

To the Graduate Council:

I am submitting herewith a thesis written by Gail L. Guymon entitled "An Historical and Archaeological Study of Brickmaking in Knoxville and Knox County, Tennessee." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Anthropology.

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AN HISTORICAL AND ARCHAEOLOGICAL STUDY OF BRICKMAKING
IN KNOXVILLE AND KNOX COUNTY, TENNESSEE

A Thesis
Presented for the
Master of Arts
Degree
The University of Tennessee, Knoxville

Gail L. Guymon

June 1986

ACKNOWLEDGEMENTS

The assistance and support of many people were instrumental in assuring the successful completion of this thesis. I am most deeply indebted to my committee chairman, Dr. Charles H. Faulkner. Throughout the various stages of my research and writing, his interest in the subject matter, personal support, and patience have never wavered. Dr. Benita J. Howell and Dr. Jefferson Chapman also served as members of my committee. Their guidance and editorial suggestions were very much appreciated.

One of the most rewarding aspects of my research has been the opportunity to meet the owners of many of the area's historic houses. Almost without exception, these people agreed to allow me to come to their houses in order to collect data. On numerous occasions, I was given an impromptu tour of these houses and asked to sit down while the owners shared whatever documents and information they had. As tedious as the data collection was, the hospitality offered by all these warm and friendly people made it a pleasant experience that I will always remember.

Staff members of several libraries were extremely helpful in locating obscure 19th century volumes and allowing me to photocopy maps and other documents. These include the University of Illinois, Special Collections at the University of Tennessee, and the McClung Historical Collection. I owe a special thanks to Sally Rapatti of the McClung Collection for searching through their collection of photographs.

The analysis of my data would have taken years without the aid of computers. John Lutz was kind enough to set up the programs I needed and Henry Case shared his access codes.

I have been fortunate in having a special group of friends who have shared in all the ups and downs inherent in the pursuit of a Master's degree in Anthropology. We have helped one another through years of classwork, exams, and thesis writing. Knowing friends were sharing these experiences has kept us all from giving up when the going got tough. So to Pat Lane, Loretta Lautzenheiser, and Chuck Bentz, thanks for seeing me through.

I am grateful to all the members of my family for their support and encouragement but especially to my father and my sisters, Sandy and Barbara. Most of all, I am grateful to my husband, Jim. Thank you for your love and for believing in me.

ABSTRACT

The history of brickmaking in Knoxville and Knox County, Tennessee is presented in conjunction with an analysis of quantitative data collected from 31 brick structures in the same area. This information is used to answer technological questions about brickmaking in the study area and to compare the sequence of changes in this technology with that for the United States in general as proposed by Walker in 1971.

Analysis of this data reveals that certain factors delayed the introduction of brickmaking machines to Knoxville until 1885. From the late 18th century until the early 20th century, local bricks were made to standard common and modified English statute standards. The popularity of these standards during the 19th century follows a slightly different pattern locally than Walker's sequence for the United States. Although bricks from the study area are slightly thicker than the limits of standard common and modified English statute standards, their Index Numbers still fall within the range allowed for these standards.

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CHAPTER I

INTRODUCTION

According to Heite (1968:43), "bricks are the commonest ceramics encountered in historical archaeology. . . .," yet until recently, few site reports included any discussion of bricks as an artifact type.

This omission seems to stem from two factors:

1. archaeologists' general lack of familiarity with the technological history of brick manufacturing; and
2. the commonly held belief that as an artifact type, analysis of bricks yields little information that cannot be obtained through the analysis of other types of artifacts.

Archaeologists' lack of familiarity with the history of brickmaking in the United States would appear to be due to reasons other than a lack of published information since numerous books on the subject were written throughout the 19th and early 20th centuries. Many of these books contain the knowledge accumulated by men who had been brickmakers all their lives (e.g., Crary, Sr. 1890; Mease 1813; Lovejoy 1913).

Dobson's book (1850) concentrates on the production of hand-made bricks and discusses the most economical placement of the structures making up a brickyard.

Davis (1884) is something of a history of the manufacture of brick and hollow drain tile. This volume is also an excellent source

of illustrations and descriptions of the most commonly used brickmaking machinery of the period. Numerous line drawings throughout the text illustrate each machine and a discussion of the operation, production capacity, energy requirements, and price is included.

Similar information aimed at the layperson is provided by Ingram (1876) in his description of the brickmaking machines which were on display in Philadelphia during the Centennial Exhibition. In addition to coverage of American brickmaking machines, illustrations and descriptions of several European machines are also included.

In addition to these 19th century sources, there have been a few articles in professional journals and publications during the past 40 years which contain information on the history and technology of brickmaking. This information is not the primary focus of the articles, however, and is included to provide the reader with the information necessary for better comprehension of the material.

For example, Harrington (1950) discusses brick and tilemaking at Jamestown, Virginia during the 17th century from both an archaeological as well as historical perspective. Two kilns discovered during archaeological excavations provided tangible proof for the local manufacture of bricks. Examination of the kilns, surrounding area, and associated artifacts yielded data relating to the technology of brickmaking as well as tilemaking.

The detailed step-by-step section on how bricks and tiles were made by hand unites the historical and archaeological data into a

single comprehensible body of information. A similar approach is taken by Smith (1976) in his publication on archaeological investigations at The Hermitage in Nashville, Tennessee.

Therefore, the reasons for which historical archaeologists remain unfamiliar with the technology and history of brickmaking in the United States clearly has nothing to do with the availability of published information on the subject. Rather, the lack of attention given to bricks by historical archaeologists seems to have its basis in the evolution of archaeological goals in the 20th century.

As the particularism of the 1950s gave way to the "new archaeology" of the 1960s, the goals of archaeology broadened to include a more scientific approach. Archaeologists were looking for patterns in the archaeological record upon which to theorize about cultural processes. Archaeologists are now beginning to realize that all types of artifacts yield clues to cultural patterns and that none can be ignored.

South (1964) and Lazarus (1965) were among the first to devote their full attention to bricks found at historic sites. South's work was a comparative study of brick sizes from a number of American Colonial sites. He based his study on a technique called the "Index Number Method" whereby length, width, and thickness measurements were taken on each brick in the sample. Each measurement was converted to a single number expressed in eighths of an inch; the sum of these three measurements being the Index Number assigned to each brick.

Using this technique, South was able to "screen out" minor variation between bricks due to differences in clays, moulds, and firing techniques. He identified several different brick "traditions" or "standards" which operated in the manufacture of bricks at these sites.

The results yielded a relatively narrow range of variation in size over a period of approximately 240 years. However, the same study isolated a size range or "standard" (Brunswick Town) with (seemingly) limited areal and temporal distribution. This finding prompted South to caution that bricks should not be ignored by the historical archaeologist since "a dramatic variation in size or form . . . may be found to have a functional, temporal, or areal significance" (1964:73).

Lazarus (1965) used South's Index Number Method to examine a limited sample of Colonial and American bricks from 14 sites in the Pensacola area encompassing a period of time from 1722 to 1878. Although the 18th century Spanish brick clearly represents a separate tradition, Lazarus concluded that "the 19th century American tradition brick at Pensacola generally parallels that of Virginia and the Carolinas as far as index numbers are concerned" (Lazarus 1965:81).

One of the most complete discussions of brick as an artifact type appeared in the report of the excavation of the Arkansas Post Branch Bank (Walker 1971). Allowing 1/4" possible variation in any dimension due to uneven firing, 20 of the 45 complete common red bricks in Walker's sample were identified as standard common (8 1/2" x 2 1/2" x

3 3/4"); 16 were modified English statute (8 1/2" x 2 1/2" x 4"); eight fell into either category; and one did not fit into either category (1971:47).

Based on historic information as well as data from historic sites reports dealing with brick (Smith 1960; South 1964; and Lazarus 1965), Walker proposed the following sequence of changes in the size of American-made brick (1971:52):

1. The manufacture of brick measuring from 9" to 9 1/4" in length, 2 3/8" to 2 5/8" in thickness, and 4" to 4 1/2" in width began in America during the 17th century and continued until the 1860s.
2. The manufacture of two smaller sizes of brick--the modified English statute (8 1/2" x 2 1/4" x 3 3/4") and the standard common (8" x 2 1/4" x 3 3/4")--began in the early 1800s, became widespread by mid-century, and replaced the earlier brick tradition by the 1860s.
3. Gradually the standard common became more popular and apparently it had replaced the modified English statute brick by the 1880s.
4. Although various sizes of brick remained in use, the Common Brick Manufacturers Association adopted the standard common brick as the standard size for American brick prior to the 1930s.

Smith's (1977) report on the 1976 field season excavations at the Hermitage in Nashville, Tennessee illustrated how archaeologists have begun to change their attitudes regarding bricks and brick kilns encountered at historic sites. Interest in the early history of brickmaking arose from efforts to determine the material history of the Hermitage while a portion of the research design was aimed at the collection of data to test questions concerning historic brickmaking technology at the site (1977:1, 64).

The report included a table of data on the average length, width, thickness, and weight of whole bricks recovered from one brick kiln and other brick structures which are part of the Hermitage Main Complex, the First Hermitage, and the adjoining areas of Tulip Grove and Old Hermitage Church. Although he did not group his data according to standard common or English statute standards, Smith did distinguish between "Soldier's Home Brick" (named for one of the structures near the Hermitage) and "Hermitage Brick"; the former being about 1/2 inch larger overall and 1/2 pound heavier than the "Hermitage Brick" (1977:91).

The Hermitage report devoted numerous pages to the history of brickmaking, brick kilns, and the changes which occurred between 1600 and 1900. Smith relied on historical documents such as the Andrew Jackson Papers and the "Hermitage Farm Journal" to provide solid evidence of brickmaking at the site and to document the sequence of additions made to the Hermitage.

In his conclusions, Smith listed several guidelines which he felt would aid in placing the Hermitage brick kilns into a relative historical time frame. Each of these guidelines was based on some facet of brickmaking technology for which a time frame has been determined.

Even more analytical uses for information collected from bricks were presented by Kelly and Kelly (1977:88):

1. they may illustrate economic networks between urban and rural areas of the region under study;

2. since brick structures reflect the social status of the builders or occupants, this provides a means for testing hypotheses formulated on the basis of information collected from other artifact classes;
3. brick brands may help to date the structural fabric of a building in instances where the remains are fragmentary;
4. bonding patterns may be important to historical archaeologists and architects; and
5. as products of an obsolete industrial practice, brick brands represent horizon markers.

While Kelly and Kelly were primarily concerned with bricks having brands, their position demonstrates that by the mid-1970s, historical archaeologists were beginning to look more closely at bricks and to explore the analytical possibilities they offer.

Statement of Intent and Justification

The establishment of brick collections by historical archaeologists across the United States, compilations of manufacturers and years of production for local areas, and the description and analysis of bricks collected during excavations constitute a significant contribution to the artifactual data base. Expansion of this data base to include information from various geographical regions will aid in the building and testing of a number of theories which are based on information provided by other types of artifacts.

Only after this data base is fairly complete will it be possible to determine the significance of bricks as an artifact type.

This thesis adds information about the history of brickmaking in Knoxville and Knox County, Tennessee to the data base mentioned above. The collection of this information will, hopefully, provide answers to technological questions and permit a comparison between the history of brickmaking in Knoxville and Knox County with that of the United States in general.

The objectives of this thesis are to:

1. present a history of brickmaking in Knoxville and Knox County from the 19th through the early 20th centuries;
2. determine the temporal distribution of "impressed center" bricks and the reason(s) for this distribution within the study area;
3. determine when machine-made brick was first manufactured in Knoxville and Knox County and the types of machines which were used by major manufacturers;
4. apply South's Index Number Method to brick measurements spanning approximately 100 years to aid in the identification of the brick standards used in the study area during this period; and
5. use the standards identified to compare the sequence of changes in brickmaking within the study area to the sequence proposed by Walker for the United States in general.

