaced BS 3921:1985 *Specification for Clay Bricks*, which was withdrawn in 2006.

Only a handful of traditional brickmakers continue providing rubbing bricks for gauged work, which affects the variety of rubbers now available. This is especially so for the repair and restoration of cut, rubbed, and gauged work on historic buildings. This contraction in manufacture has been mirrored by a steep increase in cost to levels that are of concern to all involved with traditional brickwork and its conservation.

Whilst rubbing bricks always commanded higher prices than standard bricks (typically 50–150% more), the current cost differential is several times greater, which has a clear effect on project costs. Colleges wishing to include gauged work as part of their curricula, cannot on the limited funds available, afford such expensive bricks, leading to a reduction in training opportunities and a long-term contraction of the skills necessary for the repair and restoration of historic brick buildings.

Though utilising quality top clays capable of making rubbers, no current traditional brickyard exploits the naturally high silica-bearing brickearths that were the raw material for the best rubbing bricks. Furthermore modern brickyards no longer fire their bricks using slower-burning and lower-temperature wood as a fuel, preferring labour-saving coal and liquid petroleum gas that burn quickly and rapidly reach temperatures well in excess of 1,000°C.

The significance of using such clays and high firing temperatures in excess of 1,000°C on the quality, workability, and durability of modern rubbing bricks formed part of this research programme. The open-pore structure of modern rubbers, like historic rubbers, is of significance in relation to the positive durability of the brick.

Currently, however, three traditional brick companies produce a selection of rubbers with varying degrees of associated services for cut, rubbed, and gauged work. These are W.T. Lamb and Sons (Bricks and Arches) Limited in Sussex; Bulmer Brick and Tile Company Limited in Suffolk and W.C. Reades of Aldeburgh in Suffolk. Michelmersh Brick and Tile Company Limited in Hampshire and H.G. Matthews and Sons of Buckinghamshire are working towards the production of a rubbing brick from their respective orange/red, red and Chalfont Red range of hand-made bricks. Also several other brickmakers like W.H. Collier Limited in Essex, The York Handmade Brick Company Limited, Yorkshire and Hanson Building Products, Bedfordshire, are seeking to develop and produce rubbing bricks.

W.T. Lamb and Sons Limited

W.T. Lamb and Sons Limited, which incorporates Lambs Bricks & Arches, have been producing rubbing bricks for the longest period of time. For their red rubbers, they excavate and initially prepare their clay at their Faversham works in Kent, transporting it to the Pitsham yard by lorry. Their red rubbers are available in six colours – light orange through medium to plum red in colour – to suit various architectural applications. They also continue to provide yellow and gault cutters out of their on-site clay reserves.

The raw material from Faversham is approximately one metre deep below topsoil; once excavated, and weathered over winter, it is milled, washed clean of impurities and allowed to settle in pits next to the pug mill and allowed to mature for approximately twelve months. In preparation for moulding the clean rubber clay is then placed in a pugmill and then conveyed by belt to the hand-moulding bench.

The wooden moulds – of box, beech, or teak – are dipped in water and sanded ready for the clot of clay to be thrown once it has been rolled in the same moulding sand. The green-moulded bricks are then removed for open stacking in covered hack sheds to dry naturally in readiness for firing. This takes about six to eight weeks, during which the rubbers shrink by about 11%.

Lamb and Sons have two types of kilns available for firing rubbers – two traditional downdraught kilns and three modern batch fibre kilns, all fired by propane gas. The downdraught kilns had a capacity of 30,000–40,000 bricks, and the batch kilns have a capacity of between 5,000 and 12,000 bricks. Traditionally, the old downdraught kilns would have contained out of their total capacity, some 10–15% of rubbers, these placed for four courses maximum in the centre bolt of the mid-kiln position, the overall burning temperature ranging from 980°C to 1,140°C during a 72-hour cycle. The kilns would then be left to cool for seven days or more before the wicket was removed and the rubbers were drawn from the kiln.

In the modern computer-controlled batch kilns the full capacity and content of between 5,000 and 12,000 units can be entirely rubbing bricks. These stacked inside in a block set formation. The firing temperature, dependent on the type and colour of rubber/cutter required, will be in the range 980°C to 1,060°C over a 48-hour period; with a greatly reduced cooling time varying from as little as 8 up to 18 hours. Shrinkage is about 1% and wastage is minimal.

Today Lamb and Sons TLB rubber range come in two degrees of firmness; soft rubbers for traditional carving and harder rubbers (cutters) which are intended for in-house machine cutting and moulding incorporating hand finishing.

In either respect Lamb and Sons have responded to the present-day market conditions, whereby the lack of site crafting skills increasingly demands prepared gauged elements for on-site assembly only. They therefore offer a service of surveying details and providing designs for the specials and carved units with CAD packages. Machine cutting and moulding is achieved with bench-mounted disc-cutters and reverse-moulded carborundum wheels through which the harder rubbers are passed by the skilled cutters at the Pitsham workshop to match the full-size drawings and templets.

Lamb and Sons are not currently supplying the oversized TLB and TLBHCP rubbers for on-site cutting and rubbing, unless specifically requested for bespoke work by a highly competent craftsman. They have recently (2007) communicated that as a result of a substantial increase in interest and demand they are exploring the possibility of re-introducing and producing for the market a softer rubber to satisfy an apparent demand of the industry. In respect to the latter, Lamb and Sons have continued to be particularly supportive of the author with their oversized rubbers, as well as purpose-cut and moulded units, for his many master classes, lectures, and televised work.

In addition to rubbed and gauged profiles of any shape and type Lamb and Sons also undertake carving for on-site assembly of enrichments, such as capitals and swags. All cut and carved bricks are carefully packed, in numbered order to assist laying, in timber delivery trays and shrink-wrapped to arrive at site in perfect condition. The overall accuracy of the entire hand-cut and machine aided cutting, moulding, and carving facility allows for setting out of the rubber materials supplied to site with joints that can be as fine as 2 mm, but more generally 3 mm.

In order to meet today's demands for modern construction, Lamb and Sons can now also offer pre-mounted gauged brick arches in their rubber materials. These arches are mounted upon a reinforced concrete lintel incorporating stainless steel reinforcement, brick faced on face and soffit as required. The arches are fully-face finished and pre-pointed in lime white or off-white pointing medium to suit traditional or aesthetic requirements. Structural lifting eyes are incorporated within the pre-formed arches enabling ease of installation on site where the arches are lifted into position and then installed and bedded in the appropriate openings.

Today Lamb and Sons TLB rubber range come in two degrees of firmness; soft for traditional carving work and a traditional cutter which is intended for in-house machine cutting and moulding and is also suitable for hand crafting and finishing. In either respect Lamb and Sons have responded to the present-day market conditions, whereby the lack of site crafting skills increasingly demands the requirement for prepared gauged elements for on-site assembly only. Therefore they offer a service of surveying details and providing designs for the specials and carved units incorporating CAD design packages.

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Bulmer Brick and Tile Company Ltd, Suffolk

Bulmer Brick and Tile continue their product development and currently market two types of orange/red rubbing brick, pan-ground and fully-washed, as well as a buff cutter; all of which can be supplied to standard or requested sizes.

Their 10-metre thick seam of London Bed clay, just over a metre below ground level, is dug during late August–September using mechanical diggers and left to over-winter. It is then pulled down into beds and soaked with water for up to 24 hours. With additional water, it is then put through one of three pug mills. For the 'fully-washed' rubber the clay is blended to requirement, washed, screened, taken through a filtering process, and then stored to sour for up to four weeks. Sand can be added to rubbers, the amount being dependent on the mix required.

The moulder sands his bench and draws down his warp of prepared clay and throws it in to the dampened and sanded timber mould box. The excess clay is then struck-off and the green brick turned out on to the pallet board ready for removal to dry. A good moulder will mould 200 to 250 oversized rubbers a day, depending on mix and size.

Drying takes place outside, at the hackstede, between March and October, and inside with propane heaters and de-humidifiers, during winter. Rubbers take about four weeks to dry and are only pitched one row high. Shrinkage is 10–12%.

Firing takes place in a coal-fired intermittent downdraught kiln with a capacity of 12,000 bricks, of which 500–1,000 are rubbers placed in the centre of the kiln. The fire is lit and built up over a total of four days, feeding coal every 1¼ hours during the two main days, reaching a temperature of up to 1,100°C. A three-day cooling period then follows. The overall loss is 2–3%.

Their two types of orange/red rubbers are pan-ground or fully-washed: both produce a firm brick responding well to machine cutting or a softer rubber for traditional hand cutting. In line with their development of the various rubbing brick range, Bulmer Brick and Tile Company, in partnership with Colin Pinnegar, now offer the Bulmer Brick Cutting Services (BBCS), which seeks to offer traditional and modern requirements, including working drawings.

They supply arches cut on the dry bench-mounted disc-cutting machine and gauged brick elements cut by bow saw to profile and templet, and workshop carving for on-site assembly; intended to complement the traditional craftsman's practices. This service also extends to supplying fully bonded solid arches, of rubbers cut to voussoirs, bonded and fixed with epoxy resin on to steel lintels (pointed or un-pointed) requiring only to be set in position.

All bricks are palleted and shrink-wrapped for delivery. Purpose cut-moulded or carved elements are numbered and dry assembled in packing boxes and wrapped for despatch.

It had become increasingly necessary for the ongoing development of the Company that an additional kiln needed to be built. Firstly to enable the existing seventy year old kiln to be fully refurbished, and secondly to increase their capacity and flexibility. Once they had made the decision to go ahead there was only one real answer, and that was to build a replica of the original. They were fortunate in having the original drawing providing the basis for the new model. A model which only required minor improvements to become more heat efficient and work friendly.

Now (2007) after some twelve months in the building, it is fully operational and the decision to remain using a coal fired kiln is to maintain the continuity and traditional individuality of Bulmer Bricks.

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W.C. Reades of Aldeburgh, Suffolk

Production of the uniform red-coloured rubbers at the Aldeburgh Brickworks is much as it was in the 1980s. Besides various sizes of moulded voussoirs requiring only rubbing, 'topping and tailing' to the relevant templet shape, Reades now offer three different sizes of oversized rubbers to facilitate bespoke cutting. Other brick companies who cut and supply purpose-made gauged arches for on-site assembly also buy many of their rubbers.

Their Chillisford Clay, 450 mm below ground level and from 3.5 to 4.5 metres deep, is a very clean material, greasy, and moulds easily. It is machine dug and, to a given ratio, mixed with sand from a seam in the same pit. It is then soured for up to 15 months. Due to the inherent lack of major inclusions, it is no longer washed but only ground and then pugged ready for moulding.

All rubbers are hand-moulded. The clay on the sanded bench is rolled in to a clot for throwing in to the dampened and sanded timber mould box. The excess clay is trimmed with the wire bow and smoothed with a timber 'strike'; the green brick then turned out on to a pallet and placed on to a drying tray for internal shed drying. The rubbers dry naturally during a three to four-week period. During the winter a gas-oil fired blower and under-floor heater are used.

Burning takes place in one of four fuel-oil, up-draught scotch kilns, each with a capacity of 36,000 bricks. The rubbers, as green-moulded specials, are set within a box within the upper part of the setting to protect from over-firing. The fire temperature is from 1,000°C up to 1,250°C over 50 hours, time dependent on the weather, with a cooling period of 5 to 10 days. The loss is negligible.

No in-house cutting service is offered and all bricks are delivered by contract haulier on shrink-wrapped pallets, or collected by the customer direct from their coastal brickyard.

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Michelmersh Brick and Tile Company Ltd, Hampshire

Michelmersh Brick and Tile Company Limited, based near Romsey (Hampshire), was founded in 1842 and records show that rubbing bricks have been produced in the area for over 150 years. To fulfil demand from customers for matching local arches, in the mid-1990s the company began offering purpose-cut gauged arches for on-site construction from their orange/red and red-multi range; that have a texture and appearance of many rubbers dating to before the mid-nineteenth century.

All of Michelmersh products are produced from their Reading Bed Clay, varying in seam depth from 1.5 to 15 metres; and lies between 1 to 5 metres below ground level. Machine excavation is seasonal and enough clay is won to weather outside and produce a full year's brickmaking.

The matured clay is ground down in a Craven wet pan, at which point water is added to produce a slop that is stockpiled and soured for three days prior to use. When required, it is loaded in to a mixer/feeder to be conveyed to a pug mill in to which grogging sand is added to aid plasticity and open-up the body to facilitate improved drying. The total sand content, including the naturally occurring sand/silt is between 48% and 51%. Water is added to maintain moisture contents of between 23.5% and 24.8%. Finally, in order to obtain the colour range required varying percentages of fine coal dust (breeze) is added. This breeze, it is considered by the author, should not be used as it causes internal hardening within the rubber and so effects its quality.

The pugged clay is fed to the hand-moulders by belt feed, which they remove as required. The clot of clay is rolled on the pre-sanded bench and then thrown in to the pre-sanded timber mould with the excess being removed with the wire bow and the brick released from the turned-over mould on to a tray.

All the handmade products, including the rubbers intended for the gauged arches, are dried in computer-operated chamber dryers, with full temperature and humidity control. The cycle time is 45 hours, with moisture levels reduced from 24% to less than 2%. The gas-fired dryers can reach 90°C but generally operate at 65°C, with a fully controlled airflow to monitor critical shrinkage of about 8% on length, 10% on width, and 5% on height of a typical brick.

Firing can be carried out in any one of three kilns to produce the desired product. For example, for a light orange, they might place the brick in the top part of the intermittent or moving-hood kiln, yet for a redder hue bricks would be placed to the centre of the beehive kiln.

The intermittent up-draught kiln is gas-fired with a capacity for 10,500 bricks. The downdraught moving-hood kiln is oil-fired with a 45,000 brick capacity, and the downdraught, oil-fired beehive kiln has a capacity of 38,000. In any of these kilns, the rubbers make up about 5% of the brick total. The stacking position of the rubbers is chosen only to achieve a required colour, rather than protection from over-firing. The firing temperature and time varies with the kiln. For the beehive and moving-hood, a temperature of 1,050°C for two days is normal, yet, for the intermittent kiln, 1,020°C for 12 hours are standard. The expected loss also varies with kiln type, 3% with the intermittent kiln, 8% for the moving-hood and 10% the beehive.

Michelmersh can supply oversized rubbers but generally offer machine-cut gauged arches for on-site assembly. Their service extends to assisting the designer by sending out a representative to establish a colour/texture match and then determine the exact architectural requirements; with drawings utilising their on-site CAD program. All arch sets are numbered, dry-assembled in delivery boxes for despatch to the customer, protected by shrink-wrapping.

Mr Andrew Gardiner, Assistant Works Manager of the Michelmersh Brick and Tile Company over the course of several discussions and meetings with the author comments on the current and future production of rubbing bricks:

> Until now it has been our belief that our clay does not lend itself to producing a fully fledged rubbing brick. Whilst the brick is soft enough to rub to size, once the brick face is rubbed it exposes a pitted surface rather than the close textured finish we've always associated with traditional rubbing bricks.
>
> However, during our discussions it became apparent that, with modifications to our clay preparation – removing the breeze, using a finer grade of grogging sand and altering our firing process, we could possibly produce a brick suitable for rubbing in the traditional way.
>
> At the moment we operate with a single clay preparation system feeding a factory producing 250,000 products each week. Our current ranges of facing bricks are all 'Multis' and dependant on the addition of breeze for their colour. Therefore, modifying our process to effect a trial into producing rubbing bricks would prove difficult. However, we do have plans to alter our current clay preparation system, which would enable us to undertake some small-scale trials in the near future.
>
> Ultimately the decision to add rubbing bricks to our product range, if trials prove successful, has to be a commercial one. Questions such as: Would the introduction of a rubbing brick enhance sales or be at the expense of our existing cut arches and purpose made specials business? Also, are there sufficient bricklayers with the traditional skills to rub arches or carve specials on site? And are architects/specifiers aware of the existence of rubbing bricks for their projects? – All need to be addressed.
>
> You *[the author]* have certainly shed some light on the whole subject of rubbing bricks. Thanks to your efforts it is reassuring to know that we are not that far away from being able to produce rubbing bricks, should demand be there [Gardiner, 2004].

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H.G. Matthews, Buckinghamshire

H.G. Matthews are a well-established family firm of traditional brickmakers established in 1923, and produce between 50–70,000 bricks per week of which 15–25,000 are handmade. During the last decade the company has occasionally produced bricks capable of being rubbed. The intention of the company is to produce a rubber by modification of the clay preparation and firing techniques.

James Matthews of H.G. Matthews and Andrew Hales his head brickmaker, have taken the lead in this initiative and in consultation with the author, agreed to focus on clay preparation and firing. For the clay preparation it was deemed necessary to increase the sand ratio, and to look at washing and screening the clay. It was agreed in this respect that the company would look at producing a washed and unwashed rubber, with the intention of achieving a broader range of bricks for aesthetic matching to different historic periods. With regard to firing, they were determined to fire at 900°C, and to seek to position the rubbers in the stacking arrangement within the kiln to maximise the potential of the firing process to produce quality rubbers.

Their orange through to dark-red standard handmade facing brick is called a Chalfont Red and is made from a mixture of Chalfont Clay and natural sand. This clay sits within a 6.5 metre seam about one metre below ground level. Machine excavation is seasonal and the won clay is mixed 50/50 in the pit or knott-hole. The blended clay once moved to the works is then stored for weathering for as long as possible. When required a given amount is drawn down by mechanical digger and a 'soak' is created, whereby water is added which overnight is absorbed so that the material becomes more malleable. On the day of use the 'soaked' material is turned over by the digger to crudely mix it, this is then taken to the single-shafted mixer to be pugged.

The pugged clay is taken by conveyor belt to a set of crushing rolls, the top set having a screw thread profile draws the large pieces of integral flint waste within the mix away to an awaiting container. The residual clay then falls through to a small set of smooth-faced twin rolls crushing any remaining inclusions creating a clean-bodied and workable material. This is then taken by conveyor belt to the hand-moulders' benches. The brickmaker removes his clot of clay from the large pile deposited on his bench. This clot is rolled in sand and thrown in to the pre-sanded teak timber mould, the excess trimmed off with a metal strike, and the mould tapped and turned to eject the brick cleanly. The green moulded rubbing bricks are placed on stillages under a wooden frame covered with corrugated Perspex to naturally dry for 12–14 days in ideal conditions; in the winter months drying is aided by the use of computer controlled oil-fired blowers and electric fans.

The burning takes place in a gas-oil fired, up-draught scotch kiln with a capacity for 70,000 bricks. The firing temperatures are between 900°C and

1,100°C over 20–22 hours with a 48-hour cooling period. The loss in firing is about 2%.

Of the trials, Mr Matthews says:

> Initially we took our standard Chalfont Red hand made facing brick to Gerard Lynch to see if it was suitable for a rubbing brick. Following discussion it was felt that the brick showed promise and further development were justified.
>
> Trials proceeded on two fronts under the guidance of Andrew Hales, our most experienced brickmaker. First the normal Chalfont red brick was fired at 900°C for 36 hours in our intermittent test kiln. A batch of Chalfont clay was mixed with extra sand. This was done in two ratios, one at 2 parts clay to one part sand, and another at one part clay to one part sand. These mixes were not sieved or put through the normal clay preparation system and so resulted in a course clay mix. After drying these bricks were placed into the top of our normal Scotch kiln, they were loose-set in chambers that had been set within the normal bricks either side of the kiln, about four feet from the kiln walls in order to achieve a lower firing temperature.
>
> The resultant bricks were again taken to Gerard Lynch's workshop for rubbing and cutting trials. The normal Chalfont brick fired at 900°C was found to be still too hard, though the colour achieved was most pleasing being light orange and we will now add this to our standard brick range. The bricks that were made using added sand were felt to be much nearer the mark, particularly the brick with the one part sand to one part clay. This rubbed well and cut very easily and precisely with the bow-saw. It was also a remarkably close colour and textural match to a Warfield [Berkshire] rubbing brick (*c.*1740) that was present in his collection of historic rubbers.
>
> Over the last few years we have continued to trial the manufacture rubbing bricks and have discovered that we now have several options developing. We have found through test cutting and moulding using the traditional bow saw technique, that the clay used to produce our existing range of Chalfont facing bricks needed very little to be done in terms of altering the materials, only the technique of moulding, kiln setting and firing. Also the natural quality of the Chalfont clay is giving a colour range of rubbers of orange through to bright red. Although our emphasis has been to produce a fully-washed rubber we also wish to market an un-washed rubbing brick as well; that will match bricks from the historic periods that predate refined brickmaking techniques.
>
> It is our intention to supply a range of rubbing bricks to suit the current new-build and conservation/restoration market that are priced to give us a sensible return on our manufacturing and within the budget of our clients. As part of this we also wish to be helpful to colleges and other establishments, who are providing education and training in gauged brickwork with limited funds, to enable them to obtain a selected grade of rubber set-aside for educational purposes.

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A number of other brick companies are currently looking to develop and produce rubbing bricks.

W.H. Collier Ltd, Essex

This is an independent company based near Colchester (Essex). They currently produce up to 750,000 handmade bricks per annum (2007). A small batch kiln has been installed, thus enabling them to fire rubbers and cutters for the East Anglian market and beyond. In this respect it is proposed to re-introduce the traditional Collier 'Primrose'. Trials are on-going and the range should be established by end of 2008.

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Contact: Mr Maurice Page or Jackie Longman

The York Handmade Brick Company Ltd, Yorkshire

This north Yorkshire based traditional brickmaking company recently installed a plant to manufacture rubbing bricks, including bespoke one-off sizes for training purposes and restoration work. This unit is part of a new facility for the production of non-standard clay units of all descriptions.

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Web: www.yorkhandmade.co.uk
Contact: Mr David Armitage

Hanson Building Products, Bedfordshire

As of January 2007, Hanson Building products were not in a position to manufacture oversized traditional soft red rubbing bricks for gauged brickwork. The company is, however, assessing the feasibility of relocating its Milton Hall traditional soft red brickmaking machinery from Essex to another suitable location.

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Sussex Hand Made Bricks, Virginia, USA

There have also been some recent trials in the hope of small-scale production of a rubbing brick in Richmond, Virginia, in the United States of America. The author had a chance to work with some of these, using traditional cutting and rubbing skills at an event in Bacon's castle, Virginia (2006) and the results were most encouraging.

Until recently there has been no manufacture of rubbing bricks in the United States. This is despite a revival of interest in the subject of cut and rubbed and gauged brickwork, and especially as people seek to repair and restore Colonial brickwork with these features on to the highest standards of authenticity.

Over the last year Jason Whitehead of Richmond, Virginia, who has worked for several years in the brickmaking area of Colonial Williamsburg, where they closely follow the eighteenth-century methods of brickmaking, has been liasing with the author and producing trial rubbing bricks on his family property. Made completely in the traditional manner (i.e. the first batch of bricks were made with clay treaded by foot), these hand-moulded bricks made out of a local south eastern Virginia clay with a high sand content, are fired with hardwood fuel in a clamp style kiln for around 4 days. These low-fired bricks are then sorted based on colour and hardness. This allows for matching of existing work such as their use in repairing segmented arches at the 1780's President's House of the College of William and Mary. Though only a few thousand have been made so far with moderate success, efforts to refine clay mixing and kiln firing practices should help to improve future rubbing bricks production.

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The Frost Resistance of Rubbing Bricks

Many observers today observing rubbing bricks being abraded and cut so easily wonder about their ability to perform in the weather, particularly their frost resistance. The hardness (compressive strength) and water absorptivity of bricks are two properties often linked to their frost resistance. In this respect, one might expect harder bricks with low water absorptivity to show a greater frost resistance than soft rubbing bricks with high water absorption. These properties, however, have never produced a dependable indication of frost resistance. In his *Notes On Frost Resistance Of Clay Bricks* (Hammett, 2004) several important points are explored that aid clarity of this subject, such as:

> The physical characteristics of a fired clay body that make a brick or tile frost resistant are not easy to determine or measure. Nor are they consistent. Several clay manufacturing industry and academic research projects have explored the phenomenon since the mid-twentieth century, but no practical method of predicting frost resistance has been devised.
>
> Many bricks of only modest strength (7–20 N/mm^2) and high water absorptivity (20%–30%) have excellent resistance to damage by frost action.
>
> There is no dependable correlation between strength or water absorption and frost resistance. It is generally felt that resistance can be produced by either of two different characteristics.

> The first, and perhaps the more easily believable, is that if a clay body is of great density and therefore has very low water absorption, water cannot enter the fabric in sufficient quantities to cause sufficient force by the expansion of ice formation. Furthermore, such dense bodies generally have high strength that resists what force is exerted. Water absorption is relatively easy to measure and characteristic figures vary across the range of different types of bricks from less than 2% to over 35%! But there is no correlation to frost resistance. Generally bricks of very low water absorption (below approximately 5%) are frost resistant, but some are not; there is no consistent correlation.
>
> The second characteristic is very difficult to measure or otherwise define. If the clay body absorbs water, the nature and continuity of the pores in the clay body seems to be significant. Studies reveal that the behaviour of freezing water in microscopic spaces is complex and the state of saturation produced by 'practical' exposure, i.e. in the field, is not always absolute and so tiny air voids exist behind the surface saturation that allows pressure of freezing water to be dissipated within the body.

Recent scientific testing of both historic and modern rubbers supports this latter point. It is believed that one of the main contributing factors to the resistance, and hence durability, of cutters and rubbers is their extensive pore structure, which makes them very efficient at transporting moisture (Pavia and Lynch, 2003, 19) (Colston, 2004) See Case Study. Hammett (2004), however, adds that, '…this characteristic has proved impossible to define in any practical way and the supposition remains a hypothesis'.

Frost resistance is traditionally declared by experience in firing to a semi-vitreous state and in use of the products. Testing to assist definition of frost resistance of clay bricks in the UK, since the mid 1980s, centres on replication to conditions as experienced in the field, of exposure to wetting and freeze/thaw cycles of brickwork. The vast accumulated data indicates a good correlation between long-term field experience and developed test methods of the products.

Under BS EN 771-1:2003 *Specification for Masonry Units: Clay Masonry Units*, there are three categories of frost resistance, classified by declaration as a result of observation after a number of years in use, which are:

- F0 – bricks suitable for passive exposure.
- F1 – bricks suitable for moderate exposure.
- F2 – bricks suitable for severe exposure.

Future Prospects for Rubbing Brick Producers

Modern rubbing-brick manufacture has over-concentrated on producing the fully-washed, late Victorian type of homogeneous bodied brick. This has been at the expense of handpicked rubbers selected out of a general firing, creating unique tones and textures that were important in creating the cut, rubbed, and gauged work of previous centuries. The tendency to fire rubbers at higher temperatures is also of concern, not only for the loss of any pozzolanic benefit that diminishes markedly beyond 900°C (Baronio and Binda, 1197, 41), but also for those wishing to continue executing traditional hand-crafting skills on soft rubbing bricks.

The move by some brick companies towards using mechanically cut and/or abraded rubbers for on-site assembly has led to the production of a harder brick. This enables it to withstand the spinning force of a cutting disc or profiled carborundum wheel, whereas a soft rubber would lose its all-important sharp arrises with the high-speed air vortex created by and ahead of the cutting or abrading heads. From an economic point of view, the softer rubber, ironically, causes excessive wear on these tools.

Several other brick or building product companies advertise the supply of machine-cut voussoirs for gauged arch sets for on-site assembly or as gauged-faced lintels. These are either a brick of their own or one from another supplier; some of which have a tenuous claim to being an authentic rubber.

A lot of designers today use computer-aided design (CAD) programs rather than the time-tested geometrical methods of setting out and establishing working templets for arches practised by experienced craftsmen. This can be used successfully but can and does sometimes lead to on-site assembly problems. Although CAD can be used to produce full-size drawings for templets or setting out, careful checking for accuracy should always be undertaken before use and in consultation with the designer.

Tests on the efficacy of the use of CAD drawings for fine gauged work was undertaken by architect Simon Douch with the author, alongside a traditional drawing of elevation, plans and section of the small-scale niche (see Fig. 171). From the CAD drawing the necessary templets were obtained and the results were very good, but as Mr Douch emphasised the all-important accuracy in the use of CAD is dependent on the quality of the computer software and the level of knowledge and skill of the designer operating the system. In respect of the accuracy of a computer print-out, from which to obtain precise templets, it is dependent on both the quality of the software and hardware of the system employed.

Gauged work demands accurate drawings from which all necessary information can be obtained by the cutter and setter. It is unforgiving of error and any deviation, especially when working to finer traditional tolerances, as these become exaggerated if the setter tries to build-out the mistake.

Bricklayers can sometimes find that delivered pre-assembled units do not fit precisely together and resort to rubbing-up individual bricks to resolve the problem. This should never be done as, after due consideration, one might discover the error was not with that particular brick; one is therefore only compounding the problem. This practice also removes the responsibility of the supplier to ensure an accurate fit, as one has interfered with their original setting out and cutting. Faced with such a problem, if all else is correct with the surrounding brickwork into which the intended enrichment is to fit, then first recourse must be with the supplier.

Clearly the production of purpose-made or pre-cast arches and machine-cut gauged architectural enrichments, economically satisfies a modern demand for on-site fixing of quality-controlled units and removes the need for a cutting shed and the highly-skilled labour necessary to prepare, set-out, and cut the rubbers. These, however, only serve to exacerbate the loss of traditional craft skills and associated knowledge of bricklayers necessary to set-out and work the rubbers. Furthermore, pre-cast, gauged-faced lintels will have a place on some new-build, but have little, if any place on historic buildings. Peter Hill in discussing this trend for machine-worked units in respect of traditional stone and gauged work says:

> In the face of masonry by extrusion, which is economically cost effective, allow the use of dead, lifeless, machined stone, or brick in historic buildings, a trend, which will be difficult to reverse….(Hill, 2004)

The ultimate manifestation of this development of pre-cast gauged-faced work is the entire ashlared façade of the new city of London Headquarters for international finance company Merrill Lynch, in Newgate Street (Hammett, 2000, 30–31).

Most, if not all, who cut ready-to-assemble or pre-assembled units, though good at their work, are not time-served bricklayers with site experience of setting gauged work. Bricklayers who have been taught properly how to set-out, cut and set gauged work will always produce a high standard when building purpose-cut work as they also fully understand how to then build everything correctly too. Historically, 'hewers' and 'cutters' have always been selected from the best bricklayers, experienced in setting their own and fellow craftsmen's cut work, vital, as their bench-cutting empathised with the craftsmen's work setting it.

Mechanised cut curved profiles are sometimes found wanting. For example, on an arch elevation where there is to be a moulded label, both the moulding lines and the extradosial and intradosial surfaces might be tangential rather than radial. There is also frequent conflict at the interfaces between face and return mouldings. Finally, some cut return mouldings are formed by a combination of cut and stick techniques. These are made all the worse by the use of hard impermeable epoxy resin adhesive which, despite the inclusion of brick dust to disguise the deceit, is visible and proves difficult to rub-up in finishing. These are a poor substitute for the original hand-cut originals they seek to copy and frustrate the bricklayers using them, demanding unnecessary time in finishing and made all the more difficult because of the harder rubbers.

Modern purpose-made units, for on-site assembly, are not always formed true to the style of the period, particularly gauged flat, or camber, arches that are often set out and bonded to a standard workshop format. Such practices are of particular concern, as the skills of the brickmaker are clearly not those of the qualified bricklayer with experience of working with historic gauged brickwork.

Furthermore, and especially in historic brickwork conservation or restoration, there is nearly always the need to hand-finish rubbers to match the unique facing techniques of the surrounding original work. Mechanised work looks what it is, devoid of a craftsman's touch, and can appear dead in its lack of tooling and abrading styles or, as former Senior Lecturer in Brickwork at Willesdon College Of Technology, Bob Baldwin remarked 'It has no heart…' (Baldwin, 2004) (Fig. 152). It is the very antithesis of what gauged work, as the finest expression of the art of a bricklayer, is meant to represent.

Figure 152
Hand-carved egg and dart moulding by the author behind one that has been machine cut.

Combine these points with the aforementioned problem of differing texture when matching modern rubbers to historical originals and one can appreciate how the character of charm of quality Stuart, Georgian, or Victorian brickwork can readily be lost (Figs 153 and 154).

It is entirely understandable and proper that brick companies will seek to increase productivity and some companies will produce rubbers that are better suited to their own particular in-house cutting and moulding techniques and modern site demands. We must, however, retain a balance. Pre-cut work can and

Figure 153

Gauged flat arch in which the rubbers reveal their texture and small inclusions, at Wren's The Royal Observatory, Greenwich, London, 1675.

Figure 154

A modern replacement gauged arch at The Royal Observatory, Greenwich, London, 1675. This does not match the surrounding original seventeenth-century work in brick colour or texture, and is bonded incorrectly.

will have its place and therefore the bricks must be supplied to satisfy the demand for it, but so too must oversized rubbers be readily obtainable and promoted for bespoke work that is set out, cut and built by the bricklayer. Also we must not lose sight of the variety of soft-textured rubbing bricks that can be produced – albeit in a small, even seasonal way – so that we have a product that is wholly appropriate for the repair and conservation of buildings of all historic periods.

Gauged Brickwork from 1918–1939

Building sites changed rapidly as the twentieth century progressed, especially in the towns and cities where machinery and motor-driven tools began appearing and tubular steel scaffolding replaced timber. Site congestion reduced extensive on-site workshops such as the bricklayer's cutting-shed.

Architectural changes reflected social responses about how future housing should be built, responding to the alarming findings on the overall level of poor health of the nation's young men when conscription started in 1916. Inadequate and inferior housing was held largely to blame, and the resultant Tudor Walters Committee report of 1918, set down minimum standards for workers' houses constructed during the inter-war period. This served as the foundation for other standards for a long time after.

Externally, structural brickwork reflected these changing times. Though solid-wall construction dominated, the true cavity wall was increasingly used, and cement was being added to lime mortar for both increased speed of construction and also additional strength for thinner walls. The general standard of brickwork achieved was good, and minimal enrichment was entertained to enliven principal façades, though usually along flat, angular, or recessed planes. This was achieved by the manipulation of standard bricks, 'creasing tiles' or, more traditionally, with axed arches of soft stocks neatly finished with precise, mainly 'weather-struck and cut' pointing.

Regular mechanised bricks on principal façades increasingly removed the need for the traditional colour washing and tuck pointing, or the precise cutting and rubbing of ashlared gauged work. It became ever more difficult for the discerning architect to argue in favour of gauged work because the overriding aim was to achieve quality of construction, but at minimal cost. When it was employed, usually for a simple arch, the high standards only a generation before was increasingly relaxed as a fashion for a wider joint prevailed; perhaps as a result of the overall loss of those finer skills. This killed off any remaining remnant of William Morris's ideals of a handcrafted Britain that was viewed by architects and planners as a luxurious deceit that was simply too expensive.

As Quiney (1986, 145) records:

> 'The standard cottage will depend for any attraction that it may possess, not upon the tool marks of the workman, nor upon its peculiarity or idiosyncrasy, nor in a word upon its individuality', wrote the planner and architect Stanley Adshead in 1916, 'but upon more general characteristics such as suitability to purpose and excellence of design.'

Some simply disliked the use of gauged brickwork *The Brick Builder* of March 1927 reported (1927, 44):

> I hold, for instance, that it is not possible to imagine a kind of bricks nor a manner of using them more entirely delightful for their purpose than is to be seen in the elevations of Sir Edwin Lutyens' Midland Bank in Piccadilly. Here, again, we have bricks; not bits of soap, or blocks of cheese, or nougat or chocolate, but

> real bricks; and they are in those walls, disposed as an understanding craftsman would dispose them. It is only necessary to imagine the same design rendered with rubbed flat arches, quoins of the same fashion, and a uniform close-jointed, neatly-pointed panel work, to realise how important for all brick architecture is the use of bricks which expressed the nature of bricks and a sense of them as fashioned by men's hands from clay dug from the ground and burnt hard; and the employment of right unaffected bricklaying craft, which scorns to form finer joints than the bricks and mortar make appropriate….

This writer sees honest artistry in the craft of brickmaking, but not when applied to a bricklayer crafting a rubbing brick as a mason his stone. Would he have stone never worked, but laid only as it was quarried and believe that honest? Like everything, it is a matter of knowledge, perception, and taste.

Despite this hostility to gauged work there were still craftsmen capable of producing it when required in the 1920s, as was to be seen in the new garden at Broome Park (Kent), designed by the architect Detmar Blow (1867–1939); a disciple of John Ruskin. In praising the skill of executing a gauged globe as a finial on a pier, Nathaniel Lloyd (1929, 64) remarks:

> The skill with which so perfect a sphere has been fashioned is remarkable, for such balls have proved to be the rocks upon which many a craftsman has foundered. This piece of work is characteristic of the skill possessed by many bricklayers in Kent and Sussex.

By the 1930s decorative brickwork declined further in popularity as the fashion for Art Deco pushed designers towards rectilinear forms. Brickwork became increasingly functional, with openings spanned by lintels exposed on face or standard bricks laid upright as 'soldiers'. English and Flemish bonds had remained common, even for the increasingly popular cavity walls utilising snapped 'bats' to achieve the appearance. As the 1920s and 30s progressed, however, Stretcher bond became ever more acceptable and the increased use of stronger cement mortars with 'jointed' rather than 'pointed' finishes. Undoubtedly the craft of the bricklayer and the use of brickwork were undergoing a subtle, but nevertheless substantial, transformation.

The Post-Second World War Period

The Dudley Report of 1944 led to the publication of the *Housing Manual* by the Ministry of Health and Ministry of Works, which laid down minimum requirements of post-war re-construction for strength, stability, thermal and sound insulation, and resistance to damp and fire. This influential publication became the guide for all subsequent standards in house construction for many years.

The very influential government report, *Government Houses for Today and Tomorrow*, prepared under the Chairmanship of Parker-Morris, was published in 1961, and set the 'Parker-Morris' standards of construction. The Building Regulations of 1965 (revised several times since) became a system of controlling the planning and construction of buildings throughout England and Wales replacing various local bye-laws in operation since the Public Health Act of 1875. Research, commercial, and professional bodies also contributed to the development of the style and use of masonry to meet contemporary demands; the National Housebuilder Registration Council (NHBC), Building Research Establishment (BRE) (formerly the Building Research Station, BRS), British Standards Institute (BSI), British Ceramics Research Institute (BCRI) and the Brick Development Association (BDA) being the most influential.

From a bricklayer's perspective new constructional practices emphasising economy of material meant that brickwork underwent dramatic changes directly affecting traditional craft practices and, with it, much of the rich heritage of the craft. Brickwork became functional as simple rectangular buildings, and was shorn of architectural enrichment. Cavity walls of brick, and later of brick and block requiring quick-setting and rapid strength-attaining cement mortars, superseded solid walls laid with slow hardening lime-based mortars. The craftsmen's pragmatic understanding of regional building limes and techniques involved in their common use began to contract nationally very rapidly. There was a loss of various bond patterns and universal use of stretcher bond, all the more severe on the eye because of the general acceptance of less aesthetically appealing machine-made facing bricks. Regional variations in brick size, type and use completely disappeared with the standard imperial size in 1965, and particularly with the standardisation and metrication of brick sizes in 1974, which formed part of a movement towards modularization, allowing for dimensional co-ordination using standard components and assemblies.

This was a rapid, changing, and cost-driven environment, manifesting itself in an ever-increasing site acceptance of general poor standards of work, and where traditional 'crafting' skills became increasingly supplanted by standardised national 'fixing' practices. Gauged brickwork, as the highest expression of the finest skill and knowledge of traditional bricklayers, was fast heading for extinction.

This dramatic demise of bricklayers who were skilled in gauged brickwork was highlighted in *The Brick Bulletin* of March 1954, where there was a need to re-build gauged enrichments on the bomb damaged late nineteenth-century church of Our Lady of Grace and of St Edward in Chiswick (London) (Plaskett Marshall, 1954, 4–5):

> Rarely today does an architect have an opportunity of designing in rubbed brick. In general, it is probably true to say that contemporary architects do not seek such opportunity, and if a client asked for a new building with walls of rubbed

> brick and window heads in gauged work, the architect would not encourage the whim; his reasons would be sound enough. First, the cost of material and labour would be high. Second, contemporary fashion is out of tune with the kind of elevational effect, which can be produced with rubbers….
>
> ….The walls were faced externally with red rubbers, carved in the cornice and frieze and with wall panels which, though apparently intended for carving, were never finished. The general treatment was classical, with external pilasters of rubbed brick with Corinthian-type capitals carved from the same material (Figs 155 and 156).

Figure 155

Carved brick capitals set in a frieze of rubbers, at The Church of Our Lady of Grace and of St Edward, Chiswick, London, from *The Brick Bulletin*, March 1954.

The architect for this project was D. Plaskett Marshall, FRIBA, who recorded for the benefit of others who might undertake such restoration or carved work (1954, 5):

> …The carving of the rubbed brick capitals presented certain problems and the sculptor, Mr. Joseph Cribb, encountered difficulties caused by hard nodules which occurred in the bricks themselves. The importance of very careful filling of all joints for work which is to be carved cannot be overstressed.

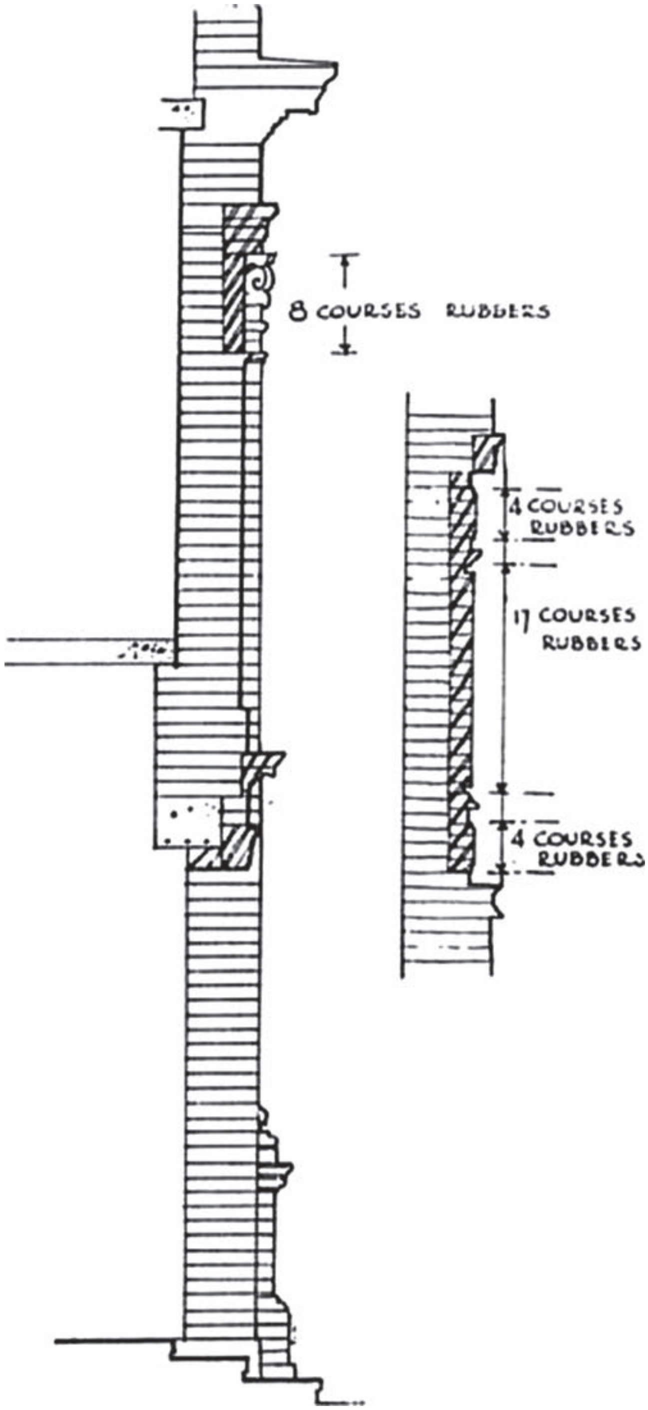

Figure 156

Sectional detail by D. Plaskett Marshall showing the gauged work as a half brick skin to the overall brickwork at The Church of Our Lady of Grace and of St Edward, Chiswick, London, from *The Brick Bulletin*, March 1954.

> Each capital took approximately ten days to carve, after much time had been spent in setting out to avoid leaving bricks undercut and to ensure that the perpends matched on each leaf of the capital.

The article concludes by expressing the following viewpoint:

> Whether rubbed work will ever be extensively used again is problematical. Fashion is unpredictable. There can be little doubt however that for relatively small areas in the right setting rubbed brickwork has great potentialities. In an age when so many designers are using drab exterior finishes, despite the wide variety of coloured materials available, it would be pleasant to see here and there the splash of strong colour, suitably relieved by carving, which rubbers make possible.

The building booms in the 1960s and '70s served only to hasten the decline in the knowledge and practice of traditional skills and when gauged work was employed, increasingly it was of an inferior quality of workmanship. Houses designed to be devoid of any form of enrichment built with machine-made bricks laid in cement:sand mortars, and as quickly and cheaply as possible was the primary aim. This was accompanied by a massive increase in unqualified men working as bricklayers and an acceptance – no matter how reluctant – of the inferior work they inevitably produced.

With sterling work from the Brick Development Association (BDA), particularly through advertising, publication ('Brick is Beautiful') and technical innovations in brick construction, the 1980s saw a reaction to this nadir with more attractive designs and detailing of buildings with improved ranges of aesthetically pleasing bricks and special shapes. Gauged work was extremely rare on new buildings viewed as an old skill, for use only on the repairs to old buildings and where it was used it was frequently not to the standard of former times. As a result a great deal of damage, some irreversible, was done to historic gauged features due to this lack of skill and understanding.

There was still occasional use of skilled gauged work during this period – for instance, the construction of several large span low rise segmental arches to enrich the façade on a large office building in Rampayne Street, London SW1. The bricks used were not authentic red rubbing bricks, but a soft red from the Milton Hall 'Medium Red' range; now part of Hanson Building Products. These bricks were delivered ready-cut to the correct voussoir shapes and were skilfully laid in a lime putty:silver sand joint of 3 mm in thickness, by the bricklayers of Harry Neal Limited, following their careful setting out and laying all voussoirs to lines ranged from profile trees. In 1980, at Hampton Court Palace, in order to match a late seventeenth-century gauged niche that had suffered extreme erosion, Dove Brothers skilfully built its replacement. Using among the last rubbers produced from Thomas Lawrence works these were traditionally cut using the bow saw and various profiled cutting boxes made to templets obtained from the original niche bricks. The work was quite rightly recognised by the BDA with an award for the excellence of craftsmanship in 1981. This, however, was quite a rare example of gauged work being employed and this situation remained true throughout the 1990s and to a large degree remains so today (in 2007). Much has been done by the author to revive the knowledge and skills of gauged work through his work with apprentices at Bedford College from 1987 to 1992, his publication on the subject (Lynch, 1990, revised 2006) and numerous other works since then which are of record.

The Lime Revival and its Use for Gauged Work

From the late 1970s a revival in the knowledge and use of lime-based mortars began, though not within the modern construction industry, being almost exclusively linked to building conservation work; though this is slowly being addressed, with positive input among various bodies; including the Building Limes Forum (BLF). The lack of education in traditional materials within craft apprenticeships and training programmes meant simple terms like hydrated and hydraulic were, and still are, confused by a great many. It was not uncommon to find bricklayers trying to make a lime putty for gauged work using bagged hydrated 'High-Calcium' lime from a Builders Merchants, a product solely intended for use as a plasticiser in cement: sand mortars, instead of properly slaked lime putty made from quicklime. In the early years of the 'lime revival' emphasis tended to centre on the benefits of use of pure non-hydraulic lime putty, due to its sacrificial nature on certain remedial works. This, however, was at the expense of a wider knowledge and pragmatic understanding of types of greystone or hydraulic limes and alternative slaking techniques and mortar preparation, which historically were preferred by masons and bricklayers (Lynch, 1998).

The specialist skills of conservators working on historic buildings during the lime revival included research into traditional materials and the ways that these could be matched for sympathetic repairs. The addition of pozzolans to pure non-hydraulic lime has a long history, particularly where hydraulic limes are not available. It is possible to produce the equivalent of a feebly hydraulic or grey chalk lime in this way but this does require considerable experience and testing to ensure the matching mix is of the correct composition to achieve the set and weathering qualities required. The range of pozzolans available is wide and the history of their application varied. A list of pozzolans, their source and the way they were used historically is set out in *Building With Lime* (Holmes and Wingate, 2002; Appendix 2 on pages 282 to 284).

As discussed earlier, feebly hydraulic limes of varying strengths were once widely available in the Britain. Formerly termed ‘greystone’, ‘grey chalk’, ‘grey lime’ or ‘stone’ lime, they were preferred for setting most gauged work; except for carved work. Some types of feebly hydraulic lime putties slaked from grey chalk quicklime, like Totternhoe, were capable of being kept for several weeks below a thin film of water, as the internal set was both slow and weaker compared to others. The compressive strengths of these grey limes ranged from a minimum of 0.7 N/mm^2 up to a maximum of 2.0 N/mm^2 (Holmes, 2006, 18). When needed, being water retentive, the stiffened putty would re-work back to a workable condition, needing only a small amount of clean ‘potable’ water and an appropriate gauging of silver sand to be added and then mixed to the consistency appropriate for setting that particular element of gauged work. By the 1970s hydraulic limes had to conform to BS 890:1972, and writing about their manufacture during the late 1980s Michael Wingate (1988, 11) stated that:

> …production in the UK seems to have collapsed because of the failure to agree British Standards to cover such wide-ranging and variable materials.

At the time of that statement Totternhoe in Bedfordshire was the only site in Britain that was producing grey chalk, or feebly hydraulic lime, but ceased that line of production in 1993; this was not only due to the increasing use of Portland Cement but also ironically because of an over-emphasis on the use of pure non-hydraulic limes in conservation and repair works. In the years that have followed the use of hydraulic limes has revived and enjoy recognition; though unfortunately it has been mainly through imported limes rather than utilising domestic products. In 2002 the Standard, BS 890 was withdrawn. Today all hydraulic limes are required to conform to BS EN 459, current from 2002, and to have the coding (NHL), which stands for Natural Hydraulic Lime, denoting they have fired to the correct temperature and are not contaminated in any way, and so classed a true hydraulic lime. They are classified in ascending order of strength, as NHL2, NHL3.5 and NHL5 respectively, the numbers representing a compressive strength in N/mm^2. There is a common misconception that these are broadly equivalent to the traditional classifications of feebly, moderately and eminently hydraulic limes. In fact the new standard BS EN 459 gives NHL 2 a compressive strength of between 2 and 7 N/mm^2. The withdrawn BS 890 gave the compressive strength for grey chalk limes as 0.7 N/mm^2 to 2 N/mm^2. This was the true traditionally feebly hydraulic lime. The new NHL 2 category is equivalent to the traditional moderately hydraulic lime and can be stronger than this. Traditional grey chalk limes, like Totternhoe (Bedfordshire), are therefore not at present in this new Standard because they were generally of a higher free lime content than NHL 2 currently manufactured by most producers, and took longer to set. There is a great need to revive these limes and to utilise local materials, therefore Stafford Holmes (2006, 20) is quite correct to say:

> It is therefore wrong to omit grey chalk lime from the British and European Standard on building lime, which should be revised accordingly.

In recent years, due to the lack of knowledge and skills in preparing building lime, Health and Safety concerns and complex 'method statements' for site use, has meant that most limes, as either a ready-slaked putty or bagged hydrate, is purchased direct from traditional mortar suppliers ready for use. Non-hydraulic lime – also termed 'fat', 'rich' or 'high-calcium' lime – is derived from pure (95%) calcium carbonate such as chalk. This class of lime being incapable of setting, only hardening by long-term re-absorption of carbon dioxide driven off during the burning phase, or 'carbonation', as discussed earlier, was not favoured on structural gauged work. Non-hydraulic lime could, and still can be, used on some types of finely cut arches that are in themselves naturally strong, as well as features contained within standard brickwork such as aprons and platt bands etc. It can also be the preferred lime on certain works of conservation where a weaker, sacrificial, lime is desired. It is important to remember, however, that modern non-hydraulic lime putty is nothing like that used traditionally. As lime mortar expert Bob Bennett (2007) states:

> Grey lime putty and modern pure lime putty are often spoken of as being virtually the same material and capable of being used in the same way. While the building Industry used almost all the Grey lime produced, only about 10% of the calcium oxide produced today goes into buildings. Most of the remaining 90% is used in the production of steel and in the food industry and therefore conforms to strict purity.
>
> I believe those small differences in the composition of the two materials accounts for the variation in performance. Burning relatively pure limestone, ranging from between 98.3% and 99.2% pure calcium carbonate largely produces the material for modern lime putty. I believe that this modern non-hydraulic lime putty is a much purer product but is a pale shadow of the old Grey lime putty, which could set both faster and harder.

By both discussing the mortar for fine arches and for ashlar work with joints of 5 mm (¼ in), Bennett (2007) concludes:

> Gauged brick arches produced in the traditional way with joints less than 2 mm could perform with joints of just Grey lime putty, but modern non-hydraulic lime putty needs the addition of a small amount of finely graded aggregate with no particles larger than one third of the joint size. On joints in excess of 5 mm (¼ in) I believe non-hydraulic lime putty is no longer an appropriate binder. I would

recommend the use of an hydraulic lime and well-graded aggregate, again no larger than one third of the joint size, to a ratio that would be subject to the supplier, but probably one part binder to two parts aggregate.

Feebly hydraulic lime traditionally obtained from Grey chalk was the preferred binder for gauged work because it had very good workability and the strength of final set was not too strong for the rubbing bricks. Like the other and stronger classes of hydraulic limes, it hardens by both an internal set (due to reactive minerals within the grey chalk) as well as through long-term carbonation. Grey chalk limes are not currently available in the UK but fortunately at the time of writing, Singleton Birch (Single Birch Limited, Melton Ross Quarries, North Lincolnshire; e-mail: sales@singletonbirch.co.uk) are trialling production of the first true traditional feebly hydraulic building lime since Totternhoe ceased manufacture of their grey chalk in 1993.