Since the history of brickmaking in an area is affected by a number of factors (e.g., geographical, economic, cultural, etc.), no two histories will be identical. The sequence of changes in brickmaking technology in an area will parallel, but not conform exactly, to that of the United States as a whole. Thus, an areal study of the history of any industry provides the archaeologist with a spatially and temporally specific body of information. This information can be used to answer questions about the diffusion of ideas, technology, and material objects related to the specific industry being studied.

In this thesis, then, the history of brickmaking within the study area should provide the information necessary to achieve the second and third objectives presented above. The measurements taken on whole bricks from 19th and 20th century structures in Knoxville and Knox County will be used to achieve the fourth and fifth objectives.

Finally, since the last objective is essentially a test of Walker's hypothesis, this thesis will provide explanations for why and in what way(s) his hypothesis is or is not valid for Knoxville and Knox County.

CHAPTER II

A BRIEF HISTORY OF BRICKMAKING IN THE UNITED STATES

17th and 18th Centuries

Historical records indicate that brickmaking was one of the earliest industries established in the New World during the 17th century. Harrington (1950:16-17) states:

It was clearly the intent of those directing the various English colonizing ventures that the settlements would be of a permanent nature, with living conditions as nearly as possible like those back in England. Brickmakers, limemakers, bricklayers, and other building tradesmen were among the first settlers, both at Jamestown and at Sir Walter Raleigh's earlier settlements on Roanoke Island.

These facts are substantiated by the dates of initial brick production in the various colonies: an unsuccessful attempt at Roanoke Island in 1585 (Harrington 1966:41), Jamestown, Virginia in 1612, New Amsterdam (renamed New York by the British) in 1628, and Salem, Massachusetts in 1629 (Jeffers 1976:20).

In addition to fostering a greater sense of permanence in the British colonies, the emphasis on the use of brick was a reflection of its popularity both as a building material and status symbol in 16th century England. Extensive use of brick in the Dutch settlements of the Hudson Valley was no doubt for the same reasons plus a desire on the part of the colonists to recreate the familiar brick architecture of their homeland (McKee 1973:41).

The first houses and buildings erected by the English colonists on Roanoke Island and at Jamestown utilized the principle of the

post-and-truss to support the roof (Pursell 1968:19). Commonly used in 16th century England, the style was slightly modified for use in America. In place of hewn beams with mortise and tenon joints, the colonists used trees with naturally-occurring forks or "crotchets". These were placed at the center of each end wall. Upright timbers were set into a stone foundation to frame the walls and stone rubble or wattle and daub were used to fill the wall spaces between the timbers. Reeds were used to cover the roof as a substitute for thatch (Forman 1938:5).

Understandably, the colonists at Roanoke were anxious to upgrade their homes from these crude "crotcheted" huts to more comfortable and familiar ones of clapboard and brick. In 1585 their attempts to make bricks for the construction of houses and a fort proved futile because the type of clay available to them on Roanoke Island simply was not suitable for making bricks (Harrington 1967:15).

At Jamestown, Virginia the colonists also used "crotchets" in their first building efforts but early on turned to making bricks:

Nevertheless, in spite of the widespread prevalence of wooden structures in the Virginia countryside, the English had a desire for brick buildings. In almost every place in Virginia there was a store of earth 'fit to make brick in,' and there was no need to bring the 'bricks from England.' The ideal town which the Company wanted in Virginia was to comprise a convenient number of houses built together with brick, and enclosed with a brick wall. This idea of brick row houses was attempted at Jamestown but never carried very far (Forman 1938:60).

That the English intended to begin making bricks as soon as possible is indicated by the fact that two of the initial colonists at Jamestown were bricklayers. When Sir Thomas Gates arrived at the

colony in 1610, he brought six more bricklayers and four brickmakers with him (Whiffen 1958:41). When production began in 1612, all bricks were used locally; yet by 1621, Jamestown was exporting surplus bricks to the Bermudas in exchange for "fruits, fowl, and other commodities" (Harrington 1950:17).

Orders sent to Jamestown at various times reflected the Virginia Company's position that brick was the preferred material for all residential and public buildings. The wheels were set in motion in 1631 by Governor Sir John Harvey who requested that additional brickmakers and bricklayers be included among the craftsmen sent to Jamestown because in the future, all houses would be constructed for spaciousness and respectability (Forman 1938:102). The next restriction occurred when the settlement received word that anyone who owned 500 acres of land was to erect a brick house upon it, yet in 1639, only one of the dozen houses and stores built around the settlement was of brick. Wooden houses continued to be built until 1622 when yet another order decreed that all future residential construction (as well as the 32 new houses which were ordered to be built) must be of brick.

Regulations occurred in other colonies as well. In 1667 a Massachusetts court appointed a committee to frame legislation which would regulate the size as well as the manufacture of brick. By 1683, brick houses had been erected in Boston and in 1692, the General Court decided that all new buildings in the city over eight feet in length

and seven feet in height had to be built of brick or stone with a roof of slate or tile (Jeffers 1976:21).

Brick was also a very popular item in other American colonies. At the same time bricks were being exported from America during the 17th and 18th centuries, historical records indicate that bricks were being imported from England and Holland aboard ships, albeit in very limited quantities:

The Virginia Gazette recorded shipments in 1737, 1739, 1745, 1753 and 1768 but did not name the sources; the greatest number that arrived in one vessel was 80,000. That quantity of bricks would suffice to construct only one two-story building 20 to 40 feet in size. In 1642, 30,000 "clinker" bricks arrived in a ship at New Amsterdam; however, the purchaser accepted only 10,000 as being fit for use (McKee 1973:48).

During the 18th century, the demand for bricks increased as cities grew. Brick was more popular as a building material than wood in New York by 1794. In part, the popularity of brick was due to the fashion of the period, but fashion brought with it a practical advantage: it reduced the amount of damage caused to cities by fires. An 1811 guide book to Philadelphia noted, "Since 1796, no wooden buildings are permitted to be erected in the thickly settled parts of the city. . . . This excellent law has greatly tended to lessen fires in the city, and improve its appearance" (Pursell 1968:22).

In addition to specifying that bricks be used for new construction, various statutes were in effect in England as well as the American colonies which regulated the size of all brick. These statutes were established to protect the buyer. Bricks were commonly priced by the thousand (abbreviated "M") and by regulating the size,

the buyer was assured a minimum amount of material for each thousand bricks purchased (McKee 1973:47-48). The legal sizes were known as "standards".

During the reign of George I, English brick standards were changed twice. In 1725, Place bricks were to be 9" x 4 1/4" x 2 1/2" and Stock bricks were a fraction thicker at 9" x 4 1/4" x 2 5/8". By 1776, all English brick was supposed to measure 8 1/2" x 4" x 2 1/2" (Forman 1938:84). Dutch and Spanish bricks were made to entirely different standards.

Sometimes advertisements for building materials specified brick size as in the following example from the Boston News-Letter of February 20, 1772. The advertisement was requesting several types of construction materials for use in a new meeting house in Brattle-Street. Eight hundred thousand bricks were needed measuring 8" x 4" x 2" (one-fourth of these were to be sand-struck and used as face brick) and 4,000 sand-struck bricks were to be made 9" x 4 1/2" x 2 1/2" for construction of outside arches (Weitzman 1976:150). Despite such specifications and numerous colonial regulations, the size of 17th and 18th century American bricks varied widely from building to building and colony to colony.

Although brick sizes have varied greatly throughout history, the dimensions and proportions have always remained within the limits of what a single workman could handle. Size was also limited by the plastic property of clay itself. Bricks made much larger than the dimensions of the various standards in use over the history of

kiln-fired bricks were likely to warp during firing. Thus, brick standards took this property into account to assure that bricks were not too large.

Brickmaking Technology in the 17th and 18th Centuries

The brickmakers who came to America during the 16th and 17th centuries brought European technology with them and adapted it to the raw materials and conditions they encountered here. The entire brickmaking process took several months to complete and like many other aspects of colonial life, was dictated by the seasons of the year. Brickmaking involved three major processes: tempering, moulding, and firing.

Moulding

The following passage (Lloyd 1925:34) describes how the tempering process was begun by digging the raw clay from naturally-occurring deposits and allowing it to weather during the colder months:

'Before Christmas we begin to dig as deep as the Earth allows, and lay it as level as can be, and end before Candlemass, that is, that the hard lumps we dig may shake to pieces; which it will do either by help of Rain or Frost; when 'tis thus dug, we let it lie till Lady Day or Easter, when we seldom fear [for] fair weather. Then we water the Earth well, and temper it with a narrow Spade about five Inches broad, that the Workman may hold out, with which we dig it down, and then temper it with our bare feet till it is in good case to make a Brick on, that is, like a piece of Dough such as will just stick in the Mould or Frame, when Tifted up, and not fall off of itself. . . .

These clay pits were dug to a depth of approximately one foot and were about four feet wide and 16 feet long. A single pit of this size

contained enough clay to produce about 1,000 bricks. In the spring, the pits were uncovered and the tempering process continued. Oxen or horses were driven across the surface of pits or the clay was simply worked manually with a spade. Finally, the tempered clay was placed in piles measuring six feet by ten feet and covered over.

Each pile contained clay for approximately 2,000 bricks (a one day supply for a good moulder). Water was added to the pile if the clay was somewhat dry and it was left to soak for about 24 hours. Using a spade, a workman added more water if needed and smoothed the pile into a compact mass. The prepared clay was covered until it was needed by the moulder. At that time, a workman brought the tempered clay to the moulder's table in a wheelbarrow (Jeffers 1976:22).

The next step in the manufacturing process involved the moulding of the tempered clay. Throughout the 17th and 18th centuries, there were essentially only two methods used in England to hand-mould bricks: stock-moulding and place-moulding. Stock-moulded bricks were formed in open rectangular wooden moulds placed over a fixed board (stock) attached to the moulding table (Figure 1). The filled mould was scraped smooth or "struck" on the open upper surface and the mould was lifted off. The brick was removed from the stock and placed on a pallet or wooden board. Filled pallets were carried to the drying floor and emptied.

Place-moulded bricks were also formed in rectangular wooden moulds but rather than being open on two sides, one side of the mould had an attached bottom. Filled moulds were "struck" on the upper

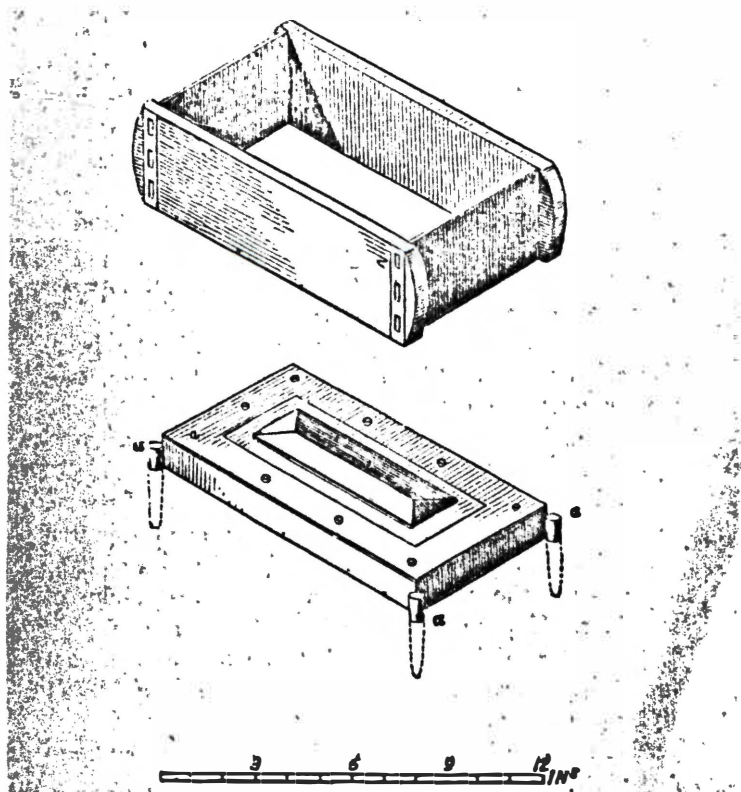


Figure 1. Wooden brick mould and metal stockboard with "frog" (Dobson 1868:135).

exposed face and carried one at a time to the drying floor and emptied. In order to prevent the clay from sticking to the moulds, sand was sprinkled inside stock moulds and place moulds were dipped in water.