Specifying any mortar must always be based on suitability of purpose, the brick type, nature and performance of the construction and degree of exposure, so that it is of sufficient strength, but no stronger – a mortar should never exceed the strength of the brick it binds – and can perform satisfactorily. In the absence of hydraulic grey chalk limes within the present range of modern NHL products one would only use the NHL2 as a hydraulic binder for gauged work, the other two remaining classes being far too strong. The range of strength for NHL 2 under BS EN 459 at present is broad and the majority of the strength requirement overlaps with NHL 3.5. It is therefore necessary to obtain test results and guarantees of the final strength from the manufacturer before deciding whether the lime is suitable for gauged work. Fortunately, following many years of lobbying by The Building Limes Forum (Edinburgh; e-mail: admin@buildinglimesforum.org.uk <mailto:admin@buildinglimesforum.org.uk>; www.buildinglimesforum.org.uk) and the efforts of the British Standards Committee on Building Limes, the next revision to BS EN 459, shortly to be published, will include a new category of NHL 1. This will be a new truly feebly hydraulic lime classification which will enable the traditional grey chalk and feebly hydraulic limes to be unambiguously specified once again. As this lime comes bagged, powdered, hydrated, to create a putty it has to be slowly added to a container partially filled with clean water and thoroughly whisked to the consistency of thick cream, then left to 'fatten up' for a maximum of 24 hours. After this period it would then be re-worked, or 'knocked-up', back to that condition and silver sand added ready for use; substantiated in the technical literature of hydraulic lime producers such as St. Astier. Any left over at the end of a working day must be discarded and new putty made.

Pure or high-calcium lime, however, as it has no internal set, is always best left for a longer period of storage, under a film of water – termed limewater –to prevent carbonation; the longer the better as it matures and increases in bulk density. Generally speaking mature non-hydraulic lime putty will weigh approximately 1.45 kg/litre, and will contain 640–650 g (equivalent dry weight) of lime per litre, or 470–480 g/kg. Some of the less dense fresh putties (e.g. 1.35 kg/litre) available may contain only 510–520 g per litre, or 370–380 g/kg. It is possible to buy traditionally ready-slaked lime putty from specialist suppliers, delivered either in plastic tubs or plastic sacks. Unless it is purchased as a super-fine putty, due to the thin joints used in gauged work it will need to be passed through a fine-meshed screen of 1 mm or less, to sieve out grit or core that would interfere with the bedding and jointing of rubbers. Once a lime putty has been placed into the dampened dipping box the desired amount of kiln-dried silver sand is added and whisked fully into it until it is the consistency of whipped cream. The only other additive that is sometimes added to the prepared mortar within the dipping box, is a tiny thimble full of boiled linseed oil; an established traditional practice, which helps to make the mortar more cohesive, work cleanly and provide a small degree of waterproofing. Boiled linseed oil, however, is a drier and thus caution must be exercised with its use, so that only this small amount added otherwise hairline cracks to occur in the joints.

Modern Use of Gauged Work

Today, due to the lack of craft knowledge and skill of gauged work amongst bricklayers and the demand for speed on projects, most rubbing bricks are delivered to site ready-cut to size and shape for the architectural enrichment from the brickmakers or cutting companies. Despite this, profiles still need to be erected and the gauged work dry-bonded so that all lines can be established and transferred to them to guide work to level, plumb, gauge, and where necessary, to correct radial alignment. Experience has shown that certain propri-etary damp-proof courses are suited to some joint sizes and can be used with great success for dry-bonding. If a problem is encountered with accuracy of fit and bonding of machine-cut gauged work, then one must not adjust or interfere with the bricks, first recourse must be to that company, for their assessment and advice.

Despite the modern movement towards machine-cut rubbers for on-site fixing there is still sometimes a need to produce gauged work by using time-honoured traditional methods; particularly when undertaking bespoke remedial work on historical buildings. This involves having such equipment as the large rubbing stone, cutting bench as well as the traditional tools and equipment, such as the try-square, sliding bevel, cutting boxes, 'grub saw', twisted wire-bladed bow saw, files and rasps etc. These and the established techniques of their use have been described earlier, and are summarised as follows:

- Squaring a Rubber
- Scribing to a templet

- Cutting and finishing a brick
- Setting Gauged Work
- Finishing Gauged Work

As in all the cutting and rubbing stages of gauged work, with so much fine high-silica brick dust, it is important to obey all relevant Health and Safety regulations and wear a mask and goggles. Also to use an industrial powered vacuum cleaner to continually remove all brick waste and dust as work proceeds. It is also important to remember that, like all traditional brickwork using lime-based mortars, this class of work was only constructed on site during the months from March to October. This is due to the aggressive action of frost, which is particularly acute with gauged brickwork due to the large amounts of water used in its construction. If work has to proceed in the winter months, outside of this window, then a suitable 'micro-climate' has to be artificially created to maintain an acceptable ambient temperature above +7°C and well protected environment conducive to such delicate work.

Once gauged work has been erected and left to dry sufficiently, it is then lightly rubbed-up using the hand-held 'float stones' of varying grades of York or carborundum, to finish the brickwork into a bright unified plane. Because of this rubbing-up process, where gauged work is to be part of the main brickwork then it is sometimes deliberately set a little 'proud' so it rubs flush. If the work is set properly, however, then the slight exussions of the 'putty joints' trim neatly and very little cleaning or rubbing-up is in fact necessary (Fig. 157). In recent years some bricklayers have started a practice of finishing gauged work by 'slurrying-up' the face of the gauged work with the lime putty mortar to flush-fill all the joints. This, however, is not a traditional practice, rather it is a means to hide poor setting techniques that had left un-filled joints. In doing this calcium hydroxide is unnecessarily spread over and into the open-textured bricks,

Figure 157

Rubbing-up the face of a gauged arch using a hand held float stone requiring over-cleaning in an attempt to draw off and remove the lime residue from the brick faces. As a result of this practice, once the brickwork has dried-out, a haze of 'lime bloom' appears over the work as the calcium hydroxide is drawn forward during the full drying-out process and is deposited on the face of the new gauged work; which gradually carbonates and forms calcium carbonate. The use of this method of finishing gauged work should be prohibited.

In recent years when it is desired to have an element of gauged work that is carved, it is usually done by a carver at the bench with best prepared rubbers dry-bonded and clamped, to permit carving; which is often executed with powered carving tools such as the 'Dremel'™ range. The completed carving is then carefully packed and delivered to site where it is laid in a lime putty: silver sand mortar as described above. Occasionally, however, there is a call for *in situ* carved gauged work when this is the case the bricks are squared and then cut to size as ashlared units to suit the bonding of the feature (Fig. 158).

The object then is to build a panel, or what is termed a 'lump', set with full flush joints in a special mortar made from a mixture of finely sifted crushed chalk or whiting and patent knotting; the use of white lead, as a toxic material, being prohibited. This is prepared and used in small amounts as it soon begins to stiffen. It is mixed to a fully integrated paste-like consistency and trowel-applied as a thin 'butter joint' on dusted clean and dampened rubbers, being carefully applied to fill all relevant bedding faces then quickly laid to position. Such joints

Figure 158
The Bedford College Coat of Arms, being *in situ* carved by the Author on to a panel of rubbing bricks setting in whiting and knotting in 1989. (Courtesy of Ian Parry)

harden relatively quickly so the exuded joints are not trimmed until they begin to show signs of stiffening. The completed work is then left to dry-out ready for carving. Though carving can be undertaken by a highly-skilled brickmason, normally it is the preserve of the 'trade carver', using soft stone carving tools, saws, scribes, abrasives and other bespoke tools of his own making, working to the established setting-out lines and templates to carve the final shape (Fig. 159).

Figure 159
The Bedfordshire County Crest, *in situ* carved by the Author on to a panel of rubbing bricks setting in whiting and knotting in 1991. (Courtesy of Ian Parry)

The present situation although far from satisfactory, is certainly much more enlightened than one could dare to have hoped for twenty years ago. Some good work is now being achieved in gauged work, which even occasionally features on new properties once again, such as eighteen camber and two bullseye arches built in 1998 on a large extension to an Edwardian country residence in North Crawley (Buckinghamshire). (See Case studies) Also six large-span, bonded, segmental arches on a private residence Prince's Place, Holland Park, London, 2001 (Fig. 160).

The renovation of the Grade I listed St Pancras station as the new London terminus for Eurostar international services also furnished a remarkable and unusual opportunity to replicate the gauged brickwork of the original building.

To facilitate construction of a new sub-surface station for the cross-London Thameslink service, it was necessary to demolish buildings immediately west of the famous train shed. Normally demolition of a major part of a key listed building would be neither desirable nor permissible but, as a Government sponsored project, the issue of public benefit took precedence over listed building issues with consent being granted by Act of Parliament instead of through normal listed building legislation.

Sixty million bricks were required for the original construction of St Pancras, mainly supplied by Thomas Gripper's Nottingham Patent Brick Company. Tuckers of Loughborough also supplied bricks for the west side of the station. Wheeler Brothers of Reading (Berkshire) and Allen of Ballingdon (Suffolk),

Figure 160

A segmental arch, the largest of 6 traditionally constructed arches in half bond, with a 315 mm soffit, laid by Adrian D. Feltham in lime putty:silver sand with 2 mm joints, for Cobalt Green Construction Limited at a private residence Prince's Place, Holland Park, London, 2001. (Courtesy of Adrian Feltham)

supplied rubbers for the gauged arches and dressings, with some from Thomas Lawrence of Bracknell (Berkshire) as well.

For the reconstruction of the west side, facing bricks were supplied by Charnwood Forest Brick from the same clay seam as the old Tucker's works, which closed in 1969. The Bulmer Brick and Tile Company, just a few miles from the old Allen works, supplied rubbers for the gauged arches.

Describing the work, Roderick Shelton, Historic Buildings Consultant for the project (2007) states:

> The demolished west side was rebuilt with a traditional load-bearing masonry façade based on the design of the original elevation. The original intention was that each arch would be fabricated on site in the traditional manner to fit its opening. The specification for the gauged work was therefore based on the traditional craft techniques of hand cutting and rubbing on site, to ensure the new work would withstand critical comparison with the adjoining 19th century workmanship. Gerard Lynch advised on the finer points and the contract specification quoted his *Gauged Brickwork: A Technical Handbook* as a standard reference for the work.
>
> Unfortunately, the good intentions of the specification were sacrificed due to misconstrued concerns over the health and safety issues of cutting bricks on site. In consequence, all bricks were cut off site and delivered as numbered and colour coded construction kits for assembly by the bricklayers, thus enabling them to work logically through the arch building process with confidence. Whilst the bricks were skilfully cut and rubbed in the traditional manner by Bulmer Brick Cutting Services, there was no good reason why this could not have been done on site by appropriately skilled bricklayers. Such issues do not generally arise with stonework conservation where it is accepted that stonemasons are properly trained in the skills of cutting and carving stones on site to fit the required location.
>
> Through no fault of Bulmer Brick Cutting Services, the splitting into two distinct processes of what should have been a seamless craft process of cutting, rubbing

and setting the bricks led to problems with the bricks being ordered slightly undersized for their purpose. Stone springing blocks and voussoirs were also cut off site to differing tolerances by another company and this, combined with the inevitable variations in the actual opening width of the arches, resulted in the joints in the gauged work being larger than found in the original work.

Despite these difficulties, there is no doubt that the finished work is outstanding (Fig. 161). Indeed, at the BDA Brick Awards 2006, the reconstruction of the West Side Buildings was awarded both *Supreme Winner* and the *Best Craftsmanship Award* whilst Irvine-Whitlock was named *Specialist Brickwork Contractor of the Year*. It is, therefore, perhaps churlish to criticise such highly acclaimed work but it can be argued that it lacks that delicate, almost intangible quality imparted by skilled craftsmen hand-working each brick on site with empathy to its setting.

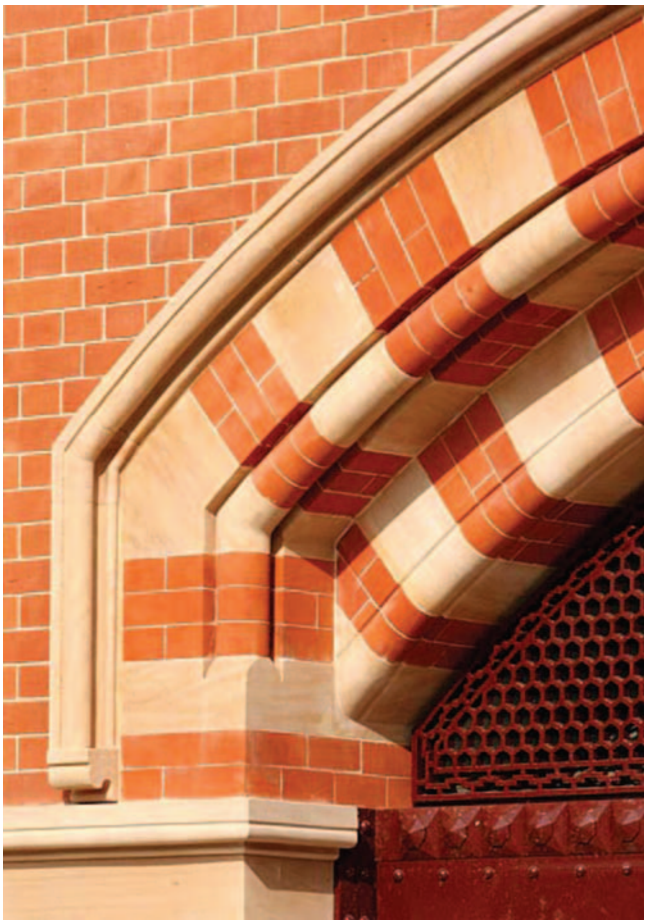

Figure 161

Part of a new gauged arch on the reconstruction of the west side of St Pancras Station, London, 2006. (Courtesy of Roderick Shelton)

Undoubtedly the bricklayers have developed valuable new skills in the fixing of pre-cut arch components as a result of this project but equally they missed out on a comprehensive education in the art of gauged brickwork. As a consequence, the industry itself has lost the opportunity of gaining young new craftsmen and

Figure 162

Front elevation of the north-west building, Colonial Williamsburg, Virginia, 2003. (Courtesy of Jeff Klee)

women trained in the skills of hand cutting, rubbing and setting gauged brickwork. Without them, who will carry the torch for the future repair and conservation of our historic gauged brickwork?

The Northwest and South building additions to Merchants Square, in Williamsburg, Virginia, USA, built in 2003, provided an opportunity to use gauged work for some of the ornamental dressings. The buildings were designed by Quinlan Terry. Edward Chappell, Director of Architectural Research with the Colonial Williamsburg Foundation, worked closely with him and states that:

> ...the design for the northwest building draws on both tidewater Virginian and East Anglian English sources, with pilasters, cornice, and framed niche inspired by similar 18th century work in Dedham, (Essex) (Fig. 162).
>
> The bricks for the load-bearing masonry walls came from three sources, salmon rubbed quoin brick made in a traditional clamp, in the historic area of Colonial Williamsburg, and an orange field brick, from Old Carolina Brick Company, North Carolina. The pre-cut ashlared and molded rubbing bricks were all supplied by W.T. Lambs, (Bricks and Arches), Sussex, England. A small amount of stone trim came from Portland, Dorset, England.
>
> The rubbing bricks, set with $3/32$ ins (2.5 mm) mortar joints were mainly laid by Raymond Cannetti as chief gauged brick mason, helping me to maintain construction quality (Fig. 163). Virginian Contractors, Snow, Jr., and King constructed the field [main] brickwork.
>
> Specifically, we used gauged brick on the south building for round and flat window arches and round windows in the pediments. The gauged brickwork is much richer on the northwest building, where it comprises the niche and its classical frame (with Portland stone trim), the west cornice, entablature blocks and pilaster caps, and segmental window archess

Figure 163

Chief gauged brick mason, Ray Cannetti, constructing the lower half of a gauged oculus or bullseye arch on the South Building, Colonial Williamsburg, Virginia. (Courtesy of Edward Chappell)

Clearly the case for the use of gauged work on a modern construction site hinges on it being shown to be time and cost effective. Therefore it is essential to carefully plan the phases of preparatory cutting and rubbing works and the building of the enrichments, to ensure these neatly dovetail into the overall programme of work. Despite concerns of costs, the future for this highly-skilled branch of the craft has great potential providing the investments of time, education, and finance are put into the aspiring craftsmen bricklayers, the relevant brick companies, and those responsible for both modern and historic brick-built buildings.

Bricklayers – from Apprenticeships to Training Schemes

The 1914–18 war devastated the flower of time-served bricklayers, men the craft could ill-afford to lose and who would have passed on the high level of skills taught to them by their Victorian masters. The Operative Bricklayers Society (OBS) merged with other craft unions in 1921 to form the Amalgamated Union of Building Trade Workers (AUBTW), losing a national voice to represent high-level craft ideals. In 1925 The Interrupted Apprenticeship Scheme was introduced to help those people whose apprenticeships had been disrupted by the Great War to resume them and the state became ever more involved in promoting skills establishing Government Training Centres, Instructional Centres and Junior Instructional Centres. Many conscientious bricklayers, however, became increasingly concerned for the future of the craft, with its heritage of skills, knowledge, and standards of excellence founded on a sound time-served apprenticeship. This was particularly true of brickwork instructors responsible for theoretical education and refining practical skills of apprentices in new technology colleges opening in major towns and cities. From the inspiration of E. Lindsay Brayley, the Guild of Bricklayers was founded in 1932, with the aim of forming an association of journeymen and apprentice bricklayers, to disseminate information and skills, and raise standards of craftsmanship and the status of the craft in the eyes of the public. The Tylers and Bricklayers Company still promoted the craft of bricklaying within its historical London area.

The hierarchy of apprentice, journeyman, craftsman, and master craftsman, nevertheless, remained a fixed and powerful force within building companies. In the larger towns and cities, apprentices increasingly attended local tech-nical colleges to gain additional theoretical and technical education and refine practical skills. This was seen as essential to achieve highly productive, accurate tradesmen capable of executing a wide range of skills within the broad canvas of the craft.

Only the finest apprentices were selected by the older experienced craftsmen to share in the knowledge and finer craft skills of the cutting-shed and learn gauged work. This judgement was based on the technical and practical competency and of the individual and all-important characteristics of enthusiasm and patience to learn and ultimately master the wide breadth of skills demanded. Although no statistics exist, it is likely that only the top 5% of bricklayers in each historic period were ever truly masters of gauged work, capable of advanced work such as setting out, cutting, and building an ornate cut and rubbed chimney stack or a gauged niche. Yet probably around 50% of all qualified bricklayers would have possessed varying degrees of competence in the skill for work on basic arches and cut-moulded enrichments, in the areas where such work was traditionally employed.

Study of the apprenticeship syllabus of college tuition to gain the Inter-mediate and Final City and Guilds examinations in the 1920s and 1930s reproduced in *The Modern Bricklayer* (Frost, 1931, 130–32), is most revealing. There is a specified emphasis and depth for sound education in theory, science, related technology, mathematics, geometry and workshop practice, which allowed the most capable apprentice to experience and develop their potential to excel at gauged work.

Frost (1931, 83), making the distinction between axed and gauged work says that axed work may be '…considered as the first step or introduction to the highest grade of bricklaying: gauged work…for this class of construction exceptional skill is necessary in the craftsman…'

In discussing the opportunity to learn gauged work, Frost continues (1931, 87):

> …The young craftsman of the present-day has no doubt great opportunities for extending his knowledge in this particular section of his craft. In the old days cutters were looked upon in the trade as very superior beings compared with the general bricklayers…great strides have been made in technical education, and today there are unlimited opportunities for the young craftsman to obtain all the knowledge he requires….

Throughout this period, up to the Second World War, practical and theoretical examinations for the City and Guilds of London Institute intermediate certificate were held for both part-time day and evening class students. Below are questions relating directly from papers of the 1920s, re-produced by Frost (1931, 135–6) directly relating to gauged work:

> BRICKWORK 2ND YEAR: THEORY AND DRAWING
>
> (1) Give full definitions and neat sketches of the following terms: Skewback, Key-brick, Gauged-apron, String-course…
>
> (5) What are the following tools used for: Cutting-saw, Pointing trowel, Three-foot level straight edge, Builders' square, Bevel, Square?
>
> BRICKWORK 3RD YEAR: THEORY AND DRAWING
>
> (2) Draw, to a scale of 1½ in. = 1 ft., the plan and elevation of a semi-circular niche with 4½ in. in thickness in gauged brickwork. Span 3 ft. 0 in.
>
> BRICKWORK 4TH YEAR: THEORY AND DRAWING
>
> (1) Draw to a scale of 1 in. to 1 ft., about two-thirds of the elevation of a gauged camber or Georgian arch, span 4 ft., face 9 in., soffit 4½ in. On this drawing indicate the method of obtaining the cutting marks or the templates for the 'Springer' and 'key' bricks or voussoirs.

Following the Second World War, Government Training Centres expanded and the apprenticeship period and City and Guild syllabi remained essentially the same as the pre-war format. Though the State was involved in Industrial training, the Carr Committee Report of 1958 recommended that '…responsibility for industrial training should rest firmly with industry' (Cannell, 2005, 4). As the 1950s settled in and extra government money became increasingly available, more further education colleges began to offer academic and practical study. Generous local authority grants enabled students to access the city and town colleges from the outlying rural areas. Far-sighted government funding allowed craft workshops to be well equipped with a variety of up to date and good-quality materials, tools, equipment and machinery. Qualified and experienced lecturers were able to provide the necessary depth to fulfil the needs of both the syllabus and local builders. Despite concerns in the Crowther Committee Report of 1959 that in the United Kingdom there was a tendency to see 'education and training' as separate issues (Cannell, 2005, 4), this was in many respects a 'Golden Age' for traditional apprenticeships.

Working as a senior lecturer at the Northern Polytechnic of London, Hodge acknowledges the fall from fashion of gauged work, yet emphasises its importance to be learnt for a full rounded craftsman (1944, 164):

> Unfortunately the demand for gauged brickwork has declined during the past three or four decades; nevertheless it is part of the bricklayers' craft and the apprentice should be prepared to carry out such work for the architect who may

> wish to find a place for it in a modern building…it gives a thrill such as only the true real craftsmen know.

Lindsay-Brayley, then Head of Junior Building School in Bournemouth (Dorset), was less optimistic. Yet he acknowledged its worth in developing future craftsmen (Lindsay-Brayley, 1945, 66):

> Gauged Work. Heavy patterning and moulding are now obsolete, and also, in a less degree, is gauged and rubbed brickwork; the only places where they are still carried on are the workshops of technical schools.…
>
> …There are still craftsmen who specialise in gauged work, which consists of baptismal fonts, niches, vases, and other ornamental details, this work being beyond the scope of the general craftsman.

Study of the City and Guilds syllabus ‘Brickwork 82, 1966–67’ for a five-year apprenticeship, reveals that gauged brickwork was introduced through theory, geometry, and drawing in the second year and at a practical level in the third year of the ‘Intermediate Craft’ stage. During the fourth and fifth years, for the more capable apprentices in the ‘Advanced Craft’ course, the content covered gauged plinth and string courses; mullioned, transomed and traceried windows; niches; and a variety of arches for construction in the college workshop.

The majority of building firms trading in the 1960s used a directly employed workforce. Most had yards in which they stored materials and plant, and workshops assigned to the particular crafts. Under such conditions, where a firm obtained the quality of work, the skills required for setting out, cutting, and setting gauged work could be employed and taught, and support of the trad-itional apprenticeship system given. Building booms of the late 1960s and 1970s attracted many bricklayers from old established building firms to subcontracting, concentrating solely on their craft needs and departing as quickly as possible to maximise earnings. These were, and remain, mainly an inward-looking, itinerant, workforce with no eye, or indeed interest, for either the past or the future; a view upheld by older and wiser craftsmen who predicted its disastrous effects on the crafts, but were powerless to restrain it.

In 1964, under the Industry Training Act, the Industry Training Boards (ITBs) (government, employers and unions) were set up with the statutory power to receive a training levy from employers to be given as grants to those offering approved training. The Construction Industry Training Board (CITB) being the body responsible for the building crafts. The end of the1960s reduced the indentured apprenticeship leading to certification by City and Guilds to four years, three years to achieve a basic Craft Certificate and a fourth year for the Advanced Craft Certificate. This was quickly reduced to three years – two years for Basic Craft and one year for Advanced Craft – and consolidated by the *City and Guilds 588 – Brickwork and Masonry* syllabus (City and Guilds, 1976).

Study of this syllabus, detailed in a comprehensive 60-page booklet, reveals an emphasis on a holistic approach to the craft, in order to provide sound theoretical and technological education supplementing a wide range of practical skill elements. Although greatly reduced in comparison with earlier syllabi, gauged brickwork was retained. It was not, however, always expressly described as such within an overall topic area. For example, in Brickwork 'Craft Theory' the syllabus required knowledge of:

> Setting out, temporary support and construction of cambered, segmental and semi-circular arches, straight on plan up to 3 m span.

In the 'Associated Subjects', the requirement was for the student to learn:

> Geometry of the circle, segment, sector, chords and tangents. Applications to setting out arch forms and curved work.

This was consolidated by the stated 'Practical Activities' for the student to practise:

> Setting out, cutting and building camber, segmental and semi-circular arches.

W.G. Nash, Head of the Department of Construction at Southampton Technical College, in his three volumed work published in 1966, that was originally intended for the four year apprenticeship, describes setting out, cutting, and constructing gauged niches and arches circular on plan and elevation. This is a craft area termed 'circle-on-circle' work that was not retained within the syllabus of the three-year City and Guilds apprenticeship.

In 1979 H. Bailey and D.W. Hancock, Senior Lecturers at Stockport College of Technology in Lancashire, published on the perceived needs of the three-year apprenticeship, but significantly there was minimal reference to gauged work, being restricted to camber arch construction alone (Bailey and Hancock, 1979, 60–61):

> …known as camber or Georgian arches. These are constructed of bricks known as rubbers, which are soft enough to be cut with a bow saw and rubbed on a stone to the exact shape required.

The simplistic explanation of how to set-out and cut a gauged camber arch reveals the resigned attitude towards this branch of the craft (Bailey and Hancock, 1979, 67):

> The traditional method is much more complicated and is considered beyond the scope of craft certificate students, as is the building of this arch.

At Bedford College of Higher Education during the 1980s, as Head of Trowel Trades the author set about broadening the curricula for the second and third-year apprentices. This move was intended to allow apprentices to gain a more holistic understanding of their chosen craft, by re-introducing long-lapsed branches of the craft and a range of traditional materials, skills and associated knowledge, without compromising the *City and Guilds 588 – Brickwork and Masonry* syllabus or their modern site needs.

This syllabus was, it is considered, being interpreted nationally at the colleges and within publications to support delivery, solely as a preparation for apprentices working with modern cement:sand mortars and cavity-wall construction. Also, despite clear references to various traditional materials and skills within the syllabus (this justifying their re-introduction), there was no historical content or context to them. This was deemed a serious omission, as apprentices would fail to understand why a certain skill was developed or recognise when and how to apply it today. Much of what was available concerning traditional aspects of the craft was narrow on interpretation of historical practices, and served only to mislead and confuse. Amongst the many traditional craft areas re-introduced was the art of gauged work.

Five main factors enabled the history, knowledge, and craft skills of gauged brickwork to be pioneered at Bedford College (Fig. 164):

1. The in-built flexibility of the *City and Guilds 588 – Brickwork and Masonry* syllabus allowing delivery of its implicit overall objectives for apprentices, yet permitting development and nurturing of the naturally talented students by a more advanced interpretation and level of a subject to extend personal ability.
2. Recognising the un-tapped natural academic ability of many craft apprentices who, for various reasons, had not pursued O and A-level examinations. Most were capable of being enthusiastically stimulated and thus receptive to the more challenging educational and skill areas of study. All true craftsmen and women possess high intelligence.
3. Recognising that most apprentices were not working for large building companies that required bricklayers proficient only in basic skills of laying

Figure 164

General view of a gauged work project designed by the author and undertaken at Bedford College, Bedford (Bedfordshire), by the Craft and Advanced Craft apprentices, under his tuition and supervision, between 1988 and 1991.

bricks and blocks to line, level, and plumb. The majority worked for small building firms on one-off new buildings, extensions and minor works, and, most importantly, on the repair, re-pointing, and restoration of traditionally-constructed buildings. This required a whole area of craft knowledge and skills simply not catered for at a national level.

4. The positive support from brickmakers, as well as the building companies and bricklayers who could see the benefits of having a more fully rounded apprentice capable of undertaking a wider range of practical work. Also, in how they could see that, as the apprentice began to learn the skills of precise gauged work, the quality of their standard brickwork improved dramatically too.
5. The knowledge, skills, experience, and enthusiasm of the author, who had for some years previously been writing about gauged work as the highest expression of his craft. (See Lynch, 1990)

The period of 1987–92 at Bedford College saw a huge rise in national awareness for and interest in gauged work, and what the craft apprentices in the workshop were achieving there at very high standards (Fig. 165). This in turn,

Figure 165

Close-up of some of the gauged enrichments set-out, cut, laid and finished by craft apprentices at Bedford College, Bedford (Bedfordshire), under the author's tuition, between 1988 and 1991.

helped to stimulate craftsmen and also brickmakers, surveyors, designers, and those charged with caring for the nations historic built environment. Brick and lime producers as well as national professional and amenity societies provided support for this initiative.

Sadly, the lofty ideals of establishing Bedford College as a centre of craft excellence for traditional skills coincided with a national policy on craft training that moved in direct opposition. Writing in 1993, after leaving the college, Lynch (1994, 66–8) urged caution:

> A significant development in the delivery of training has been the introduction of the National Vocational Qualification (NVQ) system, designed to rationalise

> qualifications throughout industry, and to guarantee the competence of trainees by demonstrating that they satisfy specified performance standards.
>
> The important consideration now is not how long it took to achieve, at what age, or where the skills were acquired. In effect, there is no set length of apprenticeship; to become qualified, it is only necessary to demonstrate job competence in the required units of construction.
>
> Until proven, however, it would seem prudent to question and examine closely whether the product of a system not demanding a prescribed training period, minimum experience or adequate maturity – the cornerstone of our historical training methods – does produce the skills required of true craftsmen.

If learning craft skills had not required a five or even a minimal three-year apprenticeship, then those with past responsibility for the crafts would not have provided them. Time-served apprenticeships were all about a combination of growing maturity and in-depth learning on site and at college to gain overall experience and competence.

By the early 1990s, acceptance of a dramatic national decline in the knowledge and skills of gauged work was revealed in the revised fourth edition of J.C. Hodge's *Brickwork for Apprentices*, where the original chapter on gauged work was omitted. The understandable reasons, though rubbers were in fact still available, were given (Hodge and Baldwin, 1993, 133):

> Much thought was given before deciding to omit this chapter (which fully described this highly skilled aspect of the bricklayer's work) from this revised edition. The primary reason for leaving it out is that these red rubber bricks are no longer available; another reason is that modern methods of cutting voussoirs on masonry bench saws have displaced the labour-intensive traditional method of cutting and rubbing by hand.

In 1994, the Conference on Training in Architectural Conservation (COTAC), working with the City and Guilds and CITB, convened a working group to develop an advanced NVQ at a higher level than that offered within the basic craft modules. This would lead to a Master Craft Diploma. Leading figures from each building craft, including the author, were invited to assist in developing this important objective, seeking to define the range of skills necessary for conservation, restoration, or refurbishment within each craft. This included gauged work within bricklaying.

This initiative had some degree of success, but struggled with inadequate funding, limited colleges capable of delivering it and (within the craft of brickwork) a lack of practical lecturer experience to teach with authority and confidence. It was also, it is felt, an error to choose to use the term 'Master' within this additional qualification, implying that upon successful completion of the course one would become a master craftsman. Such a move would historically have granted every bricklayer who served a traditional five-year apprenticeship the automatic status of master bricklayer when in fact they were only journeymen. A true master bricklayer requires not only peer respected consistent excellence in the execution of all craft skills, combined with technical authority and knowledge, but also thirty plus years on the tools to gain sufficient worthwhile breadth of experience of basic to the more advanced craft work; including gauged work.

At this time the author was approached by Mr Richard Harris of The Weald and Downland Open Air Museum (West Sussex) (who previously visited Bedford College to view the work undertaken there) to develop and present introductory courses and master classes in gauged brickwork at the museum site (Fig. 166). This, supported by W.T. Lambs with donations of their over-sized rubbing bricks as well as pre-cut units, has proved very successful down through the years, and has led to the introduction of an advanced class in which flat and

Figure 166

A student practicing dip-laying an ashlared rubbing brick ready to build a small panel as part of an 'Introduction to Gauged Work' course at the Weald and Downland Open-Air Museum (Sussex), 2005.

camber arch construction is fully examined (Fig. 167). A number of the more able students have further developed their skills and knowledge through personal tuition at the author's workshop and are now undertaking quality work on site. Other organisations have subsequently made efforts to introduce the basics of gauged brickwork to a wider audience, such as, Essex County Council in conjunction with Bulmer Brick and Tile Company Limited. The author has also tutored selected students for a 'The Prince's Foundation Craft Scholarship', the finer points of cut and rubbed and gauged work.

In recent years national political attention has picked up on problems of recruitment within the craft of bricklaying. According to the *Construction Skills Foresight Report 2003* (CITB and CIC, 2003), the average annual requirement for bricklayers is 5,300. Trainee numbers for construction courses, further education colleges and training centres show that there are 5,029 for the under 18 age group, with a further 3,370 from the over 18 age group. It is indicated that of

Figure 167

A student placing a dip-laid voussoir whilst turning a gauged arch on an 'Advanced Gauged Brickwork' course at the Weald and Downland Open-Air Museum (Sussex), 2005.

the combined group there will be a 40% drop out rate, equal to (3,360 trainees), leaving a total of 5,039 trainees who go on to complete their courses.

These figures relate to the provision of tradesmen and women with basic craft skills for modern site demands. They ignore the more acute shortage of high-level skills, such as gauged work, within the craft, necessary for executing the more complex works and especially of those caring for our huge stock of historic, traditionally-constructed buildings.

The introduction of a Construction Skills Certification Scheme Limited (CSCS), supported by the CITB, provides a construction registration system, the aim of which is to create a fully qualified workforce on UK sites by 2010. At the time of writing (2007) it is not compulsory, but is gaining full support from the Major Contractors Group (MCG) who are denying access to major sites around the country unless the operative can provide an appropriate CSCS card. For a craft operative in bricklaying the card scheme has the following grades, each of which has a Health and safety test; the complexity of which increases with the grade:

- Trainee red (R)
- Experienced worker (EW)
- Skilled blue (B)
- Skilled gold (G)
- Skilled green (Gr)

Teaching Cut and Rubbed and Gauged Brickwork within NVQ at College

The problem of finding craft teachers possessing any real on-site experience, pragmatic depth or technical knowledge of cut and rubbed and gauged work has inevitably grown as the years have passed. This, in many respects, is due to designers not specifying detailed architectural enrichments, as building design has become utilitarian, meaning the need for traditional craft knowledge and skills has been neglected. Thankfully after much lobbying by leading craftspersons and various national heritage bodies, this has been recognised and there are now moves to address this.

In response to this the National Heritage Training Group (NHTG), with the support of English Heritage and Construction Skills, have completed a suite of 'Heritage Skills' National Occupational Standards and are working on final details for the subsequent level 3 NVQ.

The Heritage Skills NVQ will have optional units covering all craft areas and will provide a qualification route not only for individuals working solely in the heri-tage sector but also those working on both modern and traditional construction projects. It is also envisaged that achievement of the Heritage Skills NVQ will see 'Construction Skills Certification Scheme' (CSCS) cards endorsed with conservation credits which in turn will provide major stakeholders of historic buildings the opportunity to ensure that only appropriately qualified crafts people gain access to site.

To support Heritage Skills NVQs the NHTG have worked with leading crafts people from various craft fields to develop a programme entitled 'Training the Trainers'. This initiative sees experts across the craft spectrum provide existing college lecturers with advanced skills and knowledge to enable them to promote and support the delivery once again of traditional building craft skills.

The problem of the acute shortage of high-level skills and its possible solutions, embraces social, economic, academic, and philosophical issues, as well as the more obvious craft concerns.

Some issues in respect of this have been highlighted in various publications from government bodies and relevant heritage groups. Among the most significant are *Planning Policy Guidance 15: Planning and the Historic Environment* (DoE DNH, 1994), *Power of Place*: *The Future of the Historic Environment* (English Heritage, 2000), *The Historic Environment: A Face for Our Future* (DCMS, 2001), *Sustaining our Living Heritage: Skills and Training for the Heritage Sector* (HLF, 2003), *Traditional Building Craft Skills: Assessing the Need, Meeting the Challenge* (NHTG, 2005) and, with specific regard for maintenance issues, *Maintenance Education and Training for Listed Buildings* (Watt and Colston, 2003).

Putting Value Back into Craft Education and Training

All crafts are learned and refined through years of dedicated study and relevant full-time practice, observing and being surrounded by those more proficient – learning through participation. This teaches the correct selection and use of tools, equipment, and materials and develops the ability to know what they are, and are not, capable of in the production of first-class work.

Quality craft education and training ensures a sound understanding of what underpins all craftsmanship – traditional and modern materials, tools, equipment, technology, and the skills of how to prepare and correctly apply them. It develops an enquiring mind that seeks to evaluate work and to reason-through the inevitable problems in the pursuit of quality work. Craft students need clearly defined high standards and ideals to aspire to, so that ultimately they will be capable of producing work that is equal to that created by their historic forebears. If made aware of these objectives from the outset of learning a craft and to readily see that this is realistically achievable, most will recognise the value of dedicated study and practice.

Education or Training?

Differentiating craft education from training can be tricky, as in many respects they are two sides of the same coin, and on-going throughout a working life. The author sees **education** as the acquisition of the practical, theoretical, arithmetical, and technological knowledge that provides the foundation for a craft and its skills, by studying relevant textbooks, attending specified formal lessons, and through on-going oral discourse with those of skill, knowledge, and experience from whom one is learning. **Training** is the organised sequential acquisition, development, and refinement of the numerous elementary and advanced practical skills that are part of a craft, by being surrounded by, observing, and learning from those who are more proficient in a certain craft.

Current Craft Apprenticeships and Training

Apprenticeships – being taught, over a number of years, about traditional and contemporary craft materials, tools, and techniques – are the bedrock of craft heritage. As detailed earlier, craft training in the United Kingdom since the early 1990s has been delivered through the National Vocational Qualification (NVQ) system, designed to standardise qualifications throughout industry, guaranteeing competence of 'trainees' by demonstrating that they satisfy specific performance standards. This replaced indentured time-served and in-house apprenticeships with programmes for students (employed or not) delivered in short, modular, assessment-led units. There is no set time limit for the acquisition of craft skills and knowledge. Once all of the modules within the prescribed craft syllabus have been assessed and accredited, that person is deemed 'competent' as a bricklayer.

Though driven by the need to reduce public expenditure, it is ironically delivered through vast expensive and wholly unnecessary bureaucracy that didn't previously exist. It is skewed in delivery toward the narrow, modern construction needs of both the Industrial Training Boards and powerful large contractors, demanding basic 'fixing' skills with simplistic levels of underlying theory – 'Bricklaying' rather than 'Brickwork'. This ignores the history of the crafts and their individual, unique heritage, which craftspeople have a duty to nurture and pass on to future generations; yet today's workers are disenfranchised from any say in their future.

The former CGLI apprenticeship system had its deficiencies: no national, unified system of performance criteria to mark practical work in college workshops, linked to acceptable standards for site work; and subjective marking by the class tutor. Occasionally bright students could gain excellent marks for academic work but barely pass the all-important practical tests, yet still become 'fully-qualified'. Though these particular deficiencies, to the credit of NVQ, have been addressed with a degree of success, the former system, with superior overall college-based study, should never have been scrapped, only fine-tuned. Many employers in the UK voice concern that a number of NVQ-qualified craftspeople are not as proficient as required, limiting secure employment opportunities. The author's experience supports this opinion, as he has many bricklayers, fully qualified by NVQ standards, come to him to learn higher-level craft skills, yet few possess the breadth of craft knowledge or advanced tool skills necessary to properly progress.

Industry and educators failing to recognise and reverse this trend are losing the highest expressions of the crafts to narrowly tutored 'specialists' and 'conservators', unqualified in them. Conservation and restoration were, and must never be, divorced from their craft homes. They are an essential part of the full repertoire of a qualified craftsperson – as they have always been down through history. The author's apprenticeship, in the traditional and modern aspects of his craft, combined with hard work, study, and dedication, fully equipped him to work on new-build and the repair or restoration of all periods of historic brickwork, as it was deemed part of craftsperson's broad range of skills. In this respect one applauds the ethos being engendered at the 'American College of the Building Arts', in Charleston, South Carolina, where they uphold many of the author's beliefs on the importance of good quality and all-embracing craft education and accompanying training (www.buildingartscollege.us). The college and the author are members of organisations in America such as the 'Preservation Trades Network' (PTN). PTN is founded on the principle that conservation of the built environment is fundamentally dependent on the quality, availability, and viability of the skilled trades (www.ptn.org). Their international arm 'International Preservation Trades Workshops' (www.iptw.org), are working nationally and internationally to promote craft education. As Lisa Sasser, President of PTN states:

> PTN was established on the principle that conservation of the built environment is fundamentally dependent on the quality, availability, and viability of the skilled trades.

> We believe that opportunities for education, employment, and compensation of people in the trades are directly reflected in the quality of the built environment, and the effective stewardship of cultural heritage. In the beginning, PTN found its identity in a single event, the International Preservation Trades Workshop. The first 'gathering of the trades' in 1997 not only proved that it could be done, it demonstrated that sharing, learning and talking with tools in hand filled a void in the mainstream preservation movement that many doubted even existed. Since then PTN has evolved into a year round networking and educational resource for people in the traditional building trades and allied disciplines.

Regaining the Balance: Delivering Craft Education and Training

Regaining the former balance requires putting value back into craft education and training, to attract and retain dedicated students who have the potential to achieve fully respected qualifications by all professionals across the whole industry. Vital to its success will be the professional retention of the foremost peer-respected, experienced, and highly skilled master craftspeople as instruct-ors. Programme planners will also need to consult with them and the rele-vant industrial organisations and professional educators, to design intuitive, validated, linear programmes with clearly defined routes from start to completion, through a well-thought-out craft syllabus. This would guide a pragmatically delivered and cross-subject related craft curriculum of skills, theory, and related technology, underpinned with historical background to achieve meaningful context.

Students once more must be reconnected to traditional materials, their preparation, and the skills of handcrafting and use, to be able to eventually replicate selected enrichments from past centuries with empathetic authenticity within their apprenticeship course. Yet they must also fully learn about up-to-date factory-made materials, tools, equipment, and associated craft techniques for contemporary construction too.

Bureaucracy and overhead costs should be kept low, so that most funding is spent within workshops and classrooms. With appropriate levels of funding by colleges, sponsorships, and financial and in-kind support by stakeholders, institutions should be able to provide first-class facilities to teach in and programmes of the quality to earn international recognition.

Recruitment of Students

This approach requires recruiting students with the right attitude, aptitude, and ability to succeed in the crafts. Young people today, however, are often influenced by prevailing social attitudes that see little virtue in the ethos of working with one's hands and years of study to qualify. This must be addressed so that both parents and their children view traditional skilled crafts as dignified and fulfilling, with real status.

One must also factor in to any new craft education and training programmes, semi-skilled adults working within the crafts, to harness and develop any potential demonstrated. Most have picked-up craft skills on-site and produce acceptable standards of work. They need to be made aware of the benefits of developing knowledge and skills to increase pride in their craft, to enhance their abilities, and to obtain full qualification that will provide a platform for future advancement in the crafts and, perhaps later, other aspects of the construction industry. To encourage them to register and attend relevant courses at the appropriate level, credits can be granted for their existing skills and experience.

As a former Head Lecturer (1987–92) the writer knows that many adult students are nervous about re-entering formal education years after leaving school, where perhaps they found academic learning difficult. Most underestimate how maturity has made them receptive to learning. Adult attendance has positive effects on younger students, brings site experiences into the classroom, and raises levels of class behaviour. Some, fed-up with years of routine craftwork on new-build, find through their studies an attraction to the more sensitive areas of conservative repair and restoration, providing a whole new challenge for the mature craftsperson.

The Learning Environment

Part or full-time formal study at approved colleges or learning centres must provide a combination of education and training linked to craft history and architecture. Too many workers today lack any empathetic understanding of the craft methods, tools, and historical practices of the buildings they work on. This knowledge is vital if we are to ensure that craftspeople can confidently meet the combined practical demands of modern and traditional work to the highest standards.

This off-site study in the colleges should be supplemented, where appropriate, by time on high-level and specialised craftwork alongside master craftspeople, in their workshops or on site. A true master not only teaches verbally but also by direct example, nor does he or she just inform apprentices of values but reveals them through conduct and inter-relationships. Students will learn lessons about resourcefulness that can never be gleaned from books, and be stimulated and inspired by witnessing a willingness and dedication to pursue perfection, no matter what it takes – the hallmark of true craftsmanship.

A Student-Employer Agreement

After the student completes formal school education and decides to learn a craft, a learning agreement based on the 'indenture' could be drawn up that binds the apprentice and company to an approved complementary course. This would assign responsibility to the student to be receptive to work and learning the craft, attend agreed courses, be well behaved, and safeguard and uphold craft knowledge and skills. Employer and college responsibilities to provide safe, productive work in a learning environment that meets the specified terms of the appropriate year of apprenticeship. The examining authority that sets the syllabi and oversees the apprenticeship would monitor progress and compensation.

Upon successful completion, employer, college and examining bodies could formally sign off the agreement, and it could be presented to the newly qualified craftsperson in a formal ceremony similar to university graduation day. Names and qualifications could then be added to an approved national and international register of qualified craftspersons.

Radical change is necessary for current craft education and training. There is little coherent future vision in current craft training systems, only optimism that somehow things will simply work out in the future. They will not! We live in an age of image makeovers, and the recent revival of the name 'apprentice' instead of 'trainee' is a good example of trying to re-create an image; but as with most image makeovers, this lacks real meaning. Those of us fortunate to have had all-embracing time-served craft apprenticeships, and to have worked alongside and learned from older craftsmen possessing traditional skills and knowledge, are now over 50 years of age. When we, and particularly the master craftsmen, are gone, that historic craft link will be forever broken.

We must invest quality time, energy, and money into well-designed craft education and training, studying and respecting both past and modern aspects, and encourage self-belief in our future craftspeople – for we are no less able today than historic craftsmen of producing the masterpieces we marvel at today. How can we ask professionals and clients whose employment we seek to value our crafts and craftspeople if we fail to place value and pride in them first? Only by demanding quality apprenticeships and learning environments that develop an ethos clearly seen to be producing superb craftspeople, employed in an industry that promotes quality of work and service, can we ask others to also place value on our once-noble crafts.

Drawing on a range of comments from invited craft and professional representatives, it is possible to summarise key issues.

Loss of Time-Served Apprenticeships

Traditional time-served apprenticeships ensured that wide-ranging skills and knowledge were obtained alongside practical experience. As Peter Hill (2002) states, 'Skills can only be learnt by practising them full time surrounded by people who are far more proficient, the seven-year apprenticeship may have been too long, but the three-year apprenticeship was too short'. Today (2007) we see a growing loss of time-served experienced craftsmen, and it is only by experience that skills are truly developed. This loss will manifest itself in the future as the lack of current investment in high-level craft skill and knowledge becomes apparent.

Craft Training

Intelligent young people are encouraged to attend university courses and not craft training as it is seen to be of less value. Careers advisors and local employment offices, because they perceive brickwork as the least skilful and technically demanding of all crafts, are inappropriately channelling students with modest ability, and after minimal assessment, into craft training. These students often have little personal motivation to embark on this route and are often disruptive.

The College Position

Pressure is put on college staff to achieve very high pass rates at NVQ levels. Paperwork and not practical experience drive the overall quality of NVQs. Low attainment rates are due to financial emphasis on colleges to fill course places at any cost, rather than enrolling suitably selected students with a common goal.

Insufficient time is allocated to students to fully achieve and develop as competent tradesmen ready for site work. This is not helped by the fact that many of the craft students who attend college unfortunately lack the key skills to proceed through the craft training programmes without difficulty. While these issues are addressed ground is lost in the all-important practical and technical lessons.

The Industry Position

There is a lack of financial and practical commitment by way of on-the-job training in the industry, by small, medium and large contractors. This is primarily due to the use of sub-contracted labour working transiently on modular building work (rather than directly employed personnel) as a way of keeping cost to a minimum. Large housing contractors dictate to modern training programmes to solely meet their needs. Where perceived needs for additional high-level skills are identified, there is often a refusal to view the fees paid for a quality course with a recognised master as long-term investment.

Recommendations

- Introduce accountable, time-served apprenticeships that are respected by the industry.

- Appoint an independent governing body to oversee the apprenticeship scheme to ensure fulfilment of contractual obligations and not as a method of ready supply of cheap labour.
- Raise the academic and practical content of education for craftsmen with a qualification akin to a university degree.
- Introduce a list of peer-respected ‘Masters’ considered to be of exceptional value to the Nation, and establish funding to enable them to pass on their knowledge, skills and experience.
- The construction industry should be re-positioned to ensure employment of suitably qualified craftsmen and women and to raise the overall status of the crafts.
- Incentives offered to employers to re-establish direct employment for apprentices, in order to provision on-the-job craft training.
- Provide financial assistance for students who have the aptitude and dedication to learn, so that they can study with a master craftsman.
- Encourage manufacturers of traditional materials to support these initiatives by generous discounts on materials to alleviate the pressure on limited budgets.

Future Prospects for Training in Cut and Rubbed and Gauged Brickwork

For cut and rubbed and gauged brickwork to be successfully taught there are several issues. Namely, that the person tasked with delivering it must have a firm grasp of the subject, historically, technically and practically and is working out of a fully equipped workshop or training centre. It would be important that the student, at any stage in their career, is assessed to ensure they have dedication, academic and practical ability to succeed. Course design would need to follow in a logical sequence of academic and practical tuition, to develop the contextual knowledge and skills necessary to ensure full understanding and balanced development. This course would require approval by the relevant examination and heritage bodies who cover, or who have an interest in quality craft training, leading to assessment with carefully determined high-level standards, resulting in qualification. It would be important to break down the traditional skills of gauged work into their individual basic elements at the introductory stage, such as squaring up for ashlar and straight moulded work. This would encompass:

- Identification and selection of the rubbing bricks
- Identification, preparation, use and care of the necessary tools

- Preparation of the brick ready for cutting
- Studying drawings, related geometry, and obtaining templets
- Cutting the brick by use of brick axe and scotch as well as the bow-saw methods
- Testing the cut brick for accuracy
- Identification and selection for materials for setting gauged work
- Preparation of bricks and materials for setting gauged work
- Setting out methods for the construction of basic cut and rubbed and gauged brickwork elements
- Construction of basic cut and rubbed and gauged brickwork
- Finishing of the built cut and rubbed and gauged brickwork

This would run side by side with the delivery of the historical background of cut and rubbed and gauged brickwork, alongside the essential related theoretical and technological aspects of the subject to underpin the above practical elements.

Obviously for the practical element it would be essential to have a small area of the workshop set up to deliver cut and rubbed and gauged work (Fig. 168). A sturdy cutting bench is essential, and of sufficient length to allow at least two to work at it. It needs to be fitted with a horizontal beam, at a sensible height above the bench and running down its centre, for strutting down to clamp the bricks in their respective cutting and moulding boxes. Above and below the bench shelves could be fitted to store tools, equipment, various cutting and

Figure 168
The author's fully-equipped workshop that provides an ideal ergonomic teaching facility.

moulding boxes, cutting block and the dipping box; as well as the dry rubbing bricks. In respect of the latter it is to be hoped that companies producing rubbers could adopt a sympathetic pro-active approach to the problems of limited college/training centre funds, by way of discounts or supplying second grade rubbing bricks for educational purposes. This would be of enormous help to introduce the skills into the workshops and allow students to familiarise with the use of their products.

The joinery section of the college or training centre could provide the entire various cutting and moulding boxes to the templets provided, as well as the dipping box. The width across cutting and moulding boxes needs to be able to accommodate two squared bricks with folding wedges between them. The tops or sides of all cutting boxes should be tipped with metal to prevent the edges wearing with repeated sawing and abrading. For cutting voussoirs an adjustable cutting box is ideal as it can be adjusted to suit the templets of all arch voussoirs. It is fitted with a fixed base for rigidity and then another board fitted with four threaded bolts through the top and bottom and then fitted with washers and wing nuts as they pass through slots cut in the rectangular sides. This board can then be tilted to suit the angle required from the templet and once this is established the four wing nuts can be tightened to secure it ready for the squared bricks to be placed in, cut and abraded smooth (Fig. 169).

The other basic tools and equipment necessary to deliver cut and rubbed and gauged work are:

Rubbing stone – of sufficient size, grit and perfectly flat.
Bedding Stone – A sufficient length of perfectly flat marble or slate.
Bow saw – about 600 mm (2 feet) long.
Coil of wire – 21 gauge mig wire to make blades for the bow saw.
Brace – Fitted with a hook, to loop a length of wire to twist wire blades.
Brick Axe – This would need to be made by a blacksmith.
Scotch – A joiner can make the traditional shaped handle and wedge.
Scotch Blade – Best made from a suitable length of sharpened old file.
Cutting Block – An inclined block of wood to seat the brick at right angle.
Grub Saw – A small hand-held saw or mason's drag.
Scribe – A large nail or other spike sharpened to a point.
Try-Square – A large try-square to check the square of the rubbed brick.
Sliding Bevel – To take-off and transfer bevels and angles to the bricks.
Trammel Heads – In pairs clamped to a batten for setting out large arcs.
Adjustable dividers – For plotting voussoirs and gauging brick courses.
Files and Rasps – Of various sizes and shapes for abrading smooth the cut rubbers.
Hand Stones – Of varying grades and shapes to rub up completed gauged work.

Figure 169

A pair of voussoirs prepared after cutting in the adjustable cutting box, set to their profile.

Industrial Vacuum Cleaner – Keep fine airborne dusts to a minimum and cleans work.
Industrial dust-masks – Worn as a sensible health and safety precaution.