The terms "stock moulding" and "place moulding" were more commonly used in England while the terms "pallet moulding" and "slop moulding" (waterstruck) were used in America. Of the two methods, stock-moulding was the more efficient, producing about three and one-half times more bricks in the same amount of time.

Stock-moulded bricks were carried to the drying floor and placed on edge to dry while place-moulded bricks were unmoulded directly on the drying floor with one face down. The action of flipping the mould over to dislodge the brick formed a raised area or "lip" along the opposing edge and end (Harrington 1966:30-31). As both types of bricks were turned throughout the first part of the drying process, irregularities were scraped off with a knife or smoothed by hand. It was at this stage of the manufacturing process that fingerprints and animal tracks were sometimes left in the surface of the soft clay.

After the bricks were sufficiently dry to permit handling, they were taken to drying sheds. These were open-sided rectangular structures covered by roofs with overhanging eaves. This design permitted the free passage of air through the sheds while shielding the unfired bricks from the sun and rain. The unfired or "green" bricks were stacked on edge in long rows two bricks high, maximizing the amount of exposed surface area. This stacking arrangement

shortened the amount of time required to cure the bricks before they were fired.

Bricks were usually dry enough for firing after one or two days in the drying sheds. Once dry, the green bricks were removed from the sheds and taken by wheelbarrow by workmen called "hackers" to an area set aside for firing.

The two methods of moulding bricks discussed above also differed in the quality of the finished bricks produced by each. "Stock bricks" were much harder after firing than "place bricks" and, consequently, more expensive. More than likely, the former was commonly used as "face brick" on the outer surface of walls since they would better withstand the effects of weathering.

Firing

From the 17th through the mid-19th century, bricks were fired either in a clamp (scove kiln) or in a permanent rectangular kiln (Figure 2). A clamp is a temporary type of kiln usually constructed near the building site with the bricks which are to be fired. When the firing has been completed and the clamp has cooled, it is dismantled. A kiln is a permanent chamber constructed of fired bricks. The green bricks are stacked inside the kiln, fired, and then removed.

Construction of a clamp began with the stacking of green bricks on edge in double rows. Channels were left between the rows for placement of the fires. The number of rows and channels making up the clamp was, to some degree, determined by the number of bricks which

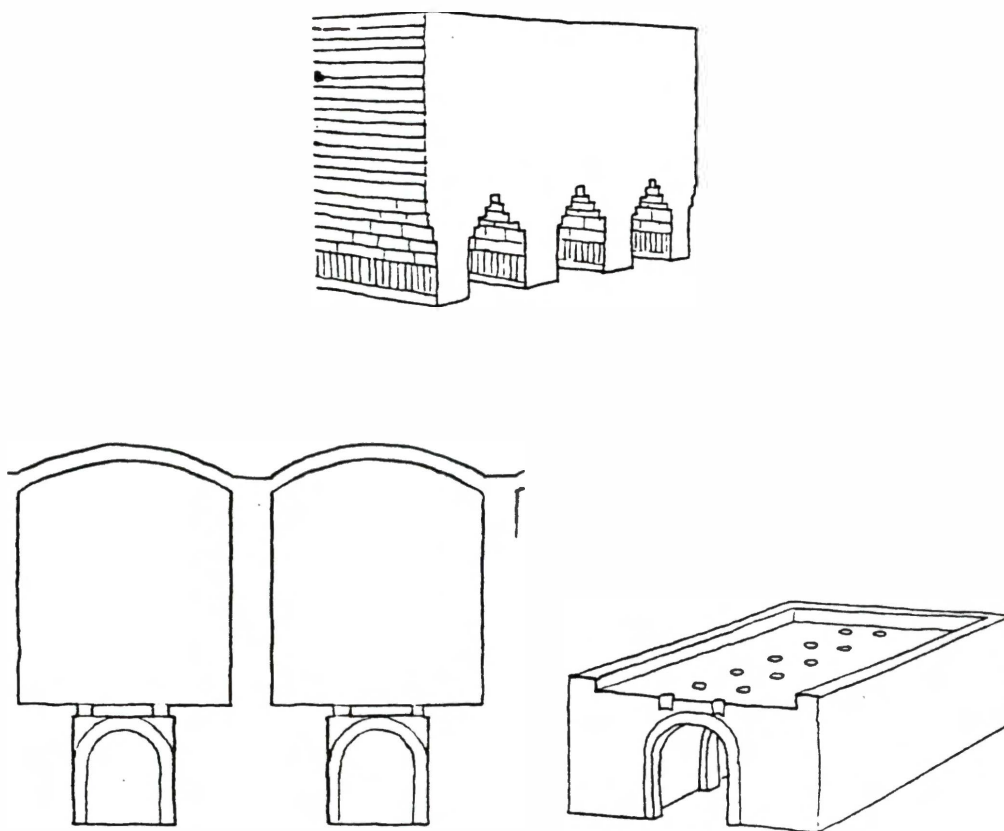


Figure 2. Illustrations of a scove kiln and permanent rectangular kiln (McKee 1973:42).

were to be fired. The upper rows of bricks were stacked to slightly overlap those underneath, producing a series of arches which closed over the tops of the fire channels. Several more courses of brick were added to the top of the arches to seal off that portion of the clamp. Although dimensions varied, clamps were usually about five or six feet in height, 18 feet in length, and contained from 20,000 to 50,000 bricks (Heite 1968:47; McKee 1976:82).

Once the bricks were stacked, wood and charcoal fires were set inside each channel. Some of the channels were partially sealed on the outside by three or four courses of unmortared brick called the "shinlog". These bricks protected the shins of the men tending the fires as well as provided a means of regulating the draft (Lloyd 1925:35; Heite 1968:45).

According to Dobson (1850:Part 1, 38), clamps (rather than permanent kilns) were used only when the bricks to be fired contained ashes or coal dust. Since the fuel necessary for vitrification was contained within each brick, only the heat from the channel fires (or bricks already ignited) was needed to spread the heat required for firing throughout the entire clamp.

It took approximately three days for the heat from the fires to spread to the uppermost bricks in the clamp. When this stage was reached, "The fire was then pushed to a strong, even red heat [1800° F] and maintained for 48 to 60 hours" (Jeffers 1976:23; McKee 1976:82). All the channel openings were then sealed by steel doors,

bricks and mortar, or mud for a period of four to five days (Jeffers 1976:23).

After the clamp had cooled, it was dismantled and the finished bricks were sorted according to quality. Hume (1969:174) quotes a portion of the 1736 edition of the Builder's Dictionary (Nevi) which explains the three grades of brick most commonly found in clamps or kilns:

'There are commonly in all kilns and Clamps three Degrees in Goodness, viz. The first and best Sort for lasting are those which lie next to the Fire, and have, as it were, a Gloss on them, which proceeds from the Saltpetre inherent in them, which by the Violence of the fire, runs and glazes them, these are called Clinkers.

The second and most general Sort for building are those which lie next in the Kiln, or Clamp, to those before mentioned.

The third and worst sort, are those which lie on the outside of the Kilns or Clamps, where the Saltpetre is not digested for want of due Heat; and these, when they come to be exposed to the Weather for some time, will moulder away like Dirt; and are called Samel or Sandel bricks. 'Tis an Observation, that whilst Bricks are burning those on the windy side of Clamp, are the worst of all.'

Unlike scove kilns or clamps, rectangular kilns are permanent structures made of bricks that have been previously fired. Kilns of this type date back to ancient Egypt and were in use both in Europe and America from the 17th through the 19th centuries.

Even though permanent rectangular kilns were in use in America by the late 17th century, temporary kilns were more common until the late 19th century. The reason for the predominance of the latter lies in the fact that brickmakers, like other building craftsmen, were in short supply in America during the 17th and 18th centuries. In some areas west of the Allegheny Mountains (including Tennessee) the

scarcity continued into the early 19th century (Michaux 1805:255).

Most craftsmen and their apprentices and/or slaves worked within an area and moved from one building site to another as their skills were needed. Under these conditions, the use of clamps or scove kilns was the most practical and economical means of firing bricks near the site where they were to be used.

Remains of two 17th century rectangular kilns were discovered at Jamestown, Virginia during archaeological excavations conducted in 1935 and 1941. The kiln discovered in 1935 (at William Sherwood's house) was built directly on the ground and although the remains were fragmentary, it was determined that it contained at least a dozen arches 20 inches wide and was approximately 18 feet in length. Harrington concedes the remains may represent two adjoining kilns rather than a single large kiln. Bricks found inside the fire chambers were laid in a herringbone pattern (Harrington 1950:19).

The second kiln was located adjacent to the "Great Road" on a five acre tract about 200 feet from the old church. This kiln measured roughly 24 1/2 feet in width and 19 feet in length. Based on English kiln dimensions, height was estimated to be between 12 and 15 feet. A kiln of this size would hold about 50,000 bricks per charge--an unusually large number: "It is said that kilns of this type, usually referred to 'rectangular updraught' or 'Scotch' kilns, usually were not built to hold more than 40,000 bricks, and some held as few as 15,000" (Harrington 1950:28).

The rear and side walls were set into a slope and a drain which ran along one side kept the area in front of the kiln dry. The front and rear walls were laid in English bond while the bond on the side walls was irregular. The bricks were laid up with loam instead of mortar as protection against the intense heat which occurred during firing. Unlike other rectangular kilns, this one had no openings in the side walls for loading and unloading; the five arches on the front wall were used to load, fire, and unload the kiln.

A clay bed near this kiln contained a pit approximately five feet in diameter. This pit was probably used to temper the clay. In the area immediately surrounding the pit, clay had been removed to a maximum depth of three feet. Harrington estimates this was enough to have produced approximately 500,000 bricks.

Rubble and refuse found on the inside of the kiln indicated that it was abandoned for some time before finally being torn down and filled. Evidence from historical documents relating to this particular tract of land supports Harrington's belief that the kiln was in use around the middle of the 17th century (Harrington 1950:24-29).

Whether a clamp or kiln was used, wood was an integral part of the firing process until the 19th century (Smith 1976:73). According to an early edition of The Encyclopedia Britannica (1771:676), wood fires were set in order to complete the drying process and "brush, furze, spray, heath, brake, or fern faggots" were added to begin the firing of the brick charge. A cord of seasoned and split wood would

burn approximately 2,000 bricks, thus a single charge of 35,000 bricks would have required 17.5 cords of wood. ". . . the man who makes from one to four million of brick annually, has a grave problem before him in the early spring months" (Morrison 1890:40-43).

For the colonial brickmaker in certain areas, the type of wood used as fuel was an additional consideration since oak was required to produce a blue-gray glaze on the header (end) face. These glazed bricks were extremely popular in Tidewater Virginia and were used most often in buildings laid up in Flemish bond (courses of alternate headers and stretchers). In the mid-18th century, however, glazed headers were rarely used. Loth (1974:94-95) attributes this change to the depletion of the oak forests in the area. Glazed headers reappeared at the end of the 18th century in isolated buildings, primarily in the Shenandoah Valley. This reappearance coincided with the second growth of the oak forests. Apparently, depletion of these forests was not a problem in the area around Philadelphia despite its position as a leading center of brick production since use of glazed headers continued there without interruption until the early 19th century (Loth 1974:95).

By the middle of the 19th century, brickmakers began switching from wood to coal in areas where wood was becoming scarce. This factor, coupled with the growth of sawmills and the increasing demand for sawn lumber, forced the price of wood beyond that of coal. Dobson states that by 1850, wood was still sometimes used during the early stage of the firing process, ". . . but not to a great extent"

(1850:Part 1, 41). Morrison (1890:40) adds that the switch from wood to coal was delayed in those parts of the country where wood was still plentiful and/or the demand for bricks exceeded that for lumber.

19th Century

Throughout the 17th and 18th centuries, the American economy was based primarily on agriculture and European technological innovations had little impact on the American way of life. During the first half of the 19th century, the construction of a system of roads and canals across the expanding nation forced Americans and technology together. The agrarian mind-set gradually broadened to encompass the realization that old ways must give way to new and that acceptance of new inventions and labor-saving machines was vital to the continued growth and strength of the nation.

Brickmaking Technology in the 19th Century

Like all other building crafts, 19th century brickmaking underwent tremendous changes as machines were invented which reduced or eliminated the most labor intensive and time-consuming tasks. Even though these machines had a profound effect upon brickmaking, the steps involved in the process remained the same: tempering, moulding, and firing.

The earliest brickmaking machines were invented during the 18th century, however, the entire process was not mechanized until the end of the 19th century (Jeffers 1976:31; McKee 1976:84). Unfortunately,

much of the history of the earliest brickmaking machines was lost in 1836 when a fire destroyed the records in the U.S. Patent Office.

Moulding

Inventors directed their earliest efforts toward designing machines which could quickly temper the weathered clay into a consistency suitable for moulding. These machines were aptly called "pug-mills" since they "pugged" or mixed the clay with sand and water. Pug-mills were usually made in the shape of an inverted cone or vertical cylinder. Steel blades or knives were attached to the inside of this chamber. The actual mixing was accomplished by the revolving action of a vertical shaft with knives and blades attached along its length. Clay, sand, and water were put into the top of the pug-mill and the shaft was turned by horsepower or a small steam engine. As the shaft turned, the mixture was churned together as it was forced downward through the chamber. The tempered clay emerged through the bottom of the pug-mill.

The success of the pug-mill prompted the next advancement in the development of brickmaking machines: combining the pug-mill with a moulding machine. The earliest patented machine of this type for which there are authenticated drawings was patented by Apollos Kinsley in 1793 (Figure 3).

Kinsley's machine was a crude attempt at best. A vertical pug-mill was turned by a horse or mule and the revolving action of the blades inside mixed and softened the clay. Rotation of the blades

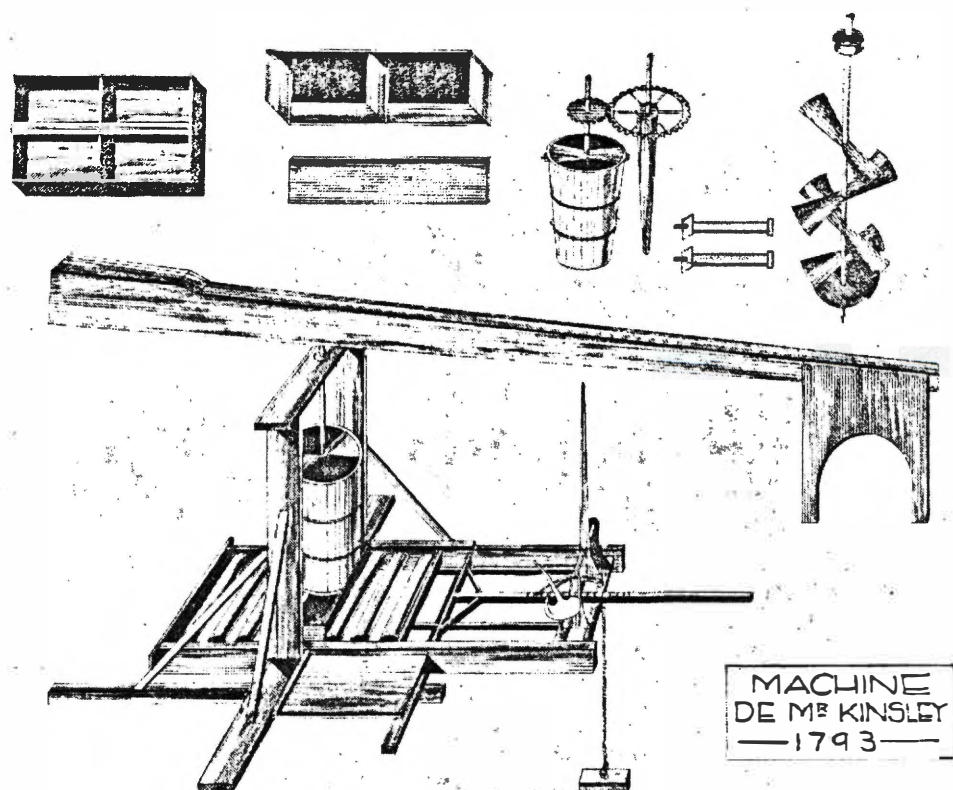


Figure 3. Drawing of Apollos Kinsley's first brickmaking machine. It combined the steps of tempering and moulding (Jeffers 1976:30).

moved the clay downward until it was forced out the bottom. Wooden moulds sat on rollers ready to receive the clay as it emerged.

Kinsley later refined his machine by using a horizontal table which revolved beneath a charger. The up-and-down action of the charger compacted the clay inside the moulds. Later improvements included a piston-driven charger augmented by an iron plate. The plate was connected to a system of weights which could be adjusted for different amounts of clay. The horizontal table and the charger were incorporated into the design of numerous brick machines for well over a century (Pursell 1968:23).

Even though the old methods of tempering were replaced by pug-mills, moulding continued to be done by hand in most small brickyards until the last quarter of the 19th century. Automatic moulding machines were developed in the early 1800s but they were only used in large cities in the Northeast. News of the successful use of these machines traveled throughout the rest of the United States yet most bricks continued to be hand-moulded until the last quarter of the 19th century.

Impressed Center Bricks

Stock-moulded bricks made with the type of metal stockboard shown in Figure 1 (p. 17) had one face with a centered rectangular depression. These depressions or "impressed centers" varied in size and depth according to the particular characteristics of the metal stockboard which was used. With the exception of this illustration

(Dobson 1868) the author has found no other clear reference to impressed center bricks in the 19th century literature.

In an effort to learn more about this type of brick, the author contacted Mr. Richard Hossman of the Royal River Brick Company in North Yarmouth, Maine. This company makes bricks by hand-moulding in order to meet the needs of persons restoring historic structures in the Northeast (see Renner 1981).

According to Mr. Hossman, the correct term for the impressed center is "frog". The "frog" serves three major purposes:

1. it reduces the amount of clay in the brick which also shortens drying and firing time;
2. it increases the surface area of each brick which creates space for a "pocket" of mortar, producing a stronger bond;
3. it provides a space for the brickmaker to stamp his initials or the name of his company (see Kelly and Kelly 1977).

During the collection of brick measurements in Knoxville and Knox County (see Chapter IV), impressed center bricks were found in several of the 31 houses and buildings making up the sample set. These are listed below in the order of historic name, date(s) of construction, and sample number: McCammon House, 1849 #2, Old Methodist Church/Masonic Hall-1868 #11, Kearnes House-ca. 1846 #15, Colonial Hall-1842 #19, Baker-Peters House-1840 #20, Boyd-Harvey House-1835 #21, and the Armstrong House-ca. 1850 #31.

Impressed center bricks were identified in these structures due to their deteriorated condition or by the examination of single bricks which had been removed for the installation of air conditioning ducts, etc. and saved by the owners of the building. If it was possible to examine individual bricks from the remaining structures in the sample set, additional impressed center bricks would no doubt be found.

In extremely deteriorated structures such as the Kearnes House, it was possible to compare many individual bricks. As a result of these comparisons, three things became apparent:

1. within any single structure having impressed center bricks, there were also bricks without impressed centers;
2. impressed center bricks were found in all parts of the structures--interior walls, exterior walls, and chimneys;
3. within any single structure having impressed center bricks, the dimensions of the impression were not identical on all bricks.

Some of these bricks appear to have been repressed, i.e., they were hand-moulded, then a repressing device was used to further compress the brick before it was unmoulded, dried, and fired. These hand-operated repressing devices probably worked like a vertical vise with a horizontal metal plate attached to one end which fit into the brick mould. As the vise was tightened, the plate compressed the

clay. Since they were more dense, finished repressed bricks were harder and stronger than unpressed bricks.

One technological question concerning repressed impressed center bricks remains unanswered at present, however. In addition to the metal stockboard, were impressed centers also made by special plates on the repressing machines described above?

By the end of the 19th century, automatic moulding machines were widely used. The stiff mud process (which utilized a drier clay mixture than the soft mud process) dominated the industry. Increased production capacities and improvements in firing methods made impressed center bricks obsolete.

Brickmaking Machines

One of the most significant changes in 19th century brickmaking technology was the switch from the soft-mud process (hand-moulding) to the dry press process (machine-moulding). The change may have begun in 1819 with a wooden machine owned by a man named Dolittle. Powered by a horse, it reportedly produced 30,000 bricks in 12 hours.

The bricks were said to be so dry when taken from the moulds that they could be fired immediately. If the account is accurate, so-called dry clay must have been used instead of tempered clay (McKee 1976:85).

By 1829, the dry press process was being used in New York where a single machine was said to be able to make 25,000 bricks in 12 hours. Like those from Dolittle's machine, they could be fired as soon as they emerged from the machine. The finished bricks sold for \$5.00 to \$8.00 per thousand (Jeffers 1976:31; McKee 1976:85). With the

demonstrated success of these machines in Washington, D.C. and New York City, use of the dry press process spread quickly across the country in larger brickyards.

The rapid acceptance of this process was a simple matter of economics. Use of drier clay reduced or eliminated the time needed for drying and the daily production capacity of a single machine greatly exceeded that of the best hand-moulder.

The success of these machines undoubtedly resulted in renewed interest toward the invention of other types of brickmaking machines--in 1811, only 11 U.S. patents had been issued for various types of brickmaking machines, but by 1847, the number had grown to 93 (Burke:1847:285-287).

In addition to the dry press machines, several types of repressing machines had been patented by 1812. Repressed bricks were made by putting hand-moulded bricks under the repressing machine to compress the clay (see discussion of impressed center bricks above). According to McKee (1976:89), hand-moulded bricks which had been repressed were sometimes called machine-made bricks in the early 19th century:

In fact there is no strict line of demarcation between machine-moulded and pressed bricks. Some machines exerted considerable force on the clay in iron moulds and the resulting bricks can properly be called pressed. . . . Pressed bricks had sharper corners and were more regular than those moulded by hand; in general they were also more dense.

Due to their regularity and high density, pressed bricks were most often used as face bricks on the exterior walls of buildings.

The manufacture of pressed bricks in the mid-19th century was still relatively uncommon, however, and was carried on in only a few major centers in the United States. The most well-known of these were Baltimore, Maryland; Philadelphia, Pennsylvania; Trenton, New Jersey; and Croton, New York. In 1852 the Sayre and Fisher Company of Sayresville, New Jersey began producing pressed face bricks and in 1863 was among the first to market face bricks which were gray-buff in color rather than the standard red.