Upon successful completion of this introductory stage, if important to their sphere of work or overall interest in the subject, the student could proceed to more advanced levels. This would need to be a planned logical progression of skills and their underpinning knowledge that deal with the more complex features of gauged brickwork. This would allow the student to also learn advanced masonry skills with associated tool use, in order that they can undertake hand work on enrichments such as return mouldings, and internal radius work. The breadth of the advanced work cut and rubbed, and gauged work would incorporate:

- Cut moulded architraves
- Pilasters, Columns and piers
- Pediments
- Tracery
- Vaults
- Mouldings
- Cornices
- Circular work plain or moulded
- Double curvature work – niches
- Carving

At this level it would be more prudent and cost effective to deliver these highly specialised courses with limited demand either within the fully equipped workshop of an acknowledged masters, or to bring these people into the college. As they would have the highly specialised knowledge, skills and experience required; delivering the subjects to meet the approved standards of the relevant certifying bodies.

Conservation and Repair of Cut and Rubbed and Gauged Brickwork

Having developed in aspects of the above cut and rubbed, and gauged brickwork, the students could be introduced to the knowledge and skills necessary for the successful repair and restoration of cut and rubbed and gauged brickwork. This would incorporate tuition on the causes of failure and decay of cut and rubbed and gauged work and an examination of poorly executed remedial works that have seriously compromised the aesthetics of historic buildings (Fig. 170). Also to study the 'philosophy of repair', the importance of the process of correct planning, and the adoption of approved remedial measures; that are all integral parts of such work; particularly on important listed properties of historical and social significance.

An overview of some practical elements, which would be taught with associated theory and technology, can be defined as:

- **Replacement of ashlar work**
  Cutting out and replacing individual bricks
  Plastic repairs
  Colour/texture matching
- **Replacement of mouldings**
  Obtaining templet/s to replicate original profiles – related geometry
- **Repairs to arches and niches**
  Recording, removal, preparing and relaying of individual voussoirs/bricks
  Recording, dismantling and re-building complete arches

Figure 170

Early Georgian gauged brick giant order pilaster and segmental arches ruined forever by inappropriate disc-cutting and cement sand repointing, and the use of stock bricks as substitutes for rubbing bricks.

- **Re-pointing**
  Preparation of joint to appropriate depth
  Preparation of joint prior to re-pointing
  Selection of materials and preparation and mortar
  Selection of tools to execute re-pointing
  Application of pointing (modified form of tuck pointing)
  Preparation of test panel to assess joint finish
- **Curing and protection** (sun, wind, and inclement weather)
  Provision of proper curing and protection
  Identification of suitable working periods (minimum temperatures)

In most respects we are no less able today than the bricklayers of previous centuries who produced masterpieces of cut and rubbed and gauged work (Fig. 171). What is rapidly being lost is the wide range of essential crafting skills, with instead, an over-emphasis on limited theory and practice to acquiring simple fixing skills, demanded by a hugely influential modern construction industry. One ignores a craft's history and traditional skills at one's peril.

Figure 171
Miniature gauged niche, from original TLB rubbers, executed by the author whilst using it as an opportunity to also teach selected students the setting-out, geometry, establishment of templets, design of cutting boxes, and aspects of the practical skills required in niche construction, 2003–4.

> If a man dwells on the past then he robs the present. But if a man ignores the past he may rob the future. The seeds of our destiny are nurtured by the roots of the past [Chinese proverb, s.I.].

Cut and rubbed and later, gauged brickwork were, and remain, the highest expressions of the bricklayer's art, for so long overlooked within studies of the nation's historic architecture. The knowledge, skill, and ingenuity displayed in the bricklayer's articulation of cut-moulded enrichments have, for many centuries, played a crucial part in our brick-built heritage. It is part of a significant national resource of which we should all be proud, and safeguard for future generations.

Summary

The period from 1918 to the present (2007) has witnessed the move away from enriched mass-masonry laid in lime-based mortars to calculated, thin-walled, structural envelopes, set in cement mortars to meet the required speed of erection. This has witnessed building crafts changing from crafting to fixing skills, leading to some brickmakers producing a harder rubber that responds favourably to mechanised cutting and shaping in order to supply pre-cut enrichments for on-site assembly. This is reflected in the demise of the traditional time-served apprenticeships to short modular training courses, supplying tradesmen for modern building sites. This has resulted in a severe shortage of highly skilled and knowledgeable craftsmen who can confidently undertake cut and rubbed, and gauged work. Such a change impacts on the quality of work vital for the successful repair, conservation, and restoration of historic brick properties, and for its positive inclusion on new buildings erected for the discerning client. Due to these factors, it is increasingly common to also occasionally employ stonemasons to carry out the repair and restoration of gauged work because of the continued emphasis on the fine crafting skills in masonry that are common to both. So, in many respects, the story of cut and rubbed and gauged work in terms of the on-going development turned full circle within the two allied masonry crafts.

Case Study: Quakers House, North Crawley, Bedfordshire, England

The Craftsman's Perspective

By Jeff Day, Craftsman Bricklayer, Harrold, Bedfordshire

Quakers House, North Crawley, Buckinghamshire is an existing Edwardian residence of some size. The extension was to be constructed using Bovingdon hand made bricks and all works specified to be carried out to the match the existing brickwork of English bond with decorative features.

The brickwork was to be executed to a gauge comprising of 9 mm bed joints and 6 mm perpends. The 6 mm perpends in English bond proved to be a challenge to maintain as the hand made bricks varied in length considerably due to the position in the kiln that they were fired in, shrinkage depending on their exposure to the heat.

Although the external appearance was for a traditional solid English bond, it was in fact a modern variation on that theme, with the headers being cut to half-bats with a Clipper Saw. This was to make use of modern cavity wall construction conforming to the standards for 'u' values required.

The heads of openings were to be formed with gauged camber arches with a rise of 10 mm at the centre laid with 3 mm joints in a lime putty:silver sand mortar (Fig. 172). Some of these arches had Portland keystones that projected 20 mm from the face.

Figure 172

General view of gauged work under construction at 'Quakers House', North Crawley (Buckinghamshire), 1998. (Courtesy of Jeff Day)

All the camber arches were pre-cut to a high standard by a craftsman called Hugh Tusting from Norfolk and delivered to site. In essence it would appear to be a simple construction with an arch ready formed by someone else. Clearly though in constructing an arch to such fine tolerances this moves the construction of them almost into the realms of engineering. It was apparent at the outset that all the gauged work needed to be carried out using lines, profiles and templates, therefore preparation was paramount and the key to success.

Gerard Lynch was brought in as a consultant to teach us how to construct the gauged arches. I first met him in 1972 when as young men we studied together for our City and Guilds at Mander College, Bedford (Bedfordshire); as we embarked on our apprenticeships as bricklayers.

In the workshop he showed us the geometry and use of the arch turning piece, with a rise of 10 mm for the camber. This was laid-out on its back on a bench with a centre line clearly marked to form a starting point for all setting out and our voussoirs were then dry bonded face-up and the centre line transferred through either the key brick or key stone.

With these positioned directly over the centre line on the marked turning piece, we used dummy spacers, 3 mm in size to represent the designed joints. Once all the bricks were spaced accurately in position over the turning piece, we positioned a horizontal timber profile called a 'tree'. This was placed at a predetermined distance above the arch bricks, determined by the gauge of the standard brickwork of the jambs. We transferred the centre line running through the turning piece up on to the tree. This is most important as these centre lines are crucial when setting out, both for preparation and for when the construction starts above the openings.

With the tree in position we used a line to radiate the leading edge of each brick, this line being long enough to reach both the tree and turning piece. As each line was radiated we made an accurate pencil line on both the tree and turning piece, positioning small nails to each pencil line; enabling us to wrap string around them for the construction phase.

The skewbacks were easily scribed to the correct angle using the lines ran-ging from the tree to the turning piece. After cutting and laying the skewbacks the first voussoirs, or 'springers', on either side of the arch were laid to the line and position. The laying of the arch to such a fine tolerance meant that unless everything was prepared absolutely perfectly there could be problems.

The delivered super-fine lime putty, which we mixed with a little amount of silver sand, was placed into a dipping box. Before laying each voussoir, it was sufficiently soaked to reduce absorption. The next process was to lower the frogged face of the voussoir into the putty mortar, lowering it brick bed face down at a slight angle, so the back-edge made contact first. If the brick was soaked for the correct amount of time the frogged face would be emerge with an even coat of putty mortar adhered to it.

We were aware from dry-bonding that some of the bricks, due to disc-cutting, were slightly out of square from face to bed, being larger at the back than the front, so slight adjustments in the bedding had to be made as we went along. As some of the soffit cuts were also very slightly out of square to the face it meant that some voussoirs could tilt forward; and this could be exacerbated with the weight of the keystone. To overcome this, once the arch was turned we immediately clamped a prepared length of straight timber across the face of the newly turned arch holding it to the standard face brickwork on both sides of the opening with large 'G' cramps until it had hardened (Fig. 173).

Once all the voussoirs were laid the putty joints were left to stiffen, or as we term it 'hazel off', and then trimmed flush. After trimming they were jointed

Figure 173

A newly built camber arch with projecting 'keystone', with the temporary timber and 'G' cramps in place. The setting-out pins for the intradosial positions of the voussoirs are still clearly visible on the timber 'turning piece'. (Courtesy of Jeff Day)

just 'off the arris' with traditional brick jointers of a blade width to suit these narrow joint sizes. We had been taught that if we laid the bricks correctly and neatly we wouldn't necessarily need to clean or rub up the to finish the arch faces; and this proved to be true. We had an occasional slight fingerprint of lime on a brick face from the gloved hand during laying. As directed we let this dry and removed it easily with the gentle action of diluted white vinegar applied with a soft-bristled toothbrush.

Within our contract, we also had to build two circular blind 'oculi', or 'Bullseye' arches. These were to be built, with the bricks cut to voussoirs by Hugh Tusting, to match the other arches. This was quite a challenge as it had different elements from the arch construction that needed to be considered to construct the oculi accurately.

First a timber centre was constructed to the exact size of the inner circumference, or soffit, of the oculi. This was marked with two centre lines both vertical and horizontal, and also a centre or 'striking point' with a small nail. Both vertical and horizontals marked centre lines gave four points of accuracy around the profile. The voussoirs were then dry-bonded using 3 mm spacing. With four points of accuracy only a quarter of the circle had to be bonded before reaching a centre line, which of course was the key brick centre.

With our voussoirs laid around the centre we made two trammels, both of which, fitted over the nail at the striking point; one for the inner circle and one for the outer circle. The larger trammel would assist the accurate scribing the standard face bricks to be cut and then checked with it as the invert to receive the lower half of the oculi.

To radiate and mark the positions of the dry-bonded bricks we devised a tree similar to that used for the camber arches. We shaped a piece of hardboard in to a 'U' shape around three sides of the dry-bonded oculi. This enabled us to be able to mark accurately the centre of the three of the four key positions (Fig. 174).

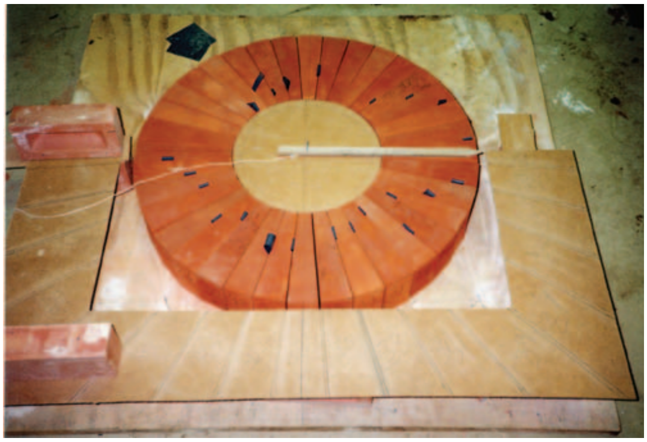

Figure 174
Setting out and dry-bonding of the oculus, establishing the trammel to cut the invert of the brickwork and the 'U' template upon which the positions of the voussoirs were marked for both the lower and upper half. (Courtesy of Jeff Day)

With the use of a line radiating from the striking point, we marked onto the hardboard all the positions of the dry-bonded voussoirs. As we had marked everything from centre lines we were able to rotate the hardboard template to be standing over the arch and thus accommodate the turning of the other half of the oculus.

We prepared the brickwork to receive the oculus, which meant we had to fix a horizontal beam with the centre line running through it upon which we accurately positioned the striking point and fixed the two trammels. 9 mm was added to the larger one, to accommodate the thickness of the mortar joint around the extrados of the oculus. With the trammel rotating on our centre nail at the striking point we cut and checked the invert. That done we were ready to turn the lower half of the oculus. We fixed the U template to the set brickwork, following the same procedure as when dry-bonding. The centre lines and template were aligned and with the smaller trammel fixed at the striking point as our radiating line.

The string line was strained from the striking point to the relevant marks on the template as the trammel governed the inner radius (Fig. 175). Each voussoir was laid in this manner until the halfway point was reached. Then the middle section of the oculus was bricked in with standard work to bond, checked for curvature with the same small trammel. Then the upper half of the oculus was constructed by simply turning the U template over and relocating it on the established horizontal and vertical centre line, passing through the striking point. We then proceeded to turn the upper half checking each voussoir to the

Figure 175
Turning the lower half of the oculus, with lines strained from the striking point and relevant point on the 'U' template to correctly position and align each voussoir, and a small trammel to check the curve of the soffit. (Courtesy of Jeff Day)

established marks on the template and the small trammel; extended to allow for the mortar bed joint (Fig. 176).

Figure 176
Turning the upper half of the oculus with the same 'U' template positioned on a horizontal beam, to assist correct lining-in of each voussoir. (Courtesy of Jeff Day)

The architect, Mr Charles Morris, the Contracts Manager and the client were all very pleased with the outcome of the gauged brick dressings (Fig. 177). Mr Morris commented that the overall work to the extension was the best brickwork seen by him for a long time; praise indeed considering among other projects he had worked on was 'Highgrove House' for the HRH The Prince of Wales.

Darren and myself gained valuable experience in building the decorative features to a high quality, and it has given us a tremendous boost as craftsmen. There is no doubt that without the skills, knowledge, experience and patience demonstrated by Gerard that we would not have produced the high standard of workmanship on the gauged brickwork that we did achieve.

Figure 177
The completed oculus.

Case Study: Practical Testing of Historic and Modern Rubbing Bricks

Rubbing bricks, and particularly those made from fine-graded and washed brickearths, are soft in comparison to all other building bricks. Fired to a point just below vitrification (900°C/1652°F), the brick possesses no fireskin, common to other fired bricks. Despite their softness and absence of a protective fireskin, these bricks are extremely durable.

Before such bricks are used, they are first soaked in clean water to enable them to pick up a fine mortar joint (1–3 mm) without the mortar rapidly drying out. When the brickwork is finished off, some weeks later, by rubbing smooth with an abrasive, hand-held, float-stone, it has been observed that a thin veneer forms over the surface of the brick, which is fairly hard to breech. Further hardening occurs over a longer period of time (several months) as the brick dries out, affecting its outer face.

The performance of modern rubbing bricks compared to their historic counterparts is important in terms of both conservation works and informing future production of such bricks. To these ends, a series of tests and analyses were carried out on a selection of historic and contemporary rubbing bricks.

Practical Testing in the Cutting of Historic and Modern Rubbing Bricks

The practical testing of rubbing bricks was undertaken to assess and compare how easily and quickly each one rubbed and cut. Rubbing was carried out on the rubbing stone and cutting by the use of a twisted wire blade in a bow saw. Due to the rarity of most of the historical bricks, only two bricklayers undertook the testing, excepting for the TLB Orange Red rubber of which an ample supply from the author's collection was available. For the modern rubbers, six bricklayers took part in these tests (Figs 178 and 179).

Figure 178

An original TLB rubbing brick on the left alongside four modern makes of rubbers for comparison, prior to rubbing them square on the stone and undertaking cutting trials.

Figure 179

An original TLB rubbing brick on the left alongside the four modern makes of rubbers after the cutting trials – to form a cavetto moulding using the wire-bladed bow saw and abraded to finish.

Results and Discussion

Generally, the historic rubbers performed well and cut relatively easily to form sharp arrises and revealing only minor inclusions. The results of the tests are given in Tables 4 and 5, and the findings summarised below:

Table 4 Results of practical tests on cutting historical rubbing bricks.

Name	Location of bricks or building source	Date	Type of brick	Colour	Observations by the bricklayers	Duration of cut (min:sec)
Wheeler's Rubber	Originally from Berkshire St Pancras station	c.1868	Voussoir moulding	Cherry red	• Dense smooth and relatively hard to cut • Arrisses very crisp • Very few inclusions	ES 0:58 GL 0:48
Wheeler's Rubber	St Pancras station	c.1868	Ashlar	Orange	• Dense, smooth, easier cut. Polished texture • Fine arrisses • Few inclusions	ES 0:58 GL 0:50
TLB Cherry Red	Bracknell (Berks.) From authors collection. Originally from Bedford Park	c.1887	Squint quoin cut moulding	Darker red than TLB Orange/ Red rubber	• Light, open textured feel. Not as dense as Wheeler's Rubber • Holds good arrisses (but not as good as Wheeler's Rubber) • Not many inclusions but gave scratch marks when rubbed • Unusually regular striations from bow saw	ES 0:27 GL 0:20
TLB Orange Red	Bracknell (Berks.) From authors collection	c.1960	Rubbing block	Orange	• Beautiful, light open texture • Slightly less crisp arrisses than the Cherry Red TLB • Hardly any air pockets or inclusions	ES 0:22 GL 0:20 AL 0:35 DW 0:45 DD 0:20
Unknown	Warfield House, (Berks.). In the immediate location of TLB works, but prior to production of TLBs (when clay would have	c.1740	Cornice moulding	Light orange (similar to the niche TLBs)	• Very fine dust. • On rubbing, surface revealed many air pockets and an almost marbled appearance with unbroken clay nodules • Light feel • Arrisses good, rubbed well	ES 0:28 GL 0:18

(Continued)

Table 4 Continued.						
Name	**Location of bricks or building source**	**Date**	**Type of brick**	**Colour**	**Observations by the bricklayers**	**Duration of cut (min:sec)**
	undergone washing for rubbers)				• Inclusions – air pockets	
'F' in frog of rubbers on main elevation. Identical 'F' found in bricks at H.C.P. yard	Eltham Orangery Niche, London	c.1710	Main body niche brick	Dark orange	• Rubbed beautifully • Surprisingly little dust • Heavier feel than TLBs • Good arrisses • Inclusions – a few stones (flint?) • Minor air pockets • Light marbling effect of unbroken clay but not pronounced • Quite hard to cut	ES 1:23 GL 1:07
'F' in frog of rubbers on main elevation. Identical 'F' found in bricks at H.C.P. yard	Eltham Orangery Niche, London	c.1710	From boss shell carving quality	Dark red colour	• Dense • Very sharp arrisses • Inclusions – less air pockets or stones • Whiter marbled streaks of clay • Easy to cut	ES 0:55 GL 0:47

Key: GL = Gerard Lynch, ES = Emma Simpson, AL = Andrew Langridge, DW = David Watts, DD = Derren D'Archambaud.

- The nineteenth-century 'Wheeler Brothers' rubber, though quite firm, produced an excellent arris.
- The eighteenth-century Berkshire rubber, apart from a less clean body (from as-raised clay), performed exactly as a twentieth-century TLB Orange Red made from the same, but washed, material.
- The two types of TLB rubbing bricks, the Orange and the Cherry Red clearly revealed why the latter was the superior rubber. Both were open-textured but the Cherry Red was less sandy and had a noticeably finer dust; both cut and rubbed very easily.
- It was interesting to note how the rubber used for the ashlared gauged work and niche body at Eltham Orangery (see case study, p. 182) was much firmer than the rubbers selected for the carved 'scallop-shell' niche boss.

All the modern rubbers, except the Hampshire rubber, proved much harder, although they still cut and rubbed well, with good arrisses:

- The Sussex rubber was quite dense and, although it had few air pockets, was speckled with tiny flint nodules and was quite hard to cut.

Table 5 Results of tests on cutting modern rubbing bricks.

Name	Location of bricks or building source	Type of brick	Colour	Observations by the bricklayers	Duration of cut (min:sec)
Company 1	Suffolk	Rubber	Dark orange	• Dense texture • Arrises good • Few inclusions or air pockets • Washed • Quite hard • Finished nicely with abrading	ES 0:45 GL 0:40 AL 0:45 DW 1:15 RD 1:07 DD 0:42
Company 2	Sussex	Rubbing Brick	Dark red	• Very dense and smooth • Excellent arrisses • A few air pockets • Speckled tiny white nodules flints–though washed • Hard to cut	ES 1:31 GL 1:20 AL 1:55 DW 2:10 RD 2:03 DD 1:23
Company 3	Hampshire	Rubbing Brick	Dark grey and reddish brown	• Light, open, sandy texture • Coarser sand/dust to others • Core breeze included in mix resulting in evidence of flash burn towards core of brick • Fragile arrisses – needed care • Air pockets and small inclusion	ES 0:26 GL 0:20 AL 0:50 DW 1:35 RD 1:05 DD 0:20
Company 4	Suffolk	Rubbing Brick	Lighter orange red	• Dense unwashed clay • Good arrisses • Large inclusions • Hard to cut towards middle • Finished nicely	ES 1:45 GL 1:07 AL 1:15 DW 2:00 RD 1:47 DD 1:13
Company 5	Buckinghamshire	1st Trial Rubbing Brick	Light orange	• Very fine dust • On rubbing, surface presented an almost marbled appearance with unbroken clay nodules • Light feel • Arrises satisfactory • Rubbed well • Inclusions	ES 0:55 GL 0:45 DD 0:42
Company 5	Buckinghamshire	2nd Trial Rubbing Brick	Light orange red	• Very fine dust • On rubbing, presented a clean homogeneous surface • Arrises nice and sharp • Rubbed well • Few minor inclusions • Cut and finished nicely	GL 0:50 DD 0:53

Key: GL = Gerard Lynch, ES = Emma Simpson, AL = Andrew Langridge, DW = David Watts, RD = Ron Denton, DD = Derren D'Archambaud.

- The washed Suffolk rubber, although dense in texture, cut reasonably well with few inclusions or air pocket voids, but finished well with abrading and good arrisses.
- The unwashed Suffolk rubber was noticeably harder to cut, especially towards the middle, with large inclusions, yet again it finished well with good arrisses.
- The Hampshire rubber cut the easiest of all the modern rubbers, but due to a much coarser sand content had fragile arrisses that needed care. The integral breeze was evident in a flash burn towards the harder exposed core of the brick.
- The unwashed Buckinghamshire rubbing brick (trial brick 1) rubbed and cut well with satisfactory arrisses, and the inclusions presented little resistance. The fully washed rubbing brick (trial brick 2) had only minor inclusions and though firmer it rubbed and cut well with good arrisses.

The opinions of those that took part in these tests was that, generally, most of the modern rubbing bricks tend to compare with the washed rubbers from the mid-nineteenth century onwards and some of the earlier, better quality, naturally clean-bodied bricks, in respect of texture and appearance. The Hampshire and Buckinghamshire unwashed rubbers have a texture and colour that particularly complements some sixteenth through to the eighteenth-century gauged work. Both were quite soft to cut and rub, although the integral fuel of the former can sometimes cause the brick to burn harder than acceptable for a consistent rubbing brick quality. The overall hardness of the others would seem to confirm that modern rubbers are burned to a higher temperature than their historical counterparts and therefore do not cut and rub quite so readily. Clearly, in terms of cutting, the majority of these modern bricks are slightly suited more towards machine cutting than hand cutting, although all can be cut by hand tools.

Case Study: The Characteristics and Properties of Rubbing Bricks

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Being easily cut and rubbed, and carved, it is easy to think that rubbing bricks are unable to withstand the weather and thus unsuited for constructional work. This ignores the survival of well-detailed and constructed work on many historic buildings. It is a fact that, after these bricks have been laid, their surfaces become hard (similar to freshly worked limestone) over time, so enabling rubbers to withstand even the polluted atmospheres of big towns and cities.

Case-hardening

Having spent much time working on many forms of both cut and rubbed and gauged brickwork, the author has noted that, when disassembling brickwork for repair, the texture of the bricks throughout has been in excellent condition. A form of case-hardening has been repeatedly observed to a depth of 5 mm, forming a protective skin on the face of the rubbing bricks. This was also noted and observed on the calcium bearing 'Malms' and white Suffolk 'Clippers' by Walker (1885, 61–2) who observed:

> 'Gauged work' is often objected to on the ground that it will not resist the action of the weather. This we can refute by our own experience, for we have taken out old 'gauged' arches in malms that have withstood for forty years the acids contained in London smoke, and have shown no sign of decay or disintegration. We can cite another instance of the indurating properties of 'gauged work' in white Suffolks when exposed to the action of the atmosphere. During the erection of the Rackham Street Marylebone Infirmary, some geometrical windows had to be cleaned down some three or four months after erection. This process had to be done by rasping the face of the brickwork, and so hard had become the bricks that it was with difficulty that an impression could be made at all, the rasps sliding off the work and leaving a black mark! Bricks in this condition have been said by bricklayers to be case-hardened.
>
> This so-called case-hardening we attribute to the process of setting. In good setting the bricks are always soaked (not to saturation) in water, which in a building in course of erection always contains more or less lime in solution, which is taken up by the brick while soaking, and by exposure to the atmosphere becomes carbonised and forms a hard coating, as it were, upon the face of the brick. This case-hardening is also attributed to 'the silicic acid in the clay acting upon the chalk so as to form some of it into a silicate of lime'.

In respect of the orange and red rubbers, the author's observations have led to the view that this case-hardening may be divided into two distinct phases. The first being an initial surface hardening that occurs over several weeks after laying and the second being a deeper internal action that accompanies a long-term and deeper surface hardening.

In laying, rubbing bricks are soaked in clean water to a point just short of saturation. This allows the brick to pick up a fine mortar joint without rapidly drying out and be set into position with an average joint size of 3 mm (but often less than 1 mm). Once this new brickwork has dried out sufficiently, it is then capable of being 'rubbed up' (i.e. finished by being rubbed smooth using a hand-held abrasive stone called a 'float stone'). This process reveals the initial surface hardening that takes place during the early drying period, forming a very thin veneer over the brick face that is difficult to penetrate with the float stone in order to achieve the final rubbed-smooth finish to the enrichment.

The secondary hardening, as stated above, occurs over several months as the rubber fully dries out. This is considered to occur as the internal minerals continue to be carried slowly in solution to the exposed face of the brick, where they crystallise at or near the surface. This view is upheld by Prentice (2000), who suggests:

> …this is due to the movement of soluble-salt-rich water from the inside of the brick – a process which sometimes manifests itself as visible 'scum', but which is always present to some degree.

The cause of this case-hardening is considered to be the result of one of two distinct processes, or possibly a combination of both:

The low-firing temperature of rubbers, at or below 900°C, causes some of the integral minerals, in particular the silica and alumina content, to become highly reactive (i.e. similar to what occurs chemically when burning a lime to create quicklime). This is a completely different mineralogical reaction to that which occurs to the silica in the burning of standard facing bricks. Here, there is the production of a glass-like bond, cementing the particles together, and the formation of a protective 'fireskin' to the surface of the brick in a process known as vitrification. This reaction, which destroys the reactivity of the silica, occurs between 900 and 1,200°C.

The highly reactive silica and alumina mineral content of these low-fired bricks is being activated by contact with water. This is initiated whilst soaking the rubber prior to setting, and later during the laying process, and leads to a hydraulic reaction during the subsequent drying-out of the newly-laid brickwork. This action could produce silicic acid, which could act upon calcium carbonate or chalk in the brickearth or clay (as in the malm cutter) to form an additional silicate of lime. These hydraulic chemical reactions could eventually form a siliceous texture to the exposed surface or face of the brick, giving it a much harder property.

In order to investigate the cause of the case-hardening phenomena, samples from ten different historic and contemporary rubbing bricks were analysed.

The performance of a building material in relation to site and environmental conditions is determined by its mineralogical composition and physical properties. A brick is composed of minerals and pores arranged in a certain pattern. The nature of these minerals and the relationships between them will determine key properties such as porosity and hardness, thus dictating the physical and chemical resistance of the material. The nature of their raw materials, as well as their firing temperature and firing process affects greatly the final mineralogical composition, porosity, and durability of the material, and therefore the final quality of the brick. In general, high temperatures and/or long firing periods will result in a harder, less porous, and more vitreous brick.

It is, therefore, considered essential to determine the mineralogical composition and texture of the brick, with a particular focus on the presence, nature and arrangement of the mineral cements, in order to understand the properties of the rubbing brick in relation to durability. To this end, petrographic microscopy and X-ray diffractometry (XRD) were used.

Furthermore, since moisture is directly responsible for many decay processes and mineral reactions that induce hardening, the presence and movement of moisture within the brick were considered important factors. Porosity, water absorption and water suction were therefore measured in order to characterise the moisture transport properties of the rubbing brick.

Methods

In the first instance, ten samples of rubbing brick from a variety of locations in England and continental Europe, dating from the seventeenth to the twentieth century (Table 6) were analysed (Pavia and Lynch, 2003).

All analyses and testing were carried out at Trinity College Dublin, the Dublin Institute of Technology and Loughborough University.

Thin sections were made from the samples and petrographic examination was carried out using both natural and polarised transmitted light.

The mineral composition of the samples was determined by XRD.

The presence and movement of water within the brick samples was determined by measuring the rate of water uptake (suction) of a dry brick and the amount of water that the brick could hold (absorption). The amount of water absorbed by each sample was determined by comparing the wet mass of the sample to its dry mass.

The volume of pore space in the brick samples (porosity) was also measured. Open porosity, or porosity accessible to water, is the ratio of the volume of the accessible pores to the bulk volume of the sample.

Results and Discussion

The mineralogical compositions of the bricks are given in Table 7.

From the results, the analysed rubbing bricks can be divided in to two main groups: those that contain calcium-bearing minerals (diopside and wollastonite)

Table 6 Samples of analysed rubbing bricks.

Sample	Date	Provenance	Details
1	1682	Gate pier Chiswick Park, England	Mortared in place
2	1950	Thomas Lawrence & Sons, Bracknell, England	Known as 'TLBs'. Never used. Kept dry
3	1856	Arch Weaver's House, New Wanstead, England	Known as 'Malm Cutter' from Malm clay of London stock bricks. Mortared in place
4	C17th	Unknown church, The Netherlands	Mortared in place
5	*c.*1500	Outside Brugge, Belgium	Mortared in place
6	1999	Traditional brickyard, England	Washed clay (London bed). Never used
7	1999	Traditional brickyard, England	Pan ground. Not washed (London bed clay). Never used
8	1999	Traditional brickyard, England	Washed clay. Never used
9	1999	Traditional brickyard, England	Carving quality rubber. Never used
10	1999	Traditional brickyard, England	Never used

Table 7 Mineralogical composition of the rubbing bricks.

	Quartz	Feldspar	Calcite	Filosilicates	Diopside	Wollastonite	Haematite	Goethite
1	XXXX	XXX	(X)	X	T		X	X
2	XXXX	XX		X			X	
3	XXXX	XXX	(X)		XX	X		
4	XXXX	XX	X	(X)		X	(X)	
5	XXX	XX	X		X			
6	XXXX	XX					X	
7	XXXX	XX	(X)	X			XX	
8	XXXX	XXX					X	X
9	XXXX	XXX	X	X			X	X
10	XXXX	XXX	X	X			X	X

Key XXXX = predominant; XXX = abundant; XX = significant; X = present; (X) = scarce; T = traces

(samples 3, 4 and 5); and those that are haematite-rich (samples 2, 6, 7, 8, 9 and 10). Sample 1 could belong to either of these groups, although only trace amounts of diopside were observed.

Microscopic examination showed that most of the bricks contain a reactive chert temper (microcrystalline silica), which at some time has reacted with the surrounding matrix, resulting in reaction haloes and the generation of cements. The temper (defined as those phases with a diameter of $>15\,\mu m$) varies in size, from $50\,\mu m$ to 1.5 mm. The calcium-bearing bricks tend to feature the finest temper (50–100 µm), whereas the haematite-rich bricks contain coarser temper (up to 1.5 mm in sample 10), and hence exhibit a more porous and open microscopic texture.

The petrography shows that the historic rubbers were probably fired at a temperature of 750–900°C, whereas the modern rubbing bricks were more likely to have been fired around the 900°C mark.

The measured porosity, water absorption, and water suction of the rubbing brick samples are given in Table 8.

Table 8 Properties of the rubbing bricks related to the presence and movement of water.

	Sample	Porosity (%)	Water absorption (%)	Water suction (gcm^{-2}/min)
Calcium-bearing bricks	3	42.73	18.60	0.73
	4	38.82	17.16	0.52
	5	38.05	21.24	0.55
	Mean ± σ	**39.87 ± 2.51**	**19.00 ± 2.10**	**0.60 ± 0.11**
	1	32.41	14.00	0.47
Haematite-rich bricks	2	34.26	12.44	0.19
	6	35.65	15.07	0.40
	7	32.68	14.04	0.30
	8	32.15	11.99	0.30
	9	30.15	11.33	0.43
	10	35.56	15.07	0.44
	Mean (±σ)	**33.27 ± 2.00**	**13.42 ± 1.50**	**0.36 ± 0.10**

Even though the haematite-rich rubbing bricks show a more porous and open microscopic texture, the results show that the calcium-bearing bricks have a significantly higher effective porosity (volume accessible to water) and water absorptivity, and a slightly higher ability to absorb water by capillary

Table 9 Reference values for porosity, water absorption, and water suction of historic, hand-made, and machine-made clay bricks (Pavia and Lynch, 2003).

	Brick type	Reference values		
		Porosity (%)	Water absorption (%)	Water suction (gcm^{-2}/min)
Hand-made range	Irish, seventeenth century (mean of 10 samples)	36.15	18.47	0.08
	Spanish, seventeenth century (mean of 19 samples)	37.13	21.29	0.22
Machine-made range	Gault facing	38.5	–	–
	Keuper marl	24.6	–	–
	Flettons	34.8	–	–
	London stock	48.9	–	–

action (suction). The mean porosity value for both the calcium-bearing bricks and the haematite-rich bricks (39.87 ± 2.51 and 33.27 ± 2.00, respectively) fall within the typical range of historic hand-made and machine-made bricks (see Table 9).

The average value of water absorption for the calcium-bearing bricks (19.00 ± 2.10) is similar to that of the historic hand-made range. The haematite-rich group, on the other hand, has a significantly lower water absorption value (13.42 ± 1.50) than the reference values given. The mean water suction values for the two groups (0.60 ± 0.11 and 0.36 ± 0.10), however, are both significantly higher than the reference values given. The difference in physical properties between the two groups could be due to differences in firing temperature.

The results have shown that the historic and contemporary rubbing bricks can be distinguished from each other through both their mineralogical content and physical properties. In order to substantiate the mineralogical difference, a further 10 historic and 18 contemporary rubbing brick samples (Table 10) were sampled and subjected to mineralogical analysis (XRD).

The mineralogical compositions of the samples (Table 11) have not revealed any distinctions between the historic and contemporary rubbing bricks, and no calcium-bearing minerals were identified in the historic samples. Five out of the 10 historic rubbing bricks showed the presence of goethite, an iron mineral formed during the firing process. As this is often found in contemporary rubbing bricks (see Table 7) it is not, therefore, considered to be a discriminating factor.

Table 10 Samples of historic and contemporary rubbing bricks analysed for mineralogical composition.

Sample	Date	Provenance	Details
11	*c.*1547	Hill Hall, Essex	Cut and rubbed moulding brick for a plastered fireplace
12	*c.*1717	Eltham Orangery, London	Rubbers from the niche – the body (light orange)
13	*c.*1717	Eltham Orangery, London	Rubbers from the niche – the boss in hood (dark orange)
14	*c.*1740	Warfield House, Berkshire	Rubber from remains of gauged cornice – close to the TLB 19th century works
15	*c.*1887	Bedford Park, London	TLB red rubber No.1 quality
16	*c.*1867	St Pancras Station, London	Wheeler red rubber
17	*c.*1930s	Cornard Brick Company, Suffolk	Rubbing brick – not used but weathered
18	*c.*1920s	Allen's of Ballingdon, Suffolk	Rubbing brick – not used but weathered
19	*c.*1950s	Thomas Lawrence of Bracknell	TLB rubber, orange, 2nd quality – soaked in water
20	1950	Thomas Lawrence of Bracknell	TLB rubber – never used and kept dry
21	2003	Company 1	Pan ground rubber – never used
22	2003	Company 1	Pan ground rubber – soaked in water
23	2003	Company 1	Mild clay rubber
24	2003	Company 1	Mild clay rubber – soaked in water
25	2002	Company 1	Fully washed rubber – soaked in water
26	2002	Company 1	Fired washed rubber
27	2002	Company 1	Fired unwashed and pan ground
28	2002	Company 2	Rubber for carving – soaked
29	2002	Company 2	Rubber for carving – never used
30	2002	Company 2	Rubber – soaked
31	2002	Company 2	Red rubber – fired
32	2002	Company 3	Orange/red rubbing brick – soaked
33	2002	Company 3	Orange/red rubbing brick – fired
34	2002	Company 4	Unwashed rubber brick – soaked
35	2002	Company 4	Fired rubber – moulded as an over-sized arch voussoir
36	2002	Company 5	Light multi – low fired with breeze
37	2002	Company 5	Red – fired
38	2002	Company 5	Imperial handmade third – to be refired

Table 11 Mineralogical composition of historic and contemporary rubbing bricks.

Sample	Quartz	Haematite	Goethite	Feldspar	Kaolinite	Muscovite	Coesite
11	X	X	X	X			
12	X	X	X	X			X
13	X	X	X	X			
14	X	X	X	X			
15	X	X		X			
16	X	X		X			
17	X	X	X	X			
18	X	X		X			
19	X	X		X			
20	X	X		X			
21	X	X		X	X		
22	X	X		X			
23	X	X		X			
24	X	X		X			
25	X	X		X			
26	X	X		X			
27	X	X		X			
28	X	X		X			
29	X	X		X			
30	X	X		X			
31	X			X			
32	X	X					
33	X	X					
34	X	X		X			
35	X	X					
36	X	X					
37	X	X			X		
38	X			X		X	

Conclusions

It is likely that the historic rubbing bricks were fired at slightly lower temperatures than their modern counterparts. This would explain the difference in physical properties observed, as a lower firing temperature would result in a greater porosity.

Apart from the usual cements generated through firing (e.g. haematite and goethite), a number of additional mineral cements were microscopically observed, interspersed within the brick matrix. These arose from reactive minerals contained within the temper of chert and volcanic rock fragments. This reactive temper was found to form reaction haloes and cements in the surrounding matrix.

The petrography of these reaction haloes and cements is very similar to that of hydraulic reactions involving certain types of pozzolans. These have been often observed during petrographic analysis of hydraulic lime mortars (Pavia, 1995–2001).

The petrography of the reaction haloes and newly-formed cements in the rubbing bricks suggests that the temper was probably activated when the bricks were soaked prior to using. The temper within the rubbing brick – rich in microcrystalline silica – is acting in a similar manner to a pozzolan in a hydraulic lime mortar. The temper has reacted with lime in the presence of water, forming reaction haloes and cements in the surrounding matrix.

The great ability of the historic rubbing bricks to absorb water by capillary action, together with their high porosity, implies that their fine pores are better inter-connected and more effective at transporting water, than the coarse, open pores of the modern rubbers. This high efficiency in transporting fluids allows free movement of water throughout the brick, and, therefore, does not restrict the local crystallisation of cements from solution.

Although modern rubbing bricks may be considered to be low fired, in comparison with other building bricks, they have probably been fired at a higher temperature than their historic counterparts, resulting in slightly different physical properties.

In both cases, however, the firing temperature has been sufficient to induce sintering. It is this sintering process, and the presence of reactive temper, inducing localised cementation, that are the main contributors to the observed durability of the rubbing bricks.

Further research is needed to investigate the differences in physical properties between historic and modern rubbing bricks and their effect on mineral cementation and related durability.

References

Adams, H. (1907), *Building Construction*, London, Paris, New York and Melbourne, Cassell and Company Limited.

Airs, M. (1995), *The Tudor & Jacobean Country House: A Building History*, Stroud, Sutton Publishing Limited.

Amery, C. (Ed.) (1974), *Period Houses and Their Details*, London, The Architectural Press re-printed by Butterworth Architecture.

Amery, C. (Ed.) (1977), *Three Centuries of Architectural Craftsmanship*, London, The Architectural Press.

Audel, T. (1924) *Audels Masons and Building Guide No1*, Audel &Co, New York.

Bailey, H. and Hancock, D.W. (1979), *Brickwork and Associated Studies*, Volumes 1–3, London and Basingstoke, The Macmillan Press Limited.

Baldwin, R.J. (2004), Private correspondence.

Barksdale Maynard, W. (1999), 'If Walls Could Talk: Williamsburg's Historic Brickwork', *Colonial Williamsburg: The Journal of the Colonial Williamsburg,* the United States of America, The Colonial Williamsburg Foundation.

Baronio, G. and Binda, L. (1997), *Study of the pozzolanicity of some bricks and clays*, Construction and Building Materials, Volume II, Number I, pp. 41–46, Elsevier Science Limited, London.

Beard, G. Dr. (1981), *Craftsmen and Interior Decoration in England, 1660–1820* Part 1, New York, Holmes and Meier.

Beernaert, B. (1997), Private correspondence.

Bell, W.G. (1938), *A Short History of The Worshipful Company of Tylers and Bricklayers of the City of London,* Henry Greville Montgomery, London.

Bellamy, J. (1986), *Stand by Your Banner, Unit A102, Foundation Course,* The Open University, Buckinghamshire, British Broadcasting Corporation.

Bennett, R. (2007), Private correspondence.

Beswick, M. (2001), *Brickmaking in Sussex – A History and Gazetteer,* Midhurst, Middleton Press, for the Sussex Industrial Archaeology Society.

Blowers, C.H. (1987), *Brickmaking of Great and Little Cornard, Suffolk*, British Brick Society Information No 43, Dartford, Kent.

Bolton, A.T. and Hendry, H.D. (Eds.) (1927), *The Wren Society Volume IV*, Oxford, Oxford University Press.

Bolton, A.T. and Hendry, H.D. (Eds.) (1934), *The Wren Society Volume VII*, Oxford, Oxford University Press.

Bolton, A.T. and Hendry, H.D. (Eds.) (1940), *The Wren Society Volume XVII*, Oxford, Oxford University Press.

Brayley, E.W., Brewer, J.N. and Nightingale, J. (1815), *History of Middlesex*, 5 Volumes, London, Sherwood, Neely and Jones.

Brick Development Association (2003), Archival Records, Winkfield, Berkshire.

Brooks, F.W. (1939), A Medieval Brick-Yard at Hull In: *The Journal of The British Archaeological Association,* 3rd Series, Volume IV, London.

Brunskill, R. and Clifton-taylor, A. (1977), *English Brickwork*, London, Ward Lock Limited.

Bryant, C.A. (1902), *Essay on The Building of Christ's Hospital* (s.l.).

Burnell, G.R. (1874), Rudimentary Treatise on Concretes, Mastics, Plastering, Etc, Lockwood and Company, London.

Cannell, M. (2005), Training: A Short History, pp. 1–12, www.cipd.co.uk/subjects/training/general/thistory.htm

Campbell, J.W.P. (2002), *17th Century Bricklayers,* British Brick Society Information No 87, Dartford, Kent.

Campbell, J.W.P. and Pryce, W. (2003), *Brick a World History,* London, Thames and Hudson.

Chadwick-Healey (1971), 'Historical Abstracts' In: *British Labour Statistics*, London, HMSO.

City and Guilds *588 Brickwork and Masonry 1976 Onwards,* London, The City and Guilds of London Institute.

City and Guilds, *Brickwork 82,1966–67,* London, The City and Guilds of London Institute.

Coppack, G. (2002), Private correspondence.

Clarke, J.W. (Ed.) (1886), *The Architectural History of the University of Cambridge and the Colleges of Cambridge and Eton*, Volume 1, Cambridge, The University Press.

Clarke, L. and WALL, C. (2006), *Omitted from History: Women in the Building Trades*, The Proceedings of the Second International Congress on Construction History, Volume 1, Construction History Society, pp. 35–59.

Clifton-Taylor A. (1978), *a Fine Caroline Tower, St Mary's, Winkfield, Berkshire,* Brick Development Association.

Colvin, H.M. (Ed.) (1976), *The History of the King's Works, Volume V, 1660–1782*, London, Her Majesty's Stationery Office.

Colvin, H.M. (Ed.) (1982), *The History of the King's Works, Volume IV, 1485–1660* (Part II), London, Her Majesty's Stationery Office.

Colvin, H.M. (1995), *A Biographical Dictionary of British Architects, 1660–1840.* New Haven and London, Yale University Press.

Colvin, H. and Newman, J. (Eds.) (1981), *Of Building – Roger North's Writing on Architecture*, Oxford, Clarendon Press.

Construction Industry Training Board and Construction Industry Council, Construction Skills Foresight Report 2003, CITB and CIC, Norfolk, (2003).

Conway, P. (2002), Private correspondence.

Corder-Birch, A. and Neal, K. (Ed.), (1996), *Brickmaking in Essex*, Oxford, Leopard's Head Press Limited.

Cox, A. (1979), *Brickmaking, A History and Gazetteer – Survey of Bedfordshire*, Bedford, Bedfordshire County Council.

Cox, A. (1989), 'Bricks to Build a Capital' In: *Good and Proper Materials,* Hobhouse H. & Saunders A. (1989), Publication 40, London, The London Topographical Society.

Cox, A. (2004), Private correspondence.

Cruikshank, D. (1998), 'Renovation', *A Supplement Published by the Architects' Journal,* London, The Architects' Journal 1998.

Cruikshank, D. and Wyld, P. (1975), *London: The Art of Georgian Building*, London, The Architectural Press Limited.

Curl, J.S. (1992), Encyclopaedia of Architectural Terms, London, Donhead Publishing.

Dearne, T.D.W. (1809), *The Bricklayers Guide to the Mensuration of All sorts of Brickwork, According to the London Practice,* High Holborn, London, J Taylor at The Architectural Library.

Department of Culture, Media and Sport (2001), *The Historic Environment: A Force for Our Future*, December. London, DCMS (Architecture and Historic Environment Division).

Department of Culture, Media and Sport (2002), *Protecting our Historic Environment: Making the System Work Better,* July, London, DCMS (Architecture and Historic Environment Division).

Department of the Environment/Department of National Heritage (1994), *Planning Policy Guidance 15: Planning and the Historic Environment*, PPG 15, London, HMSO.

Dobson, A. (Ed.) (1906), *Diary of John Evelyn,* Volume III, London, Macmillan and Company Limited.

Dumbleton, M. (1990), *Brickmaking: A Good Local Industry – Ascot, Bracknell and Wokingham*, Berkshire, Bracknell and District Historical Society.

Edwards, A.C. (1977), *The Account Books of Benjamin Mildway, Earl Fitzwalter,* Regency Press, London and New York.

English Heritage (2000), *Power of Place: The Future of the Historic Environment*, December, London, English Heritage.

Firman, R. (1998), 'Gault: A Geologist's Cautionary Tale of Words as a Barrier to Under-standing', In: *British Brick Society Information Number 74*, June, 1998, Dartford, Kent.

Forman, B.M (1970), In: Montgomery, C.F. (Ed.). *Joseph Moxon's Mechanick Exercises, Or The Doctrine of Handy-Works, Applied to the ART of Bricklayers Work,* (1703), Facsimile Edition, New York, Washington and London, Praeger Publishers.

Frost, W. (1931), *The Modern Bricklayer*, (3 volumes), London, The Caxton Publishing Company Limited.

Frost, W. and Boughton, R.V. (1954), *Modern Practical Brickwork*, London, B.T. Batsford Limited.

Gage, J. [afterwards Rokewode, Gage, J.] (1822), *The History and Antiquities of Hengrave, in Suffolk,* London, J Carpenter.

Gardiner, A. (2004), Private correspondence.

Giovannoni, G. (1925), *Brickwork in Italy – A Brief Review from Ancient to Modern Times*, Chicago, American Face Brick Association.

Girouard, M. (1977), *Sweetness and Light: The 'Queen Anne' Movement 1860–1900,* New Haven and London, Yale University Press.

Godfrey, W.H. (Ed.) (1946), *The Survey of Building Sites in the City of London*, Volume 1, London, The London Topographical Society.

Gomme, L. and Norman, P. (Eds.) (1932), *London County Council – Survey of London, Volume III, The Parish of St Giles-In-The-Fields, (Part 1), Lincoln's Inn Fields*, London, London County Council.

Gunther, R.T. MA Hon LL.D (Ed.) (1928), *The Architecture of Sir Roger Pratt,* Oxford Oxford University Press. Reissued (1972) by Benjamin Bloom Incorporated, New York.

Gwilt, J. (1888), *An Encyclopædia of Architecture*, London, New York, Bombay and Calcutta, Longmans, Green and Company.

Hamilton-Thompson, A. (1920), *The Building Accounts of Kirby Muxloe Castle, 1480–1484*, Volume XI, Parts 3–6, Leicester, The Leicestershire Archaeological Society Transactions, Leicester Archaeological Society.

Hammett, M.J. (2000), 'Precast Quality', *The Brick Bulletin, Winter Edition*, The Brick Development Association, Windsor, Berkshire.

Hammett, M. J. (2004), Private correspondence.

Hammond, A. (1875), *The Rudiments of Practical Bricklaying*, London, Lockwood and Company.

Hammond, A. (1889), *The Art of Practical Brickcutting and Setting*, London, Crosby, Lockwood and Son.

Hammond, M. (1981), *Bricks and Brickmaking*, Shire Publications, Princes Risborough, Buckinghamshire.

Harley, L.S. (1974), *A Typology of Brick: With Numerical Coding of Brick Characteristics*, The Journal of The British Archaeological Association, 3rd Series, Volume XXXVII, London.

Harris, J. and Higgot, G. (1990), *Inigo Jones Complete Architectural Drawings*, London, Royal Academy of Art.

Harvey, J.H. (1984), *English Medieval Architects: A Biographical Dictionary down to 1550*, Revised Edition, Gloucester, Sutton Publishing Limited.

Heritage Lottery Fund (2002), *Sustaining Our Living Heritage: Skills and Training for the Heritage Sector*, February, London, Heritage Lottery Fund.

Hill, P.R. and David, J.C.E. (1995), *Practical Stone Masonry*, London, Donhead Publishing Limited.

Hoare, F. (1980), 'Fontley Hand Brick Making Yard' In: *Fareham Past and Present*, Book VIII, Volume II, Fareham, Hampshire, Fareham Local History Society, 1980.

Hodge, J.C. (1944), *Brickwork for Apprentices*, London, Edward Arnold Limited.

Hodge, J.C. and BALDWIN, R.J. (1993), *Brickwork For Apprentices*, Fourth Edition, Revised by Bob Baldwin, London, Melbourne and Auckland, Edward Arnold.

Hollestelle, J. (1976), *De Steenbakkerij in de Nederlanden tot Omstreeks 1560*, Van Gorcum and Co. (H J and HMG Prakke) Arnhem.

Holmes, S. (2006), *To Wake a Gentle Giant – Grey Chalk Limes Test the Standards*, The Journal of the Building Limes Forum, Edinburgh, Volume 13, pp. 9–20.

Holmes, S. and Wingate, M. (2006), *Building With Lime*, Intermediate Technology Publications Ltd., The Schumacher Centre for Technology and Development, Rugby.

Hughes, P. (1994), 'Thomas Surbey's 1699 Survey of the Rivers Ouse and Humber, Yorkshire Archaeological' In: *Yorkshire Archaeological Journal 66*, York.

Hume, I.N. (1993–4) *The Ruins of Rosewell*, The Journal of Colonial Williamsburg, USA.

Hyett, J. (1992), 'Hampton Court Palace: The Great Kitchen Chimneys', *Association for Studies in the Conservation of Historic Building Transactions*, Volume 17, pp. 3–14.

Janse, H. (1998), *VAN AAKS TOT ZWEI, Historische handgereedschappen in de Nederlands en Vlaamse bouwwereld,* Rijksdienst voor de Monumentenzorg, Zeist sdu Uitgevers, 's-Gravehage.

Jennings, A.S. and Rotherey, G.C. (1936), *The Modern Painter and Decorator*, Volume 1, London, The Caxton Publishing Company Limited.

King's works, Volume 1, part 1, note 4, *Account of works at Calais, Guines and Hammes,* National Archive Reference, E[Exchequer] 101/197/5 and 101/197/19. London. (8 & 9 Edward IV (r. 1442–83)).

Knoop, D. and Jones, D.P. (1937). *The London Mason in the Seventeenth Century,* Manchester University Press.

Kupershoek, E. (1997), *De Waag op de Nieuwmarkt,* Stadsuitgeverij, Amsterdam, Netherlands.

Kuyper, W. (1980), *Dutch Classicist Architecture A Survey of Dutch Architecture, Gardens and Anglo-Dutch Architectural Relations from 1625 to 1700*, Delft, The Netherlands, Delft University Press.

Lamb, J. and Shepherd, T. (1996), 'The History and Use of Red Rubbers', *The Building Conservation Directory*, Wiltshire, Cathedral Communications Limited.

Langley, B. (1740), *The City and Country Builder's and Workman's Treasury of Designs*, London.

Langley, B. (1747; 1749), *The London Prices of Bricklayer's Materials and Works*, London.

Lawrence, R.R. and Chris, T. (1996), *The Period House, Style, Detail and Decoration 1774–1914*, London, George Weidenfield and Nicholson Ltd.

Lindsay Braley, E. (1945), *Brickwork*, London, Sir Isaac Pitman and Sons Limited.

Lloyd, N. (1925), *A History of English Brickwork*, London, H. Greville Montgomery.

Lloyd, N. (1929), *Building Craftsmanship in Brick and Tile and in Stone Slates*, London, Cambridge University Press.

Lounsbury, C.R. (Ed.) (1999), *An Illustrated Glossary of Early Southern Architecture and Landscape*, University Press of Virginia, Charlottesville and London. Originally published (1994) by Oxford University Press, Incorporated, New York.

Lucas, R. (1997), *The Brick-Trade in Colonial America*, The Georgian Group Journal, Volume VII, London.

Lynch, G.C.J. (1990), *Gauged Brickwork: A Technical Handbook*, Aldershot, Gower Technical Press, 2nd edition, 2006, Donhead Publishing.