One of the most famous manufacturers of pressed bricks in the mid-19th century was the Peerless Brick Company of Philadelphia. By the 1870s, they were shipping pressed bricks all over the United States. Peerless first relied on hand presses but later switched to power presses. They were also instrumental in developing the dry press process which remains the standard process in the industry even today. Largely due to this company's reputation and share of the market, Philadelphia pressed brick was the generic phrase used for all pressed brick made in this country in the 1870s (McKee 1973:46).

Despite these technological advancements, the majority of brickyards still relied on the old method of hand-moulding. Reluctance to accept the new machines was based on two factors:

1. the machines were better suited to some types of clay than others--what worked well in New York might be totally unsatisfactory elsewhere; and
2. most brickyards were small operations whose moulders considered themselves to be self-employed craftsmen rather than businessmen.

Most of these men also lacked the capital and business acumen necessary for automating their brickyards. As a result, mid-19th century methods persisted in the United States for at least another 50 years outside the main centers of progress (McKee 1976:88).

Prior to the Centennial Exhibition held in Philadelphia in 1876, most of the machines used in the United States were designed and manufactured in England. Of the 20 brickmaking machines on display at the Exhibition, the design of two of the American machines had a dramatic effect on the way in which bricks were tempered and moulded. By 1910, the impetus provided by these two designs had transformed the craft of brickmaking into an important industry.

One of the American machines was based on a horizontal design and was manufactured by Chambers, Brother, and Company of Philadelphia. This machine utilized the stiff mud process to produce extruded wire-cut bricks. Raw clay was fed into one end through a hopper. Loam, sand, clay, or water could be added to achieve the desired consistency if needed. The clay mixture moved into a conical chamber containing a revolving horizontal steel shaft which was set with knives. As the shaft turned, the knives tempered the clay by repeatedly cutting through it. The clay was extruded from this chamber and forced through a rectangular die the width and thickness of finished brick. A spiral cutter at the opposite end of the machine sliced the extruded bar of clay into the proper length and a continuous chain carried the bricks to an automatic sanding machine. At this point, the bricks were ready for the drier.

The capacity of one of these iron machines was from 25,000 to 30,000 bricks per day (Ingram 1876:198-200). The model shown in Figure 4 was guaranteed to produce from 40,000 to 50,000 bricks per ten hour day. Cost was \$2,500 for the machine plus as additional \$1,000 for the right to use it (Davis 1884:200-201). These machines came into wide use within the next several years after the Exhibition display (McKee 1976:88).

Also on exhibit in Philadelphia was a Triple Press machine made by the William L. Gregg Company. Ingram (1876:200) observed it in operation there:

This machine had a circular mold-board, rotating intermittently, which had eight sets of molds, with four in each set, making thirty-two molds in all. The crude clay was fed into a hopper, from which, by the action of agitators, it was filled into the molds. The molds, as the board carrying them rotated, passed under a roller and received a steady pressure as they passed. This was a sort of preparatory pressure. The molds then passed under a horizontal knife, placed diagonally, the knife removing from each mold any excess of clay developed by the preparatory pressure. Passing on in their rotary journey, the molds received pressure number two. This was an upward pressure and was caused by a toggle joint. The third and last pressure was a double one, both upward and downward, and was brought about by a simultaneous action of cams and toggles. The bricks were then discharged from the machine on to an endless carrier, and transported by it direct to the burning kiln. The expense of working the machine is trifling, it being entirely automatic in its operation.

The capacity of the Triple Press machine was 25,000 to 30,000 bricks in ten hours depending on the amount of power used to run it and the speed at which it was set to run. It weighed approximately five tons and cost \$5,000 (Figure 5). A disintegrating mill which prepared the clay for the machine cost an additional \$1,250. A

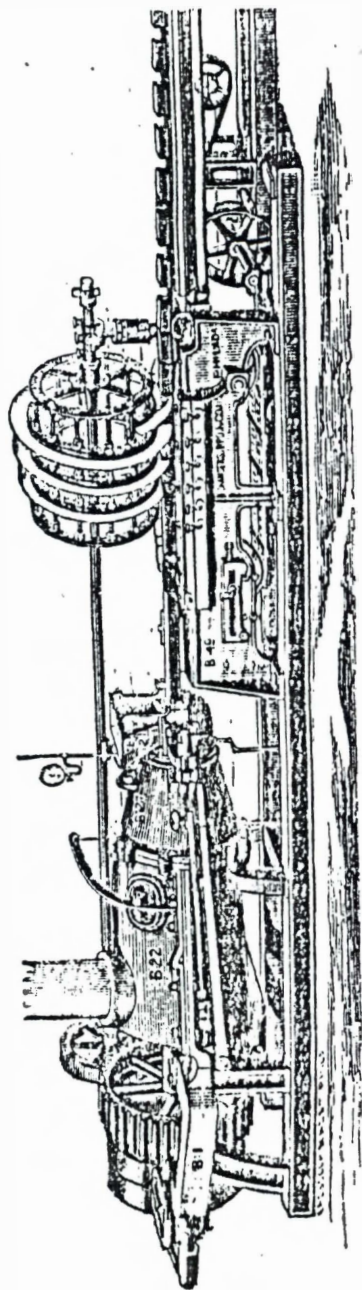


Figure 4. The Chambers, Brother and Company's horizontal brickmaking machine
(Davis 1884:201).

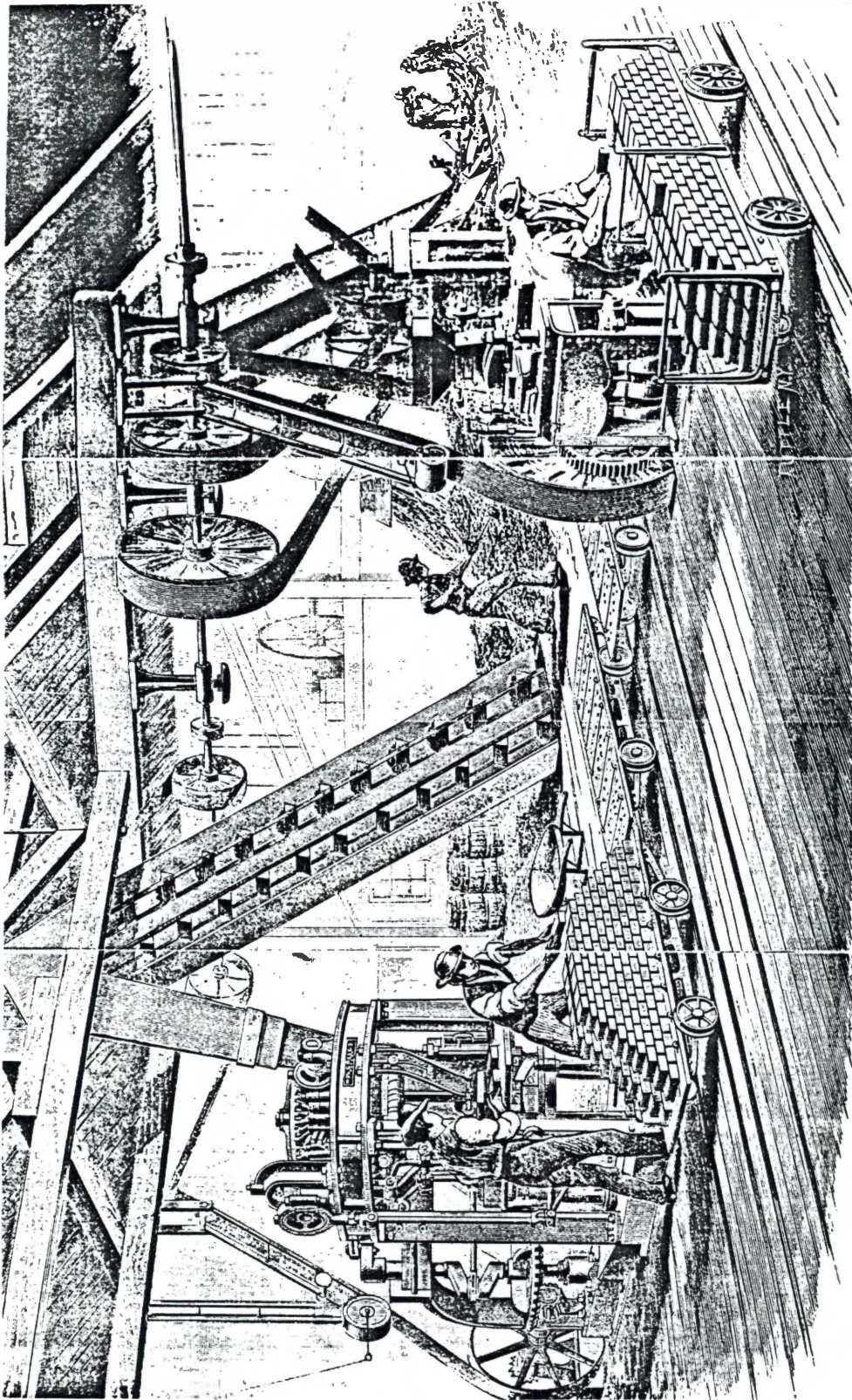


Figure 5. The interior of the Western Brick and Tile Company showing a Gregg Triple Press Brick Machine in use (Davis 1884:180).

35 h.p. engine provided enough power to run both the press and the disintegrator (Davis 1884:179).

The Gregg No. 2 machine was very similar to the Triple Press and could manufacture 8,000 to 10,000 common bricks in ten hours using a double pressure system. Different moulds could also be attached for producing specially-shaped front and ornamental brick. Like the Triple Press, the No. 2 required a smaller disintegrating mill to prepare the clay. The price of the machine was \$1,500, the mill \$500. A 12 h.p. engine was required to run them (Davis 1884:179).

The illustration in Figure 5 shows the Gregg Triple Press and No. 2 machines in operation. Finished bricks from these machines required no additional drying time since pressure-moulded bricks were made from a drier clay mixture than extruded wire-cut bricks. Handling costs and damage were also reduced by loading the bricks onto cars mounted on rails leading directly to the kilns. Less handling meant less damage and a higher margin of profit for the brickmaking company.

Firing

At the same time these machines were transforming the way in which bricks were tempered and moulded, improvements were also being made in drying and firing techniques. One of the more significant advancements was made by Cyrus Chambers, Jr. of Chambers, Brother, and Company. In addition to pioneering the stiff mud process, Chambers developed a warm air tunnel drier.

After the bricks were made by the horizontal machine described earlier, they were loaded onto wheeled cars. As the cars moved

through the rectangular tunnel on rails, waste heat from steam boilers was piped in to dry the bricks. Once they emerged from the tunnel drier, the bricks were ready to be fired. Chambers' machine and drier were so successful, the stiff mud process became the most widely used method for manufacturing bricks.

Improvements in manufacturing techniques were not limited solely to the invention of mills, presses, or driers, however. In order to keep pace with the increased production capacity of these various types of brickmaking machines, advancements also had to be made in the methods used for firing. Clamps and scove kilns, trademarks of the mobile craftsman, were replaced by various types of permanent kilns which were an integral part of the late 19th century brickyard.

All permanent kilns can be classified as belonging to one of two general types: intermittent (periodic) and continuous. An intermittent kiln has a single interior chamber. After the kiln is loaded with green bricks, the temperature is gradually increased until the proper firing temperature is reached. After the bricks have been fired, the kiln is allowed to cool and the bricks are unloaded. With each new charge of unfired bricks, this same process is repeated. In contrast, a continuous kiln is subdivided into a series of interior chambers. A system of flues and forced air circulates through the kiln and aids in regulating the temperature of each chamber. Charges of bricks within these chambers are dried, fired, and cooled by the precise regulation of heat. As soon as the chambers containing fired and cooled bricks are unloaded, they are refilled with another load of

green bricks. Thus, in a continuous kiln, the cycle of drying, firing, and cooling is constant or continuous, hence the name.