Lynch, G.C.J. (1994), *Brickwork: History, Technology and Practice,* Volumes 1 and 2, Aldershot, Donhead Publishing Ltd.

Lynch, G.C.J. (1998), 'Lime Mortars For Brickwork: Traditional Practice, Modern Misconceptions – Part One', *The Journal of Architectural Conservation*, Volume 4, Number 1 March, pp. 5–20.

Lynch, G.C.J. (1998), 'Lime Mortars for Brickwork: Traditional Practice, Modern Misconceptions – Part Two', *The Journal of Architectural Conservation*, Volume 4, Number 2, July, pp. 7–19.

Lynch, G.C.J. (1998), *Gauged Brickwork Tracing the Netherlandish Influence*, M.A. by independent study, De Montfort University, Leicester.

Lynch, G.C.J. and Pavia, S. (2003), 'The Characteristics and Properties of Rubbing Bricks used for Gauged Brickwork – Part One', *The Journal of Architectural Conservation*, Volume 9, Number 1, March, pp. 7–22.

Lynch, G.C.J. and Watt, D. (1998), 'Gauged Brickwork: Tracing the Netherlandish Influence', *Association for Studies In the Construction of Historic Building Transactions,* Volume 23, pp. 52–66.

Lynch, G.C.J, Watt, D. and Colston, B. (2002), 'The Conservation and Repair of Decorative Brickwork' In: Morledge, R. (Ed.), *Cobra 2002: The proceedings of The RICS Foundation Construction and Building Research Conference*, RICS Foundation in association with Nottingham Trent University, London, pp. 169–81.

Marsh, A. and Ryan, V. (1987), *Historical Directory of Trade Unions*, Volume 3, Aldershot, Gower Publishing Company Limited.

Metcalf, B. (1997), 'Craft and Art, Culture and Biology' In: Dormer, P. (Ed.), *The Culture Of Craft*, Manchester, Manchester University Press.

Millar, W. (1897), '"Plastering" Plain an Decorative', B.T. Batsford, London, (Re-Printed Donhead Ltd, Shaftsbury, 1998).

Mitchell, C.F. and Mitchell, G.A. (1904), *Brickwork and Masonry*, London, B.T. Batsford.

Mitchell, C.F. and Mitchell, G.A. (1906), *Building Construction and Drawing*, London, B. T. Batsford.

Montgomery, C.F. (Ed.) (1970), *Joseph Moxon's Mechanick Exercises: OR, The Doctrine of Handy-Works. Applied to the ART of Bricklayers Work*, (1703), Facsimile Edition, New York, Washington and London, Praeger Publishers.

Moore, N.J. (1991), 'Brick' In: Blair, J. and Ramsay, R. (Eds.), *English Medieval Industries: Craftsmen, Techniques, Products – Bricks,* London, The Hambledon Press.

Moore, N.J. (1996), The Supply of Bricks to Coughton Court, Warwickshire in 1663–66 In: *The British Brick Society, Information no 69*, October, 1996, Dartford, Kent.

Mowl, T. and Earnshaw, B. (1995), *The Rise of Puritan Classicism 'under Cromwell'*, Manchester and New York, Manchester University Press, Manchester.

Moxon, J. (1703), *Mechanick Exercises, Or The Doctrine of Handy-Works, Applied to the Art of Bricklayers Work*, London.

Nash, W.G. (1966), *Brickwork,* volumes 1–3, London, Hutchinson Educational Limited.

National Archive Reference, E[Exchequer] 351/326,*Works and Buildings: Surveyors and Paymasters,* (Task-work: William Dodson, Bricklayer) London. (1 October 1635–30 September 1636).

Neve, R. (1726), *The City and Country Purchaser and Builder's Dictionary*, London. A reprint of the work, subtitled '*The Competent Builders Guide*', T.N. Philomath, (1703), as a facsimile edition, (1969), New York, by Augustus M. Kelley.

Nicholls, C.S. (1993), *The Dictionary of National Biography,* Oxford, Oxford University Press.

Nicholson, P. (1823), *The New Practical Builder, and Workman's Companion*, in *Carpentry, Masonry, with the Theory and Practice of the Five Orders, as Employed in Decorative Architecture.* Part 2, London.

Noble, J. (1836), *The Professional Practice of Architects,* London, John Weale.

Orton, J. (2007), Private communication.

O'Shea, E.W. (1981), 'Mathematical Tiles in Lewes' In: Dodson, K. (Ed.), *Mathematical Tiles, notes of Ewell Symposium, 14 November 1981*, Issue 3.

Oswald, A. (1968), *Kimbolton Castle, Huntingdonshire*, reprinted from Country Life, Dec 5,12,19,26 1968, London.

Pain, W. (1769), *The Builders Companion and Workman's General Assistant*, 3rd Edition, London.

Pam, D. (1990), *A History of Enfield – Volume One – Before 1837, A Parish Near London*, Enfield, Enfield Preservation Society.

Pasley, C.W. (1826), *Outline of a Course of Practical Architecture, Compiled for the Use of Junior Officers of Royal Engineers*, Chatham, Kent, Royal Engineer Establishment, Brompton Barracks. Reprinted (1862).

Pavia, S. (1995–2001), 'Petrographic Analyses of Masonry Mortars, Plasters, and Renders', unpublished reports.

Pavia, S. and Lynch, G.C.J. (2003), 'The Characteristics and Properties of Rubbing Bricks used for Gauged Brickwork – Part Two', *The Journal of Architectural Conservation*, Number 1, Volume 9, March, Dorset, Donhead Publishing Ltd, 2003, pp. 7–21.

Penoyre, J. and Ryan, M. (1958), *The Observer's Book of Architecture*, 2nd Edition, London, Frederick Warne and Company Limited.

Percival, A. (1989), 'Netherlandish Influence on English Vernacular Architecture – Some Considerations', *British Brick Society, Information 47,* February 1989, Dartford, Kent.

Plaskett Marshall, D. (1954), 'Restoration in Rubbed and Carved Brickwork', *The Brick Bulletin, Volume 2, Number 12,* The Brick Development Association, Windsor, Berkshire.

Postgate, R.W. (1923), *The Builders History,* London, National Federation of Building Trade Operatives.

Prentice, J.E. (1996), *Aspley House Bedfordshire – Brick and Clay Analysis*, commissioned report.

Quiney, A. (1986), *House And Home*, London, British Broadcasting Association.

Richards, H.W. (1901), *Bricklaying and Brickcutting*, London, New York and Bombay, Longmans Green and Company.

Rivingtons' Series of *Notes on Building Construction Part III, Material*, Fifth Edition, First published 1879, revised (1901), London.

Robinson, H.W. and Adams, W. (Eds.), (1935), *The Diary of Robert Hooke, MA, M.D., FRS – 1672–1680*, London, Taylor and Francis.

Ruskin, J. (1849), *The Seven Lamps of Architecture*, Orpington, Kent, G. Allen.

Russell, R.L. and Chris, T. (1996), *The Period House, Style, Detail & Decoration, 1774–1914,* London, Phoenix Illustrated, The Orion Publishing Group.

Ryan, P. (1996), *Brick in Essex from the Roman Conquest to the Reformation* Chelmsford, Essex, P. Ryan.

Salaman, R.A. (Ed.) (1975), *Dictionary of Tools used in Woodworking and Allied Trades c.1700–1970*, London, Allen and Unwin.

Salzman, L.F. (1967), *Building in England down to 1540: a Documentary History*, 2nd Edition, Oxford. At the Clarendon Press London.

Searle, A.B. (1936), *A Rudimentary Treatise On the Manufacture Of Bricks and Tiles*, based on the work by Edward Dobson, Fourteenth Edition (1850), Thoroughly Revised and Rewritten and Enlarged by Searle, A.B., London, The Technical Press Limited.

Sheppard, F.H.W. (Ed.) (1970), *Survey of London*, Volume xxxvi: *The Parish of St Paul, Covent Garden, London*, London, The Athlone Press for the Greater London Council.

Simpson, W.D. (Ed.) (1960), *The Building Accounts of Tattershall Castle 1434–1472*, Lincolnshire, Records Society (transcript), 65 (translation).

Smith, T.P. (1981), 'Brick-Tiles in East Kent: an Interim Report' In: Dodson, K. (Ed.), 'Mathematical Tiles, notes of Ewell Symposium', 14 November 1981, Issue 3.

Smith, T.P. (1983), *A Note on Samel Bricks*, British Brick Society Information No 31, Dartford, Kent.

Smith, T.P. (1987), *Rendered Details to Brick Buildings – some Kent examples*, British Brick Society Information no 42, Dartford, Kent.

Smith, T.P. (1999), *The Early Tudor Chimney Brick from Bridewell Palace London and its Significance*, British Brick Society Information no. 76, Dartford, Kent.

Smith, T.P. (2001), *Hertford Castle, Hertford*, British Brick Society Information no. 83, Dartford, Kent.

Smith, T.P. (2003), *The "Wittiest Fellow of a Bricklayer in England": A note on Ben Jonson (pp. 12–14), Venturus Mandey: No Ordinary Bricklayer (pp. 16–19),* British Brick Society Information no. 90, Dartford, Kent.

Smith, T.P. (2005), *Damaging Ruins Editorial,* British Brick Society Information no. 90, Dartford, Kent.

Spencer, W. (1988), *Memories of Thomas Lawrence Brickworks*, British Brick Society information no. 97, Dartford, Kent.

Spiers, W.L. (1919), *The Note-Book and Account Book of Nicholas Stone Master Mason to James I and Charles I*, for The Walpole Society, Oxford. At the University Press.

Stoesser-Johnston, A. (2000), *Robert Hooke and Holland: Dutch Influence on his Architecture*, Bulletin Knob, Jaargang 99, Number 4, Rijksdienst voor de Monumentenzorg, Zeist, The Netherlands.

Summerson, J. (1947), *Georgian London*, London, Pleidas Books Ltd. First printed by the Shenval Press, London and Hertford.

Summerson, J. (1953), *Architecture in Britain, 1530–1830*, London, Penguin Books.

Thompson, M.W. (1960), *The Date of "Fox's Tower", Farnham Castle, VII*, Surrey Archaeological Collections.

Thurley, S. (2003), *Hampton Court a Social and Architectural History,* New Haven and London, Yale University Press.

Trew, D. (2006), *The Making of Wire,* www.barbwiremuseum.com/makingwire.htm

Verschelde, C. (1871), *Les Anciens Architectes De Bruges*, Belgium, Iprime Chez Vandeecasteele – Werbrouck.

Walker, F. (1885), *Brickwork: A Practical Treatise Embodying the General and Higher Principles of Bricklaying, Cutting and Setting*, London, Crosby, Lockwood and Son.

Ware, I. (1756), *A Complete Body of Architecture*, London, First Edition, Osborne, T., and Shipton, J.

Watt, D. and Colston, B. (2003), *Maintenance Education and Training for Listed Buildings,* London, Maintain our Heritage.

Webb, C. (1996), *London Apprentices, Volume 2, Tylers and Bricklayers' Company 1612–1644, 1668–1800*, London, Society of Genealogists.

Whinney, M. (1971), *Wren*, London, Thames and Hudson Limited.

Whitaker, C.W. (1911), *An Illustrated Historical, Statistical and Topographical Account of the Urban District of Enfield*, London, York House, Portugal Street, George Bell and Sons Limited.

Wight, J.A. (1972), *Brick Building in England – from the Middle Ages to 1550*, John London, Baker (Publishers) Limited.

Wingate, M. (1988), An Introduction To Building Limes, The Society For The Protection of Ancient Buildings (SPAB) News, London, Volume 9, Number 2, pp. 9–12.

Wise, P.J. (2000), 'A Seventeenth-century Landscape: The Chesterton Estate and the Willoughby DE Broke Papers' In: Bearman, R. (Ed.), *Compton Verney, A History of the House and its Owners*, Shakespeare Birthplace Trust, Stratford-upon-Avon, 2000.

Woddforde, J. (1976), *Bricks to Build a House,* London, Routledge and Kegan Paul Limited.

Bibliography

Brickwork

Corkhill, T. (Ed.) (1930–31), *Brickwork, Concrete and Masonry*, 3 Volumes, London, Sir Isaac Pitman and Sons.

Cutter, W. (1960), *Brickwork,* 4 Volumes, London, Cassel and Company Limited.

Frost, W. (1931), *The Modern Bricklayer*, (3 volumes), London, The Caxton Publishing Company Limited.

Hammond, A. (1889), *The Art of Practical Brickcutting and Setting*, London, Crosby, Lockwood and Son.

Lloyd, N. (1925), *A History of English Brickwork*, London, H. Greville Montgomery.

Lynch, G.C.J. (1990), *Gauged Brickwork: A Technical Handbook*, Aldershot, Gower Technical Press.

Lynch, G.C.J. (1994), *Brickwork: History, Technology and Practice,* Volumes 1 and 2, Aldershot, Donhead Publishing Limited.

Lynch, G.C.J. (1999), *Gauged Brickwork Tracing the Netherlandish Influence*, M.A by independent study, De Montfort University, Leicester.

Montgomery, C.F. (Ed.) (1970), *Joseph Moxon's Mechanick Exercises: OR, The Doctrine of Handy-Works. Applied to the ART of Bricklayers Work*, (1703), Facsimile Edition, New York, Washington and London, Praeger Publishers.

Richards, H.W. (1901), *Bricklaying and Brickcutting*, London, New York and Bombay, Longmans Green and Company.

Walker, F. (1885), *Brickwork: A Practical Treatise Embodying the General and Higher Principles of Bricklaying, Cutting and Setting*, London, Crosby, Lockwood and Son.

Conservation, Restoration, and Training Policy and Guidance

British Standards Institution (1998), *Guide to the Principles of the Conservation of Historic Buildings*, London, BS 7913. British Standards Institute.

Clark, K. (2001), *Informed Conservation: Understanding Historic Buildings and their Landscapes for Conservation*, London, English Heritage.

Department of Culture, Media and Sport (2001), *The Historic Environment: A Force for Our Future*, December. London, DCMS (Architecture and Historic Environment Division).

Department of Culture, Media and Sport (2002), *Protecting our Historic Environment: Making the System Work Better*, July, London, DCMS (Architecture and Historic Environment Division).

Department of the Environment/Department of National Heritage (1994). *Planning Policy Guidance 15: Planning and the Historic Environment.* PPG 15. London, HMSO.

English Heritage (2000), *Power of Place: The Future of the Historic Environment*, December, London, English Heritage.

Gates, C. (2002), *Worthy Inheritance*, *Building Design*, 29 November, p. 9. This article draws attention to the skills shortage in conservation architecture and highlights both the different approach and different set of priorities required for working in the heritage market.

Heritage Lottery Fund (2002), *Sustaining Our Living Heritage: Skills and Training for the Heritage Sector*. February, London, Heritage Lottery Fund.

International Scientific Committee for Analysis and Restoration of Structures of Architectural Heritage (2003), *Recommendations for the Analysis, Conservation and Structural Restoration of Architectural Heritage*.

Traditional Building Craft Skills, *Assessing the need, meeting the challenge*, The National Heritage training Group, published 2005 in England and 2007 in Scotland and Wales.

Watt, D. and Colston, B. (2003), *Maintenance Education and Training for Listed Buildings,* London, Maintain our Heritage.

Glossary of Terms

Abutment The solid part of a pier, or structure, which receives the thrust of an arch or series of arches.

Acanthus Carved formalised foliage used for the capital on a Corinthian column.

Air-slaked Slaked lime that has degenerated by exposure to the air and is unsuitable for mortar. Also called 'Fallen lime'.

Alum The trade name for Potassium Aluminium Sulphate or Potash Alum. Used as a mordant in some colour washes.

Alumina The principal constituent of a good brickearth or clay, imparting the plastic qualities.

Amorini Head and wings of an Italianate cherub or cupid. Not to be confused with putti which usually have no wings.

Apprentice A young person legally bound, through signed 'indentures', stating both parties obligations and responsibilities, for a specified period of years to learn a craft.

Apron Projecting panel of brickwork directly under a window cill.

Arcade Term for a row or series of arches carried on columns, piers or pilasters, to form a rhythmic, decorative pattern.

Arch A construction of bricks disposed in a curve or curves and supporting one another by mutual pressure. Its geometrical shape can classify an arch, as can the manner of its construction, or the number of centres it radiates from.

Architect A person competent to design and supervise the construction of any building or other structure. A master-builder. From the Greek 'Architekton', meaning 'Builder-in-chief'.

Architecture The art, science and practice of designing and constructing buildings and other structures.

Architrave Lowest of the three main parts of entablature; moulding applied round door or window opening.

Archivolt The continuous curved and concentric architrave of Classical moulding on an arch face.

Arris The sharp edges of a brick; the sharp edge at the junction of two surfaces.

Art Deco A style fashionable in the 1920s and 1930s. Its rectilinear forms were explored in reaction to curvilinear shapes of 'Art Nouveau'.

Art Nouveau A romantic decorative movement of the late nineteenth century, and a style characterised by flowing, curvilinear, sinuous lines.

Artificer A craftsman who designs as an architect and who ranks above the artisan.

Artisan A tradesman or craftsman whose knowledge is limited to their trade or craft only. They could not design a building like the artificer.

Arts and Crafts An English social and aesthetic movement in the late nineteenth century which admired traditional art and craftsmanship as a reaction against the quality of mass-produced artefacts.

Ashlar Cut and/or rubbed squared, brickwork with tight joints and brought to a true smooth surface. Sometimes spelt 'Ashler'.

Axed Work Originally stones and bricks cut and finished with the Brick axe. Later arch voussoirs cut with the hammer and bolster to the templet.

Axing An old bricklayer's term for cutting a brick to shape and size, and sometimes dressing its face, using the Brick axe.

Baksteen An old Dutch word for a brick and still in use today meaning 'baked stone'.

Banker A mason or brick cutter's bench.

Bar Iron Wrought iron formed into bars for use by blacksmiths.

Baroque A florid form of Classical architecture fashionable during the seventeenth and eighteenth.

Base The lowest part or division of an element, or a building. The bottom support of any object.

Bat A part of a brick cut from a half to three-quarter in length.

Batten A length of timber of slender scantling.

Batter Inclined face of wall usually for extra stability.

Bed The underside of a brick. Also setting brickwork in mortar.

Bed Joint The horizontal mortar joint upon which the bricks are laid between two courses.

Bedding Slate A flat slab of slate or marble to test the rubbed side of a brick for flatness and used with the templet to scribe the brick. Also called a 'Bedding Stone' or 'Trying Slate'.

Belt Course An American architectural term for a projecting or flush horizontal 'string course' or 'Platt Band'. Used to delineate the location of floor levels.

Bevel An adjustable bladed tool (sometimes called a 'shift-stock') for taking irregular angles. A horizontal, sloped surface; usually and incorrectly called a splay.

Bewerkte Baksteenen A Flemish term for cut and rubbed and gauged work. It translates as 'worked-on bricks'.

Blocked Another word for 'rusticated'.

Boasted A mason's finish to stone with the boaster leaving regularly spaced and angled tooling marks.

Body The lower part of a niche supporting the hood.

Boiled Oil Linseed oil that has been heated for a short period and sometimes added, in very small amounts, to a lime putty mortar for gauged work. The addition of too much oil will create cracking.

Bond The organised system of joining units of masonry together for strength, appearance and economy.

Boaster or Bolster A broad-bladed chisel used by masons for drafting a finish on stonework.

Bonding The manner in which individual bricks are locked together to form a sound structural element. Consistent sizing of bricks permitted numerous aesthetic patterns, each of which are given defining names.

Boss Semi-circular or semi-elliptical radiating point at the base of a niche hood.

Bracket A support to carry the weight of an overhanging element such as a balcony, shelf, jetty, pediment and cornice.

Brick Axe A tool with two opposing cutting edges at either end, like a double bolster, used for cutting, shaping and dressing bricks. From Eighteenth century the brick axe became a much bigger tool used mainly for cleaving.

Brickearth A topmost argillaceous material used for making bricks.

Brick Mason A very old term for a bricklayer when the lines of demarcation between the crafts of a bricklayer and stonemason was not so defined. Also spelt 'brekemason'. Still used in the United States of America.

Brick Tiles Also called 'Mathematical Tiles'. Clay tiles specially shaped so that when fixed and jointed with mortar on the façade of an earlier building they created the appearance of fashionable face brickwork. Popular in eighteenth-century England.

Bow Saw A saw having twisted steel wire blade, stretched by means of a bow, and used by bricklayers from the late nineteenth century for cutting rubbing bricks.

Brace A wooden tool intended for boring holes but utilised by bricklayers after the 1870s to twist wire into blades for the bow saw to cut rubbing bricks for gauged work.

Brick A rectangular shaped walling unit made primarily from brickearth and clay and hardened by being fired in a clamp or a kiln. Later also made from lime and concrete.

Brickmaker An artisan engaged in the manufacture of bricks. Historically many brickmakers were also bricklayers.

Bricklayer A craftsman engaged in the setting out and building brickwork. In parts of North America the old English term of Brickmason is used to mean a bricklayer.

Bridge The bricklayer's term, used in gauged brickwork, for the short batten to spread the weight across two rubbing bricks from the timber strut clamping them for shaping within the cutting box.

Bull's-Eye Arch A small circular or elliptical arched opening. Also called an 'Oculus' or an 'Oeil-de-boeuf' meaning 'Ox-eye'.

Buttress A bonded projection from a wall to create additional strength and support.

Builder A person undertaking the erection of a building or structure and the management of the craftsmen employed.

B.W.G. Birmingham Wire Gauge

Calcareous Containing chalk or other forms of calcium carbonate.

Calcite The mineral form of calcium carbonate.

Calcium Carbonate A solid which occurs naturally as chalk, marble, calcite and various forms of limestone. Also in seashells, corals and in bones.

Camber A very slight rise in an otherwise horizontal surface.

Camber Arch An arch having a very slight rise on the soffit. Some camber arches also have a very slight rise on the extrados too.

Camber Slip A slip of shaped timber for scribing the 'rise' to a camber arch.

Canted A bevelled or splayed face on bricks.

Capital The crowning feature of a column or pilaster.

Carbonation The gradual hardening of a building lime by absorbing carbon dioxide from the atmosphere through a process called 'Induration'.

Carolean Of the time of King Charles 1st (1625–49) or Charles II (1660–85). Also 'Caroline'.

Cartouche Ornamental, often carved, display of inscriptions or coat of arms enclosed within a scroll-like panel. Also spelt Cartouch.

Carved Hand-cut embellishment in relief undertaken by a carver in wood, stone or brick, using chisels and other tools and abrasives.

Case Hardening The formation of a hardened surface on soft textured rubbers.

Cavetto A hollow or concave quadrant moulding.

Cement A term used to describe an adhesive compound composed of a powdered substance made into a paste with water. 'Natural cements' were made from naturally occurring forms of impure limestone. Modern cements are processed blended materials fired at very high temperatures.

Centre A shaped temporary support made from several lengths of timber upon which arches are turned. Also called 'Centering'.

Chalk A soft limestone. A pure form of calcium carbonate when burnt to form quicklime and slaked with water to create a non-hydraulic lime for mortar. A grey chalk, also called 'greystone', 'grey lime' or 'stone lime', due to a small percentage of integral silicates and aluminates, will create a feebly hydraulic lime that was favoured for the mortars of most general brickwork, including gauged work.

Chamfer Strictly an edge shaped at an angle of 45 degrees.

Chimney Shaft The part of the chimney that rises above the roof as a single column containing the flue.

Chimney Stack The term for a number of shafts rising above the roof as one group.

Circle-on-circle The craft term for arches that are curved on plan and elevation requiring two templets to guide the desired shape of each voussoir. Also called 'Double Curvature'.

Clamp Bricks Green bricks close-stacked and burnt in a temporary clamp or stack, distinct from bricks burnt in a fixed kiln. Also spelt 'Clampys' and 'Clampe'.

Classical Architecture The architectural styles of ancient Greece and Rome, broadly divided into Doric, Ionic, Corinthian and Composite. Derived from the Lattin 'Classicus' meaning 'of the highest class'.

Closer Quarter part of a brick usually about 57 mm ($2\frac{1}{4}$ in) on face.

Clot An old brickmaker's term for a lump of clay to throw into the brick mould.

Coade Stone A compound of china clay, sand and finely ground stoneware, shaped in moulds and fired in a kiln to producing artificial stone. Invented in the 1720s but not perfected until fifty years later by George and Eleanor Coade.

Coign From the French 'Coin' meaning corner. Also historically spelt 'Coyn' and 'Quoin'.

Colour Wash The application of an ochre dissolved within glue-size water, with a mordant such as alum or copperas, using a large paint brush to colour the show face of the brickwork.

Column A vertical cylindrical support usually with base, shaft and capital, as a support for an arch or beam.

Common A cheap brick for use on common walling where appearance is of secondary importance.

Compass A geometry instrument for scribing a small circle or part of it. An old term to describe all arches with a segmental or semi-circular shape.

Composite Order Roman and the most elaborate of the five orders of Classical architecture mixing features of Ionic and Corinthian Orders. The details and proportions were recognised and codified by Renaissance writers in the fifteenth and sixteenth centuries.

Conduit A hollow metal tube sometimes used by cutters in gauged work to help abrade curved profiles.

Console A carved bracket, usually with an S-shaped scroll, of a greater height than projection. Also called 'Ancones', 'Trusses' or 'Crossettes'.

Contractor A person who enters into a contract, or formal agreement, to supply materials and labour in order undertake all or part of building a structure.

Copperas The trade name for sulphate of Iron. Used as a mordant in some colour washes.

Corbel Loadbearing projection, or over-sailing, from a wall face to form a ledge or support.

Corbel Table A linked row of corbels to support projecting parapets or machiolations.

Core The brickwork filling in the space between the lintel and the relieving arch. Also the un-slaked stone from the 'heart' of a piece of quicklime.

Corinthian Third of the classical orders revived in the Renaissance.

Cornice Terminating decorative feature along the top of a building; in classical architecture, the top section of the entablature. Also traditionally termed a 'Cornish'.

Course A horizontal layer of bricks, or stones, between two bed joints.

Crocket Foliage decoration on a finial or at the pinnacle of an arch.

Crown The top of the extrados of an arch.

Curf cut The term used for an initial cut made to the underside of a projecting rubber to prevent it tearing when cut down to size from the top. Also spelt Kerf.