Intermittent kilns are generally cylindrical or circular with a domed top. The "beehive" kilns used into the 20th century in the United States and Europe are perhaps the most familiar form of intermittent kiln. Around the base of the kiln is a series of openings or fire-holes through which the fuel is added to the kiln. The bricks are loaded and unloaded through a door. Beneath the floor of the kiln, the fire holes in the outer wall and the flue system are connected to a single chimney. The older versions of this type of kiln were an up-draught design in which "the products of combustion pass from the fire mouths, through the flues, into the bottom of the firing chamber, and thence directly upwards and out the top" (The Encyclopedia Britannica 1910:520).

Lovejoy lists the advantages of the up-draught kiln as: being economical to fuel, providing the best possible sanitation, possessing a large capacity, and finally, being economical in filling and unloading. He also points out that the loss of heat from these kilns is relatively small since the fires are applied directly to the ware (1913:55).

The more modern form of the up-draught intermittent kiln is the down-draught kiln. This design was used more in the United States than anywhere else. Down-draught kilns "usually give a more regular fire and a higher percentage of well-fired bricks" (The Encyclopedia Britannica 1910:520). Lovejoy (1913:55) considers the down-draught

kiln to be inefficient due to the high radiant heat loss and high fuel consumption. Despite these drawbacks, down-draught kilns produced more high grade ware than any other type of kiln simply because they burned uniformly. Again, Lovejoy adds that down-draught kilns were ". . . used universally to burn sewer pipe, and until recently, the only one satisfactory for paving brick and principally used for tile, fireproofing and fire bricks."

The term "continuous kiln" is derived from a design patented in Germany by Friederich Hoffman in 1857. This extremely heat-efficient design was based on that of the regenerative furnaces used in metallurgy.

Hoffman's original design was a circular kiln which was divided into 12 equal-sized chambers (Figure 6). Each chamber had its own doorway, flue, and damper which were connected to the central chimney. Once a fire was set in the furnace in the center of the kiln, the heat was circulated through a portion of the chambers by opening and closing the dampers instead of being permitted to escape as in most types of kilns. As fresh bricks were set in one or two chambers, warm air was allowed to enter to gradually dry them. At the same time, hot air was drawn off the chambers in which the bricks were fired, beginning the cooling stage. The temperature was shifted up or down in each chamber as the bricks (or tiles) completed one stage in the drying, firing, or cooling process and moved on to the next. As each chamber of fired and cooled bricks was emptied, an unfired wet load was put in to take its place. This made the entire process a

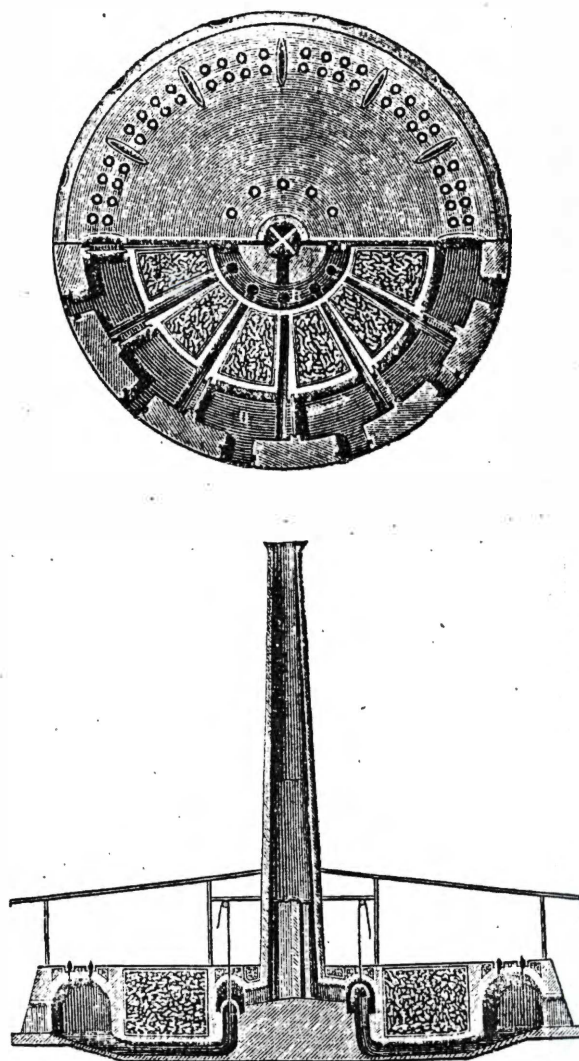


Figure 6. The Hoffman Continuous Kiln. The upper illustration shows the interior arrangement of the firing chambers. The lower illustration shows the kiln in cross-section (Dobson 1868:237-238).

continuous cycle which followed a precise sequence around the chambers of the kiln.

Hoffman and Licht modified the circular design of the continuous kiln to one which was rectangular in 1870. Since gases formed during the firing process can discolor the bricks, Hoffman introduced hot-air flues which carried clean air into the heating chambers from those which were cool. The gases formed in the firing chambers were vented off through the flues to the chimney and not allowed to recirculate.

The invention of the continuous kiln, in conjunction with the stiff mud process, revolutionized the brickmaking industry on both sides of the Atlantic by making it possible to produce good quality bricks from colliery shales. This was of particular importance for the utilization of the coal fields and expansion of the railroad in Lancashire and Yorkshire, England where vast quantities of brick were needed to build tunnels through the hills there (West 1969:5).

The second type of continuous kiln is the tunnel kiln. It is the most efficient kiln for firing large quantities of bricks, a factor which partially accounts for its widespread use in the United States at the present time. The design of the tunnel kiln is based on those used in France in the mid-18th century to fire the overglaze on porcelain. A century later, attempts were made to adapt the tunnel kiln to the brickmaking industry in Denmark in 1840 and in England in 1858. These attempts were unsuccessful because of problems with the seals between the chambers of the kiln and the breakdown of the tunnel cars due to the extreme heat (Rhodes 1968:54). In principle, the

tunnel kiln works like Hoffman's kiln except that it has an opening at each end rather than at each chamber. Wet bricks are put in at one end and warm air gradually dries them. As they enter the central part of the kiln, the bricks are subjected to firing temperatures. At the opposite end, the fired bricks are again surrounded by gradually cooling air. When they emerge from the end of the kiln on tunnel cars, the bricks are completely fired and cooled.

In England, the first successful tunnel kiln was patented by Bock in 1877. Apparently, Bock's design had reduced the problem with the seals but the kiln itself was not long enough to adequately fire bricks. Since the kiln was fueled by coal dropped from the top of the kiln into the chambers, the temperature was also difficult to control (Rhodes 1968:54).

Inventors in the United States were also working on their own versions of the tunnel kiln. The first tunnel kiln patent in this country was issued to John McDonald in 1866. A year later, the first kiln of this type was being used in conjunction with an auger brick machine in a plant near Philadelphia. Probably due to the same problems experienced by Bock, it was unsuccessful (Jeffers 1976:21).

Even though a patent for sand seals in tunnel kilns was issued in 1870, use of this type of kiln in the heavy clay industry did not become popular until about 1915 with the switch to oil for fuel. Part of the reason for the delay in the use of the tunnel kiln was the widespread success of the Hoffman kiln.

In 1913, the continuous kiln (Hoffman's design) was beginning to attract many supporters despite its high initial cost. Lovejoy (1913:56) points out, however, that the price was similar to that of a battery of down-draught kilns of the same capacity. Their advantages were a 50% to 60% saving in fuel since there was little or no waste heat. The continuous kiln was found to work well for firing paving bricks as well as building bricks.

For the person setting up a brickyard in the early 20th century, Lovejoy (1913:555) recommends the circular down-draught kiln if there was sufficient room and the rest of the yard arrangement was properly laid out. Up-draught kilns were the preferred choice for the best yard arrangement but rectangular down-draught and continuous kilns were considered to be almost as adaptable.

The transformation of the craft of brickmaking into a competitive industry did not occur overnight, nor did it take place simultaneously all across the United States. Major manufacturers of brickmaking machines were located primarily in the Northeast (Appendix A). Since the purchasers also had to pay shipping charges on the machines and the engines needed to run them, the cost was extremely prohibitive to brick companies in other parts of the country. For many brickmakers, the capital needed for automation was simply more than they could afford. For the older men, automation also meant having to relearn how to make bricks and they were unwilling to do so. Thus, many of the small brickyards were forced out of the market for technological as well as economic reasons.

Taking their place were men with large amounts of money and various degrees of experience in running a business. Some knew little or nothing about making bricks while others had some experience working in the old non-mechanized yards. The former, if they were good businessmen, hired the latter to set up and run their operations. In fact, Lovejoy (1913:8-9) cites lack of experience as the primary reason for the failure of any brickyard followed by "extravagance in construction, insufficient capital, and bad management or clay." A business could also be seriously jeopardized by inadequate bookkeeping.

With automation, fewer brickyards could meet the needs of local markets. Yards which were strategically located near clay deposits had a lower overhead than those which had to pay to have clay hauled to the yard. Location was also vital to the size of a brickyard's market since those adjacent to a railroad, river, or harbor could compete in distant markets. For this reason, some early 20th century brickyards remained small operations which served a local market while others were able to grow by taking advantage of their location.

In the early 1930s when the nation's economy was in a state of collapse, many brickyards across the country were not able to survive. Some had exhausted their sources of clay and others were heavily in debt. The more successful companies benefitted in two ways. First, they had the opportunity to buy out their failing competitors. Secondly, they could expand their sales areas into markets left open by the companies which had failed.

During the last 50 years, the takeover of smaller brickmaking companies by large corporations has continued. Rising prices for fuel and rail shipment as well as fluctuations in the market can only be absorbed by companies with multi-million dollar assets. As the 20th century draws to a close, the art of making bricks has come full-circle and is again in the hands of a few.

CHAPTER III

THE HISTORY OF BRICKMAKING IN
KNOXVILLE AND KNOX COUNTY, TENNESSEEEarly Settlement.

In 1770 when William Cobb constructed his log house in Kingsport, Tennessee, he was probably unaware that he was making history--the bricks he used to construct the hipped chimneys of his house were the first produced in the state (Yarbrough 1963:34). Despite this early example, bricks were not commonly used for construction in East Tennessee prior to the first quarter of the 19th century. Several factors were responsible for the small amount of early brickwork.

First, the process of making and laying bricks required specialized skills and knowledge which the average person did not possess. In the South, those serving as journeymen or apprentices in the brickmaking craft were subject to competition from skilled slaves. However, despite the presence of these slaves, brickmakers and bricklayers were still in short supply. In Travels to the Westward of the Allegheny Mountains, F.A. Michaux commented that in 1802, brickmasons were "scarcer than carpenters or joiners in Tennessee" (1805:255).

Prior to 1800, the majority of bricklayers came to Tennessee from the surrounding back-country or the Piedmont. A few came from as far away as Philadelphia, Baltimore, or Charleston (Patrick 1981:18). By

1850, however, half the brickmasons in Knoxville and Knox County were natives of Tennessee.

A second factor which affected the availability of bricks in East Tennessee before 1825 was geography. Many items which were not produced locally were shipped inland to the area from the port cities of Philadelphia, Baltimore, and Charleston. "Of these Philadelphia, [one of the major centers of brick production in the 19th century], in 1800 the second largest city in the United States, exercised the greatest influence over the back country . . ." (Patrick 1981:18). Overland shipment of goods by wagon from these cities was slow and expensive; shipment on inland waterways was faster but still costly. Since the early settlers in East Tennessee had to erect shelters against the elements and hostile Indians as quickly as possible, waiting for shipments of bricks to arrive or taking time to have them made locally were not prudent alternatives to building with the materials which were abundant and required little preparation, i.e., wood and stone.