Cusp	A point formed by the meeting of two curves, particularly in respect of Gothic tracery.
Cut and rubbed	An old term for the post-fired working of low-fired bricks, later used to mean gauged work.
Cut Brick	Brick shaped by cutting or carving after firing in contrast to a green moulded brick.
Cutter	The term used from the eighteenth century for the craftsmen engaged in preparing gauged work in the cutting shed. Also a mild brick specially made for cutting to shape, similar to a 'rubber'.
Cut-Moulding	Cutting and working rubbers, or cutters, to a set profile.
Cutting Box	A joiner-made profiled box to contain the rubbing brick whilst it is being cut to that shape with the bow saw and abraded to a precise finish.
Cyma	A double curved moulding sometimes referred to as an ogee. Also spelt 'Cima'.
Deadman	Temporary erection of plumbed and mortared bricks as a profile for 'lining-in'.
Dentil	One of the course of a cornice, in which bricks cut with a 'block' and a 'sinking' alternate. From the Lattin 'Denticulus', meaning 'little tooth'.
Depressed Arch	A flattened Gothic arch of the late medieval and Tudor times.
Distemper	A water-based paint containing crushed chalk, or whiting, with animal glue as the binder. Used by bricklayers for 'Pencilling' joints.
Dome	A hemispherical vault, circular in plan.
Doric	First and simplest of the Classical orders which exists in Greek and Roman forms.
Drag	A comb-like metal tool intended to drag or scrape across soft stone or brick to abrade a true surface, sometimes utilised as a grub saw by bricklayers for gauged work.
Drawn-out	A blacksmith's term to describe the process where iron and steel is heated and hammered out on an anvil to reduce its thickness as with the Brick axe.
Dressed	Bricks which have been worked to a finish like stone.
Dressings	Cut-mouldings around openings or corners of buildings in cut and rubbed and gauged work.
Drip Course	Another name for a label, or hood, mould.
Dummy-joint	A false joint created by cutting an appropriately sized slot to aesthetic bond on a brick face and inserting the mortar.
Dutch Gables	A gable with convex and concave curved sides, and properly topped with a pediment.
Eaves	Lower edge of an overhanging roof.
Edwardian	The architecture of the period of the reign of King Edward VII (1901–10).
Efflorescence	Powdery white salts crystallising and deposited on a wall face as it dries out.
Egg and Dart	A carved enrichment, worked on an ovolo moulding in Classical architecture, so called because of its resemblance to alternating eggs and darts or arrow heads. Alternative terms are 'Egg and Tongue' and 'Egg and Anchor'.

Elizabethan An architectural style which prevailed during the reign of Queen Elizabeth I (1558–1603). It was based on Continental Mannerism imported from the Low Countries.

Enfilade A system of aligning internal doors to connecting rooms in palaces so that long vistas are achieved. From the French 'enfilade', meaning a succession of rooms.

Engaged Column A column embedded, or partly concealed, within a wall. A true engaged column must have between half and three-quarters of its shaft exposed. Also known as an applied, attached or inserted column. Must not be confused with a pilaster.

English Bond Alternate courses of brickwork laid as headers and stretchers.

Entablature In classical architecture, all the horizontal members above a column – i.e. architrave, frieze and cornice.

Entasis The convex tapering worked on large columns without which they would appear to be thinner in the centre. The top is smaller than the base, but the reduction is greater from halfway.

Estuarine Clay A clay found in river beds and marshland. The first clay used by medieval brickmakers.

Exothermic A chemical reaction that generates heat, as in slaking quicklime.

Extrados Outer or upper curved side or surface of an arch.

Eye-line The craft term for the line on the lower-edge of a projecting feature which is kept perfectly level.

Façade The external walling of a building, sometimes used to describe the front face.

Face The front of a building or the exposed surface of the brickwork.

Face Joint Part of a cross-joint that is seen on the face of a wall.

Fascia Unadorned horizontal band on an architrave or cornice which provides a plain interspace between decorative mouldings.

Fat Lime A lime burnt from a source of relatively pure carbonate of lime. A non-hydraulic lime.

Feather-edge An alternative name given to a bricklayer's timber pointing-rule, used to guide the pointing action.

Feebly-hydraulic A hydraulic lime which would set underwater in more than 20 days. The active minerals such as silica and alumina would be less than 12%.

Festoon A carved decorative motif consisting of a garland of fruit and/or flowers draped between two supports. A favoured device of Baroque and Neo-Classical architecture.

File A roughened metal tool used in the cutting shed for final shaping and smoothing of the cut rubber.

Fillet A small continuous moulding square in section – a flat band between two mouldings.

Fine Stuff A mixture of fine silver sand and lime putty.

Finial The ornament atop of a pinnacle, gable, canopy etc.

Firing Bricks hardened by being burnt in a clamp or kiln.

Flashing Lead, copper or zinc covering as an impervious barrier.

Flat Arch Another term for a straight arch.

Flemish Bond Stretchers and headers alternately in every course.

Flemish Mannerism A north European variety of High Renaissance styles were mixed with the Gothic. Made popular with pattern books out of Antwerp (Belgium) by such architects as Vredman de Vries.

Flemish Revival A variation of Flemish Renaissance architecture fashionable in England in the 1870s and 1880s making great use of gauged work. Seen particularly in the work of Sir Ernest George in the Kensington and Knightsbridge areas of London. Also called 'Pont-Street Dutch'.

Fletton A brick named after Fletton in Peterborough (Cambridgeshire). Made from a belt of 'Oxford Clay', that stretches from Buckinghamshire through to Cambridgeshire, and which contains an oil that permits partial self-burning.

Float Stone An old craft term for a small, hand-held, abrasive stone used to work across the face of an element of cut and rubbed or gauged work to bring it to a smooth finish. Also called a 'Hand Stone'.

Fluting/flute A cut semi-circular, segmental or elliptical channel, usually on a column.

Form An old term used for the frame or open mould box for making regular shaped bricks. Also historically spelt 'forme' or 'fourme'.

French Plane A block of wood with flat or saw-tooth blades set at different angles used to finish a soft stone or brick. Called a 'Steenschaaf', or 'stoneplane', in Flanders.

Frieze The middle division of a classical entablature; decorative band on an elevation. Often carved. Any carved band, usually depicting a scene.

Frijnen A Flemish mason's term for the 'tooled' or 'batted' finish to the face of a stone or brick.

Frog The indentation on the bottom of a brick created in moulding the 'green' clay by the raised board or 'kick' on the stock board. Possibly a contraction of the Dutch word, 'Kikker', meaning 'frog'. Bricks should always be laid frog-up.

Frontispiece A pedimented doorway treated architecturally as a separate composition from the rest of the house.

Functionalism One of the principal ingredients of the philosophy of 'Modernism' of the 1920s and 1930s that emphasised the aesthetic consideration had to arise out of the functional aspect of a building, or that 'form follows function'.

Gable The generally triangular end of a building with a pitched roof, though it may be stepped or curved.

Gatehouse The fortified entrance, of at least two storeys to a large house, castle etc.

Gauge To shape by cutting and rubbing a rubbing brick to precise size and shape. Also the vertical height of a brick.

Gauge Pot A watering can or other container for pouring liquid grout.

Gauged Work Brickwork built with selected low-fired bricks, or 'rubbers', that have been precisely cut and rubbed to the exact shape and size required, and having a joint typically of less than 2mm.

Gauging Sawing and rubbing bricks to size and shape for gauged brickwork. Also means measuring precisely.

Gault A white or buff brick from a special type of calcareous clay.

Georgian Architecture of the period of the first four King Georges (1714–1830). Term is also applied to a very simple form of Classical domestic architecture.

Geslepen Metselwerk The term for gauged work in the Netherlands. It literally translates as 'sharpened brickwork'.

Gibbs Surround Stone or gauged work dressings around an opening consisting of square blocks set at intervals and crowned by a multiple keystone. Named after the architect James Gibbs (1682–1754).

Gildeproeven The old Dutch word for the masterpiece produced by an apprentice for his guild masters to positively assess permitting him to become a qualified craftsman.

Globe A spherical ornament of gauged work as a terminal feature on a pier.

Gothic Architecture A term first used by Renaissance observers for the medieval form of architecture, coming after the Norman, or Romanesque, and before the Renaissance. Commonly placed in three separate styles: Early English, Decorated and Perpendicular; after which it gradually merged into Tudor and Elizabethan styles.

Gothic Revival Generally held as a style that began in the eighteenth century, but which became full-blooded in the nineteenth century after the re-building of the Houses of Parliament by A.W.N. Pugin (1812–52) in the 1830s.

Gouge Chisel with curved cutting-edge for hollowing-out when carving.

Grade An American architectural term for ground level.

Green Brick A brick in its freshly moulded and pre-fired condition.

Groin Angle formed by the intersection of two adjoining barrel vaults, usually at 90° to each other.

Grout Very thin, or liquid, mortar, hydraulic lime, or cement for filling the interstices in the joints of brick or stonework.

Grub Saw The bricklayer's term for a small hand-held saw to mark deep lines around a templet to prevent the arris spalling during the cutting action. Also used to cut away straight sections.

Guild Originally a religious fraternity dedicated to a Saint, associated with a craft and its brethren. Concerned with quality of product, apprenticeships, prices, conditions and social welfare. Also historically spelt 'Gild' and 'Gilde'.

Hack A long parallel run in a brickfield, raised slightly off of the ground, upon which the green bricks are stacked to dry. Also called 'Hackstead' in old accounts.

Hack Barrow A special wheelbarrow used to transport green bricks from the moulding shed to the hacking area to dry.

Hack Shed A roofed but open-sided shed where green bricks can be left to dry prior to firing.

Hansa	The adjective of Hanseatic. A powerful medieval North German and Scandinavian trading organisation with offices in ports and commercial links to other countries like Flanders and Britain.
Haunch	Lower part of an arch ring, from the springing line to between one-third and one-half of the height.
Header	End or short face of brick, laid with its principal axis at right angles to the face of the wall.
Hewentile	Used in some accounts in the fifteenth century to describe cut-moulded bricks.
Hewer	A very old term, from the word 'hew', to cut, and used to describe a craftsman at the status of a mason who prepared cut and rubbed bricks. Also historically spelt Hewyer.
High-Calcium	Another term for a pure or non-hydraulic lime.
Hollow Moulding	A concave moulding in Gothic architecture, approximately corresponding to the Scotia of classical architecture.
Hood Mould	A curved-moulded course running over an arched opening to divert the downwash from rain. Also the name for the centre upon which the upper portion, or hood, of a niche is built.
Hydrated Lime	Slaked lime ($Ca(OH)_2$), formed by adding water to quicklime (CaO). Generally used to denote a dry-powdered lime.
Hydraulic	Lime which sets and hardens under water due to the presence of reactive aluminate and silicate. Formerly called 'Water Lime'.
Impost	A projection, usually with a simple moulding at the springing line of an arch, from a wall or a flush pier.
Intrados	Lower or interior curve of an arch.
Ionic	The second of the classical orders, revived at the Renaissance. The capitals on Ionic columns have 'volutes' which curl round and downwards like a scroll.
Ironstone	Found in irregular layers in Lower Greensand.
Italianate	A term indicating that a building is in the Italian manner because it has borrowed some features of Renaissance Italy.
Jack Arch	An American term for a flat or straight arch with a horizontal intrados.
Jacobean	Refers to a style of architecture and decoration of the reign of King James 1st (1603–25) that though mainly Elizabethan did add its own distinctive contribution.
Jamb	The vertical side of an opening to the full thickness of the wall. Also historically spelt 'Jam', 'Jamm', 'Jambe' and 'Jaume'.
Joggle	A cavity or notched vertical joint, which does not appear on the face, into which grout is poured to prevent movement.
Joiner	A man who makes joinery; his work, done in a workshop, is much finer than a carpenter.
Jointer	A shaped tool for jointing brickwork and for laying on putty joint into the 'dummy joints'.
Jointing	The finishing of a mortar face joint while it is still green.
Joints	The layer of mortar between masonry units.
Kerf	An alternative spelling of Curf.
Key	The centre brick of the crown of an arch.

Keystone Central wedge-shaped stone or 'blocked' group of bricks which completes an arch on face and soffit.

Kiln A building for the accumulation and retention of heat in order to fire bricks, pottery, terracotta and lime. Also historically spelt 'Kylne', 'Kill' or 'Kele'.

Knotting Shellac dissolved in methylated spirit.

Label mould A projecting moulded course running over a flat arch immediately over the extrados.

Label Stop The termination, often decorated, at the end of a label mould.

Laggings Narrow strips of wood used to cover centering.

Lancet A tall narrow gothic arch.

Lantern Windowed turret crowning a dome or cupola.

Larry A tool 2.1 m long, shaped like a hoe, used for mixing mortar or slaking down lump lime.

Larrying-up Filling the centre of walls and piers by bedding the bricks in thin sloppy mortar.

Lime The resultant product from all forms of calcium carbonate that has been burnt in a kiln to form quicklime and slaked to a hydrate.

Lime Putty Formed when quicklime is slaked in water, passed through a 3 mm sieve, and allowed to settle for a month in a maturing bin. Sometimes used with fine sand and also some linseed oil to set gauged work.

Limestone A sedimentary rock consisting of particles of carbonate of lime.

Lintel A horizontal beam of timber, stone, concrete or metal, to provide support over an opening. Also spelt Lintol.

Loggia Part of an entrance into a building where one or more sides are open to the air.

London Stock A durable coarse-textured brick, containing an added integral fuel, from buff through red with dark purple colouring, produced in London and its environs, once commonly used in the capital.

Lunette An arched opening in a vault or arched ceiling.

Maaswerk The Flemish term for Gothic tracery.

Malm A bright soft stock brick.

Malm Cutter A soft brick from calcareous loam: used for arches.

Mannerism A style of sixteenth-century architecture characterised by the use of Classical motifs outside their normal context, or in a wilful or illogical manner. When the master craftsmen did this it became termed 'Artisan Mannerist'.

Medieval The term usually applied to the period of the Middle Ages that ends in 1485 with the accession of the Tudors.

Metselaar Dutch word for a bricklayer.

Mig wire Metal Inert Gas: Type of wire used in welding that is utilised to make the blade used with a bow saw for cutting bricks.

Mill-Bill and Thrift A scotch-like tool used to cut furrows in stone mill-wheels. The bill is the chisel-edged blade and the thrift is the handle.

Mortar A mixture of lime, sand and water, later cement, for bedding and binding bricks together.

Mould	An alternative term for a templet. Also used to describe the profiled box to receive the prepared rubbing brick ready for cutting.
Moulding	A green-moulded special shaped brick fired in the kiln. Also a decorative profile given to a continuous projection.
Mullion	A slender vertical member dividing a window opening into two or more sections, or lights.
Newel	The central column around which a spiral staircase winds and climbs.
Newel Staircase	A spiral stair in which the newel takes the narrow, pointed end, of the steps and ploughshare vaulting with their wide ends bedded into the wall.
NHL	Natural Hydraulic Lime. A modern coding that determines the authenticity of a hydraulic lime.
Niche	A recess formed in a wall for the original purpose of receiving a statue, vase or other ornament.
Non-Hydraulic	A building lime from pure sources of calcium carbonate that can only harden in the presence of the atmosphere by a process called 'carbonation'. It cannot set under water hence the term non-hydraulic.
Oculus	A circular arch to window. Also called a 'Bullseye' or s'Oeil-de-boeuf' – properly an 'Ox-eye'. Such an arch is normally, but not always, decorated with four keybricks at the cardinal points.
Offset	The horizontal part exposed when a wall is reduced in width.
Ogee	An arch which has characteristic double S-shaped curves, one concave the other convex.
Orangery	A garden building with large south-facing windows providing a warm artificial environment for exotic plants, especially oranges.
Order	In Classical architecture this denotes the style and disposition of the various elements of a building according to rules. The Doric, Ionic and Corinthian were evolved by the Greeks and later modified by the Romans who added the Composite, a cross between Ionic and Corinthian. Tuscan may have its origins in the ancient architecture of the Etruscans.
Ordinary Portland Cement	Hydraulic cement made by heating to clinker in a kiln a slurry of clay and limestone. Cheapest and most common in use on the construction of modern brickwork.
Oriel	A projecting window supported on corbelled brickwork on an upper floor. Also historically spelt Oriole and Oryel.
Overhand	Facing brickwork laid from the inside of a structure.
Ovolo	A convex moulding, usually a quadrant of a circle.
Palladian	A style of Classical architecture evolved from the work of the sixteenth-century architect, Andrea Palladio (1508–80). First seen in England in the work of Inigo Jones (1573–1652).
Panel	A framed sunken or raised area for decorative purposes.
Pattern Books	Published collections of designs as a guide for builders and craftsmen, particularly during the eighteenth century.

Pedestal A substructure directly below some columns in Classical architecture.

Pediment Low-pitched triangular, or curved, gable above a portico, and above door and window openings in Classical architecture.

Pencilling The fine-line painting – freehand or guided by a rule – of the mortar joints of brickwork with a natural or pigmented distemper to emphasise the joints to a lesser scale.

Perpend The visible part of a cross-joint in brickwork.

Pier An isolated element of brickwork, such as between two openings or a loadbearing support.

Pilaster A shallow projecting pier, usually rectangular and sometimes fluted, attached to a wall face, usually for decoration. Must not be confused with an 'engaged column'.

Pinnacle The apex of a buttress, often crocketed.

Place Brick A weak under-fired brick used for internal partition walling.

Plaster of Paris A natural cement obtained by burning gypsum or alabaster.

Platt band Also Platband. A flat horizontal fascia of gauged work the projection of which is less than its height. Often used in the seventeenth and eighteenth centuries to externally delineate floors.

Plinth Projecting base of a wall or columns, usually finished with a bevelled, or moulded, weathering.

Plinth Brick Horizontally weathered brick used on offsets.

Ploughshare vaulting A term used to describe the vaulting of a spiral stair, when the brickwork is laid as stretchers in a series of rough triangles.

Plumb Vertical. From the use of the lead 'plumb-bob' to check upright. Derived from the Latin for lead – 'Plumbum'.

Plumb Line A length of cord with a lead weight, or plumb-bob, attached and used in conjunction with the plumb-rule.

Plumb-rule A thin timber straight-edge, having a plumb-bob attached, used to ascertain whether a wall or structure is perfectly upright.

Pointing Raking out mortar joints and refilling with a face mortar that is usually richer and for finer composition than that which built the wall.

Polder Land reclaimed from the sea.

Polychrome The use of bricks of more than one colour in a façade for aesthetic effect.

Portland Cement Made from a limestone and clay blend that is burnt and ground to a fine powder which is light grey in colour. So termed because of its supposed likeness of appearance to Portland stone.

Portland Stone A white limestone from Portland off the south coast of England commonly used for buildings, and often with gauged work, after the Great Fire of London in 1666.

Post-Modernism First coined in the 1940s to describe styles that were a reaction against the worst excesses of 'Modernism'.

Pozzolan Volcanic ash or other natural materials containing silica and alumina that react with the lime and water to create an hydraulic set. Artificial pozzolans, like low-fired clay bricks and tiles, can become pozzolanic provided they have the right silica and alumina content and are fired between 600–900°C. Traditional low-fired rubbing bricks are ideal.

Proefstucken The old Flemish term for an apprentices masterpiece presented for his guild masters to positively assess to become a qualified craftsman.

Profile Tree A craft term for the horizontal beam over an arch onto which the skewback and voussoirs positions are marked to aid their radial alignment during construction.

Queen Anne Style A style of domestic architecture that became fashionable from the 1860, derived from the late seventeenth- and early eighteenth-century brick houses, which made great use of gauged work.

Queen Closer A brick cut in half down its length and placed next to the quoin header to create quarter bond.

Quicklime Burnt or calcined calcium carbonate to form calcium oxide. As it comes from the kiln before being slaked with water.

Quirk A narrow groove between mouldings, or between mouldings and ashlar work.

Quoin Brickwork or stonework at the corner of a building. Also historically spelt ‘Coyn’ or ‘Coin’.

Radius The distance from the centre to the circumference of a circle or segment.

Rake An angle of inclination.

Raking Anything sloping at an angle to the horizontal plane.

Rasp A roughened length of metal sometimes used in the cutting shed to scrape smooth a cut surface on a brick.

Red Mason An old term used to describe the hewer, or cutter, of bricks for cut and rubbed and gauged work.

Regency The architectural style that provided the transition between Georgian and Victorian, taking its name from the Regency of the Prince of Wales (1811–20) who later reigned as George IV (1820–30).

Relieving Arch A segmental arch turned over a suitably shaped brick core laid on top of a timber lintel. Usually placed behind a flat or camber arch.

Renaissance A French term meaning ‘Re-birth’. The re-discovery of the architecture of Ancient Rome and Greece that was initiated in Italy in the fifteenth century.

Respond A half-pier bonded into a wall that supports one end of an arch, usually at the termination of an arcade.

Restoration The period of the Restoration of the monarchy, through the reign of King Charles II (1660–85). The period immediately following this is termed the ‘Post-Restoration’ period.

Return Any wall or moulding which changes direction, horizontally or vertically.

Reveal That part of a wall which is at right angles to the face where openings occur.

Revival The use of any earlier architectural style, based on archaeological and scholarly investigation.

Rise Vertical height of an arch from the springing line to the highest point of the intrados.

Rough Arch An arch where the bricks are not cut and the joints radiate to give the desired curve.

Rubbed Brick faces rubbed smooth and flat to ensure a close fit. The face of an enrichment rubbed to a smooth finish.

Rubber A soft, smooth, even grained, brick suitable for rubbing and cutting to shape for gauged brickwork.

Rubbing Stone A large, generally circular and perfectly flat slab of York, or similar, bench-mounted stone upon which the bed and stretcher faces of rubbing bricks are rubbed square to one another prior to cutting to shape. Stones from the 'Park Spring' Quarry near Leeds (Yorkshire) were particularly favoured.

Rusticated A 'blocking' proud of the wall face, several courses of bricks followed by courses (usually one or two), flush. Commonly used on quoins and arches. Intended to simulate stonework dressings.

Sag An arch that has dropped at the centre.

Scantling Dimensions of a piece of timber in breadth and thickness and in masonry the length, breadth and thickness of a stone.

Scheme Arch An arch which springs from a level bed, the springing line taking the place of the skewback. The intrados and extrados curves of the arch are struck from one point, but the voussoirs radiate to the centre of the opening upon the 'springing line'.

Scotch A hafted tool into which a blade is slotted and wedged tight that was traditionally used by bricklayers to cut bricks to shape. It replaced the brick axe for fine shaping. Also spelt 'Scutch'.

Scotch Kiln An up-draught rectangular kiln with three permanent walls and one temporary wall, erected once the kiln is loaded and ready to fire.

Scotia A concave moulding.

Scribe The craft term for a sharpened cut-nail used for marking or scribing the outline of a templet on a brick prior to cutting.

Semel A half-fired brick, sometimes historically spelt 'samel' or 'samwelle'.

Set-off An alternative term for an off-set.

Setting Out Marking the position of work before commencing to build.

Shaft Column-like section of a chimney between the base and the cap.

Shellac An incrustation formed by an insect on the trees of India and neighbouring regions. It is a natural resin.

Sieve A tray with one or more meshes per linear millimetre.

Size A thin keratin-based glue derived from animal sources, skin, hooves and horns etc, used as a binder in a colour wash.

Skewback The line of abutment receiving the thrust of an arch.

Slaked Lime The product remaining after the chemical combination of quicklime and water.

Slaking A hydration of quicklime ($CaO + H_2O = Ca(OH)_2$).

Siding Bevel A joiners tool consisting of a wooden stock into which a steel blade is placed and secured with a wing nut. It is utilised in the cutting

	shed for taking off various bevel angles and positions of soffits of Voussoirs.
Small Tool	A small curved steel tool for mitring and finishing intricate mouldings.
Soffit	Under surface of a cornice, arch, vault or lintel.
Spandrel	The triangular shape of brickwork between two adjacent arches that fills the space above the skewback or springer and the haunch. Also historically spelt 'Spandril' or 'Splandril'.
Spiralled	A vertical twist given to a column or chimney shaft. Also called 'barley-sugar' or 'Solomonic'.
Splay	A slope across the full width of a surface.
Springer	The first or lowest voussoir in an arch.
Springing Line	The lowest or commencing level of an arch.
Spur-top	A blunted point decoration with scallops in between at the head or cap of a chimney.
Star-top	A pointed decoration at the head or cap of a chimney.
Stock Board	A brickmaker's term for the fixed block of wood on the moulding bench over which the open mould is placed and into which the clay is thrown to form a brick. The raised part on the stock board is called the 'Kick', to force the clay into the sides and edges, which creates the 'Frog'.
Straight Arch	Originally an arch with a level soffit, but later used to describe a camber arch too.
Strapwork	Type of raised surface decoration consisting of broad flat bands of interlacing patterns, particularly popular in the Elizabethan and Jacobean periods.
Stretcher	Long face of a brick.
String Course	Horizontal moulded course across a building face.
Stuart	Architecture of the early seventeenth century, otherwise 'Jacobean' or 'Carolean'.
Sub-contractor	A person who enters into a formal agreement to undertake a specified part of a contract to build a structure from the main contractor.
Suction	The adhesion of bricks to wet mortar.
Swag	A carved looped garland also called a 'festoon'.
SWG	Standard Wire Gauge.
Tailleur	A Flemish mason's term for a 'finisher' of stone or brick faces.
Template	All, or part of the overall plan or profile to aid the setting-out and construction of a feature. It is sometimes used to mean templet. In masonry a template refers to a slab on which a beam end rests. Also known as a padstone.
Templet	The traditional craft term for a rigid material cut to the exact shape, from the full-size drawing, to which the brick is to be cut and moulded to.
Tracery	Cut-moulded ornamental stone or brick in the upper part of an opening.
Tradesman or Craftsman	An artisan who has been an apprentice for some years in a building trade and has therefore enough skill to be considered a journeyman.

Trammel A device for scribing circular and elliptical arcs.

Transom Horizontal member across a window or door opening. Also historically spelt 'Transome'.

Trass A natural pozzolan from Germany that was processed by the Dutch and exported to England especially during the seventeenth and eighteenth centuries. Also historically called 'Tras' and 'Terass'.

Trefoil A Gothic ornament of three foils in a circle or roughly triangular figure. From the French 'Feuille', meaning leaf. The number of foils or lobes determines the pattern, i.e. trefoil (3), quatrefoil (4), cinquefoil (5) etc.

Try-Square A joiners tool used by bricklayers in the cutting-shed to test the square of the rubbed bed and stretcher faces to one another. Also used to transfer scribed lines around the brick working from the rubbed faces.

Tuck Pointing A refined type of pointing, dating from the late seventeenth century, which creates the illusion of gauged brickwork. Originally termed 'Tuck and Pat' pointing.

Tudor The late perpendicular Gothic period associated with the reign of the Tudor monarchs from 1485–1547.

Tumbling-In Sloping courses of brickwork uniting with horizontal courses.

Turning Piece A centre cut from one piece of timber.

Tympanum Decorated filling between soffit and springing line of an arch.

Vault An arched masonry roof, generally with a smooth curved soffit.

Venetian Arch Is a form of an arched opening consisting of a semi-circular or pointed arch within the centre of a flat arch. Structurally weak and is therefore usually supported on columns at the intersection of the two arches. Also called a 'Queen Anne Arch'.

Vernacular Buildings created by craftsmen in the traditions and needs of their materials, locality and climate.

Victorian Anything dating from the reign of Queen Victoria (1837–1901).

Vitrification A glass like bonding material produced as a result of firing clay bricks beyond 900°C.

Volute Spiral scroll forming the principal feature of an Ionic capital.

Voussoir An individual wedge-shaped arch brick cut from a templet.

Warp An old brickmaker's term for a lump of clay to throw into the brick mould.

Water Limes An old term for hydraulic building limes.

Weathered Exposed to the elements and worn. Also a horizontally inclined surface.

White Lead An opaque white pigment. Toxic.

Whiting Finely crushed chalk used for making distempers and glazier's putty. Also termed 'Whitening'.

William and Mary Architecture and style of their period of reign in England (1688–1702).

Workability A craftsman's term describing the plasticity of a mortar and its ability to be spread smoothly and lightly.

Wrought Iron Iron that is heated and hammered into shape by a blacksmith on his anvil.

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