The use of bricks in late 18th century architecture in East Tennessee was also influenced by the nationality of the settlers and craftsmen who first came to the area. For example, the use of post-and-girt framing and half-timbering on the buildings constructed at Fort Loudoun in 1757 and 1758 reflects the European heritage of the soldiers from the English colonies of Virginia and South Carolina. Adapting to local conditions, they substituted stone and earth for the traditional European wattle and daub or brick filling known as

"nogging" which was placed between the upright wall timbers. (According to Perrin [1975:16] mid-19th century German examples of half-timbering in Wisconsin contain nogging of wooden staves covered with mud and straw and pargetted with lime plaster).

Even though framing techniques changed to the use of the braced frame by the 19th century, the practice of filling the walls with "nogging" persisted. This is particularly evident upon examination of early settlement patterns which followed the French Broad and Holston rivers. In Knox County alone, three houses built between 1790 and 1825 which have survived to the present were built with braced frames and "nogging" in the walls (Knox County Historic Sites Survey). No doubt countless other early 19th century houses long since demolished were also constructed using these same techniques.

A second type of early building tradition which reflects nationality is log construction. In America, log construction can be traced to a core of Germanic settlements in the colonies of Pennsylvania, New Jersey, Delaware, and Maryland. As settlements spread, a secondary core area developed to the south of Pennsylvania "along the forelands and valleys in front of the Appalachian Mountain barrier which loomed to the west" (McAlester and McAlester 1984:82). This secondary core tradition subsequently spread across the mountains as settlers moved into East Tennessee. By the middle of the 19th century, the techniques involved in log construction had diffused eastward from the Appalachian domain into Middle Virginia (Glassie 1975:125). Patrick (1981:17) notes that in addition to this primary

and secondary core, the French brought pièce sur pièce log construction techniques down the Mississippi River from Quebec.

The number of building craftsmen in the area increased gradually as these artisans followed settlers into East Tennessee from the Carolinas and Virginia. Census records show that in 1850 there were 17 brickmasons in the city of Knoxville and 11 others in Knox County whose age ranged from 17 to 56 (Table 1). Exactly half of these men were from Virginia, North Carolina, and Kentucky; the other half were born in Tennessee.

Examination of this census data reveals the following significant facts: 1) the majority of brickmasons over the age of 40 were not born in Tennessee; 2) in at least one instance, one of the older brickmasons from Virginia brought two of the youngest men with him, presumably to serve as apprentices; and 3) four of the younger Tennessee brickmasons lived with one of the older men from Virginia. Thus, there is a direct link between early 19th century brickwork in Knoxville and Knox County and the brickmaking traditions of Virginia and North Carolina through the craftsmen who came to live and work in Knox County.

In addition to brickmoulds and other tools of the trade, the Virginia and North Carolina brickmasons brought with them a specific set of traditions which governed both the manufacture as well as the laying of brick. The physical expression of these traditions was manifested in such things as the dimensions of their brick moulds and their skill in executing decorative brickwork, i.e., tangible

Table 1

Brickmasons in Knox County and Knoxville-1850.

	Age	Place of Birth
<u>Knox County</u>		
Lea Brannum	39	TN
Bright Berry Haynes	34	TN
Charles Morrow	45	TN
Meyer W. Wilkinson	40	TN
George R. Wilkinson	19	TN
Charles W. Hunt	35	TN
William W. Graves	31	TN
William Holland	52	KY
John Hackney	56	NC
William Spears	24	NC
Daniel McCoy	38	NC
<u>Knoxville</u>		
William Horner	47	VA
David Weatherford*	23	TN
Riley Clark*	23	TN
William Wilkerson	38	TN
George Wilkerson*	21	TN
Jacob Newman	47	VA
Littleton T. Newman	23	VA
William G. Newman	20	VA
John Lobo	22	TN
John Bico (Bice)	45	VA
Jesse Golden**	18	VA
James Damens**	17	VA
John Dozier**	24	VA
Leonard Middleton	23	VA
Adam Simpson	30	NC
Preston D. Blang	38	TN
Augustus Culler	20	NC

*Boarded with Horner

**Boarded with Bice

Source: Compiled by Laura Elizabeth Luttrell in 1949 on behalf of the East Tennessee Historical Society, Knoxville and was taken from census records for 1850.

characteristics which distinguished North Carolina and Virginia brickwork from that of other regions of the country such as the Hudson Valley.

Even though these factors limited early brickwork, several brick houses were built in Tennessee before 1800. The oldest of these was constructed ca. 1788 in Sumner County. These early brick houses had at least the front wall laid in Flemish bond. Side and rear walls were usually laid in common bond with headers every sixth, seventh, or eight course (Patrick 1981:25).

There were also brick houses in Knoxville in the early 19th century. An article on the early history of Knoxville which appeared in an 1871 issue of the Knoxville Daily Press and Herald stated that in 1816, there were very few buildings east of First Creek and only about four or five brick houses in the entire town. Of these, only the James Park House (Knoxville Academy of Medicine) is still standing today. By 1818, at least one more brick house was constructed. The Craighead-Jackson House was completed that year adjacent to Blount Mansion on a hill above First Creek which overlooks the Tennessee River.

The home of Territorial Governor William Blount, Blount Mansion was one of the earliest frame houses built west of the Allegheny Mountains. (While brickmakers and brickmasons were still rare in Tennessee in 1800, housecarpenters began arriving by the mid-1700s.) Construction began about 1792 and continued until 1796. With the help of slaves, clay was dug from a natural deposit at the foot of the hill

on White's (First) Creek and burned near the construction site (Sullivan n.d.:5). The bricks were used in the foundation, chimneys, and sidewalks. Blount Mansion was undoubtedly one of the frame houses seen by Abashai Thomas in 1795 when he was in Knoxville (Patrick 1981:17).

The older brickmasons who came to Knoxville and Knox County from Virginia and North Carolina influenced local brickwork both in the work they executed as well as in the skills and knowledge they no doubt shared with the younger Tennessee craftsmen. (It would also prove interesting to research the place of birth and occupation of the Tennessee brickmasons' fathers since crafts were often passed from father to son. Such research might reveal additional ties with Virginia as well as other centers of brickmaking.)

A few of these 28 men established permanent locations in Knoxville on one of the creeks or along the Tennessee River adjacent to the natural clay beds. Others settled in small communities throughout the county while the rest found work by traveling from site to site as houses were under construction.

One of the stories which has been mentioned in various locally written manuscripts (e.g., Hicks 1964; and Summers and Ellenburg n.d.) claims that many of the ante-bellum brick houses in Knox County were the work of a single Virginia contractor and his two crews of slaves. Hicks (1964:56) states: "One crew made the brick, the other built the houses." No written documents have been found by this author which support this statement.

In many instances, slave labor was undoubtedly used to help with the construction of the large brick homes of wealthy East Tennessee farmers; however, the guidance of a trained brickmaker (or slave) would have been essential in order for their efforts to have been successful. Due to the relatively small number of slaves in East Tennessee and Knox County, a gang of laborers was sometimes recruited from among the sons and friends of neighbors to assist the moulder at the construction site.

At least one known historical account of the making and burning of bricks in Knox County has survived in the form of entries in the diary of Samuel J. McCammon (1846-1854). A successful farmer, McCammon purchased 200 acres of land from Hugh L. McClung in 1846. The tract was a portion of the estate of General James White, the founder of Knoxville. McCammon and his family occupied the old "saddlebag" log house which was located on the property until 1852 (see Faulkner 1984). In 1849, McCammon hired several local craftsmen to begin working on a brick house which was to sit on top of the rise immediately east of the log house.

In February, two men offered to "do all the brickwork for \$300" (1849:61). The man hired to actually build the house was also supposed to mould, burn, and lay the brick. McCammon was to supply the wood as well as the hands which were needed. Since the actual making of the bricks was to begin August 1, McCammon set about contacting his neighbors in July: "Hired Robert Renfroes sons to bear of brick at \$5 per month in trade bacon" (1849:69).

The builder, Mr. Haynes, brought two men with him to work as brickmoulders. McCammon hired six additional men, five of whom were his neighbors' sons. Apparently, this was still not enough hands since he "went down to the Country" the next day (July 31) "to hire some boys but did not succeed."

Preparation of the site began with the cleaning of the year. Several boatloads of sand were then brought in to prepare a sandbed. Moulding of the bricks began on August 2 but was halted whenever it rained. After two weeks of moulding, the crew had moulded and hacked enough bricks to begin constructing the kiln.

No direct references are made to the methods used to actually assembly the kiln; however, a clamp was probably used since the moulding was being done at the construction site. McCammon uses the phrases: "kilning the brick" and "putting brick in a kiln" (1849:71) which this author interprets as meaning the bricks were assembled into a clamp. Interestingly, the man who was responsible for "kilning the brick" was a different person from any of the moulders. On August 18, 1849, McCammon writes:

Mr. Haynes Came up and brought Mr. Robison to put the brick in a kiln done but little at the brick in Consequence of the rain. . . . August 20 Monday fine day all hands at brick Wm. Robison putting brick in a kiln.

By August 22, all the bricks which had been moulded and dried must have been used to construct the clamp because the hands spent the day hacking brick and no references are made to the kiln. In the midst of numerous related activities which included quarrying for lime (to use in the mortar), cutting and hauling wood, and hauling

boatloads of sand to the site, the moulding of bricks continued for another two weeks.

On Saturday, September 8, the last bricks were moulded by noon, over a month after the crew had begun. The remainder of the following week was spent drying, hacking, and kilning these bricks prior to firing. Final preparations to the kiln itself took another three days but on September 24, "Mr. Haynes came and commenced burning brick kiln." Burning continued through the 28th: "finished halling (sic) wood before night and Suppose we will finish burning brick tonight and finished about 12 o'clock."

Apparently, William Robison's services were either not available or else not required to actually fire and watch the kiln since one of the moulders set the fires. One possible explanation may be that Haynes had been too busy moulding to stop and kiln the brick so Robison was asked to help with only that one task.

Mid-19th Century

By 1850, Knoxville, like the rest of the nation, underwent a period of rapid expansion. Advancements in construction techniques such as prefabricated wall, window, and roofing units, as well as balloon framing coupled with new and improved materials (e.g., plate glass, cast and wrought iron, waterproof composition roofing materials, and high quality brick) greatly facilitated the boom which occurred in the building industry (Rifkind 1980:258).

Between 1850 and 1862, the city of Knoxville grew northward away from the river; however, its eastern and western boundaries continued to be defined by First and Second creeks, respectively. As Figure 7 shows, in just over a decade, High Street had developed parallel to Second Creek and the northern boundary shifted from Clinch (1850) to Vine.

It was during this period that the brickmaking industry in Knoxville also began to grow in response to the surge of expansion. An editorial on the growth of Knoxville in the Sons of Temperance in 1853 mentions that the six or eight brickyards which were in business at the time were unable to keep up with the demand. Sixteen years later in 1869, the Knoxville Daily Press and Herald notes that there were then 15 or 20 brickyards smoking on the outskirts of town and bricks were selling for \$6.50/1,000. The City Directory for that same year lists 34 men employed as bricklayers, brickmasons, or brickmoulders. Only four men were listed as brickmakers: W.T. Lowery, Luke Wilds, J.C. Kinzel, and Joseph Mabry.

The following excerpt from the same directory sums up this growth in brickmaking: "The manufacture of brick has become an important branch of industry furnishing a large amount of excellent building material, and employing hundreds of laborers and very considerable capital" (Knoxville City Directory 1869:47).

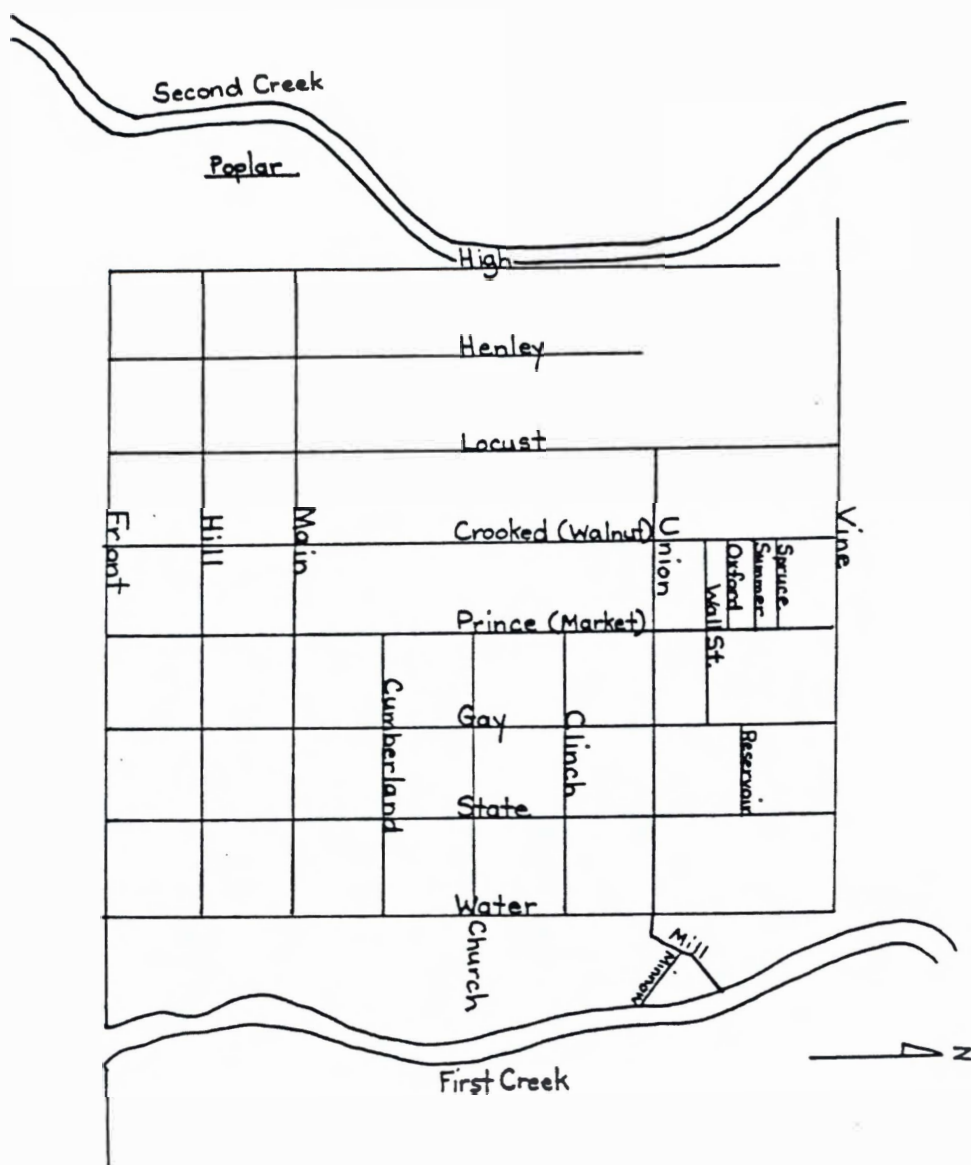


Figure 7. Map of Knoxville about 1850 (Rothrock 1946).

Late 19th Century

Between 1860 and 1900, the population of Knox County more than tripled and in the ten year period from 1880 to 1890, it grew 52% (Rothrock 1946:221). Many of the people who entered Knox County during the second half of the 19th century were drawn to the jobs and economic opportunities available in Knoxville.

For a time during this period of growth, the city experienced a shortage of housing and downtown Knoxville felt the pressure to expand outward and upward. In 1882, an article from the Knoxville Daily Tribune of August 12 refers to the "current building boom" and notes that the hundreds of buildings under construction had created a shortage of building materials. Plate glass windows and pressed brick storefronts were "the order of the day for fine business houses and now our finest residences will be built of pressed brick."

This tremendous surge in population and construction centered around the fact that during the last quarter of the 19th century, Knoxville began to rival Atlanta and Memphis as a Southern trade and manufacturing center. A large jobbing market developed along the north end of Gay Street and Jackson Avenue where several wealthy businessmen headquartered their wholesale houses inside large brick warehouses. These businesses brought a great deal of capital into Knoxville in addition to employing many people and creating a market for service-related businesses. In the areas of Lonsdale and Mechanicsville, foundries and textile mills employed hundreds of workers who lived in newly-constructed houses nearby.

The key to Knoxville's industrial and commercial growth lay in its ties to distant regional markets via the railroads. As early as the 1820s, Knoxvillians such as Dr. James G.M. Ramsey were ardent supporters of efforts to bring the railroads to East Tennessee (Folmsbee, Corlew and Mitchell 1960:379). Ramsey and others realized that rail transportation into the area was a basic prerequisite for long-term economic growth and development.

By the 1850s, Knoxville had already become a wholesale center. Drummers for the wholesale houses carried manufactured goods from the city to the small community stores throughout the county. The growth of railroads through these rural areas made the drummers obsolete: "The railroads greatly increased the wholesale houses' ability to transport their goods to the small towns and country merchants who were the lifeblood of the jobbers [drummers]" (Briscoe 1976:410). Rather than disappear, the drummers adapted to the changing market and later "worked" the railroads, bringing potential customers to their respective wholesale houses.

After the Civil War, there was a regional surge of railroad construction which facilitated the creation of a modern market economy. ". . . the fanning out of railroads from urban centers was an integral part of the modernizing process, tying the natural and human resources of rural areas to the industrializing core" (Eller 1982:65). During the second half of the 19th century, Knoxville enjoyed tremendous growth and prosperity as the industrial core of Knox County.

In response to this growth, the number of brick companies in Knoxville increased during the late 19th century. Between 1880 and 1910, numerous brick companies were in business in Knoxville and Knox County for a period of five years or less and almost nothing is known about them other than their years of operation and location. Others remained in business for several years but changed owners at least once. Long-term successful companies were the exception rather than the rule. A partial chronology of Knoxville's brick manufacturers spanning more than 50 years and based on City Directory listings is presented in Appendix B.

One of the earliest successful companies grew out of the partnership of Leonard Middleton and J.W. Weatherford. Little is known about Middleton except that he was born in Virginia in 1827. By 1850, he was a brickmason in Knoxville (U.S. Census 1850).

Goodspeed (1974:1065) provides some information about Weatherford: He was born in Sullivan County, Tennessee in 1835 and at an early age, began his brickmaking career by working as an off-bearer in a Knoxville brickyard. He returned here after the Civil War and formed a partnership with Middleton in 1866. "Their outfit was a horse and a mud-mill [pug-mill] for which they were in debt. Now they make their bricks by steam power, turning out a daily product of 30,000 bricks."

The 1880 Manufacturing Census (see Table 2) gives the location of Middleton and Weatherford as the Tennessee River, yet in 1882, the Knoxville City Directory states they were near University Avenue and

Table 2

Knox County Brick Yards and Tile Works - 1880.

Name	Middleton & Weatherford	Edward Kinzel	Greenlamb & Ray
Capital	\$4,000	\$1,750	\$2,500
# Employed	35 (28 over age 16)	12 (6 over age 16)	20 (8 over age 16)
Daily Wages	\$2.50 skilled, \$0.45 ordinary labor	\$1.50 skilled, \$0.90 unskilled	\$1.50 skilled, \$0.75 unskilled
Annual Wages	\$6,450	\$800	\$3,600
# Months Worked/Yr.	8 full time, 4 idle (Dec.-Apr.)	6 full time, 6 idle	10 hr. days all year
Cords of Wood	1,000	300	----
# of Bricks Annually	150,000 pressed, 2,000,000 common	----- -----	500,000 pressed, 1,000,000 common
\$ Value of Annual Production	\$12,000	\$1,600	\$8,000
\$ Value of All Materials	\$2,500	\$400	\$2,500
Location	on Tennessee River	-----	-----

Source: United States Bureau of Census, Non-Population Schedules 1850-80. Schedule Nos. 5 and 6, Manufacturing.

West Branner. This location is in Mechanicsville which was annexed into the city in 1883. This location is further substantiated by the Sanborn Insurance Map of 1903 which shows a Middleton and Weatherford Addition immediately east of the intersection of University Avenue and Boyd Street. Middleton and Weatherford made the brick for many homes in this area and some of the buildings of Knoxville College (Knoxville Heritage, Inc. 1981).

On September 8, 1889, the Knoxville Daily Tribune featured an article on local factories which lists a Middleton Brick Factory but it is not know if this is the same as Middleton and Weatherford. The Middleton Brick Factory operated with \$5,000 capital, produced an annual product worth \$25,000 and employed 25 men whose annual payroll was \$8,000. Middleton and Weatherford are not listed in the City Directory by 1890.

In the 1880s it was "now or never" for Knoxville's brickmakers-- automate or go out of business because no one trying to mould bricks by hand could hope to compete with the larger-scale operations which came into being during the next decade. The railroads were also vital to the survival of these automated companies since rail shipment permitted the shipment of finished bricks to distant markets. Proximity to railroad lines was a prime consideration to late 19th century brickmakers since the competitive edge gained by shipping by rail could mean the difference between success and failure.

Establishing a brickyard in the 1880s required large amounts of starting capital, an understanding of the manufacturing process, and most importantly, a keen business sense.

One of the men who had both the capital and business acumen to automate was W.C. Fulcher, a contractor and builder who specialized in wood and brick. In 1882, Fulcher purchased the first steam-powered brick machine ever brought to Knoxville. (Middleton and Weatherford purchased theirs a short time later.) Based upon this author's research, the Monarch Brick Machine used by Fulcher was the first machine in Knoxville which could mass produce bricks. The pug mills and repressing machines operated by hand had been in use for some time; however, the daily production capacity of a brickyard remained low wherever moulding was still done by hand. Machines like the Monarch combined the steps of tempering and moulding. The result was a much higher production rate and the possibility for greatly increased profits.

According to the description provided by an article in the Knoxville Daily Tribune of August 12, 1882, the vertical Monarch machine tempered the clay which was fed into it through a hopper on top then pressure-moulded nine bricks at a time. Three men were needed to dig the clay, two to shovel it into the hopper, and two more to take the bricks from the mould wheel. One boy oiled the moulds while four men carried the bricks to the yard to dry.

The Monarch was built in Hamilton, Ohio by Hoover, Own, Renschler, and Company and was advertised as "P.L. Word's New Improved

Steam Power Brick Machine." The price of the Monarch was \$2,000 and it required a 10 h.p. engine for power. Its capacity was 42 bricks per minute, 2,520 per hour, or 25,000 per day.

The bricks it produced were described as "hard, firm and more compact than any which can be made by the ordinary little hand machine and when borne to the yard are nearly dry enough for the kiln. When burnt they are nearly as smooth as polished marble" (Knoxville Daily Tribune, August 12, 1882). The arrival of the Monarch Brick Machine in Knoxville marked the beginning of a new era in local brickmaking.

Reps Jones, a local businessman and contractor, purchased the title to a tract of Fulcher's property at the intersection of Kentucky and Depot Avenues (Title Bond G1 p. 389). This area is not far from the "Jones Brickyard" shown near Jessamine and Fifth Avenue on an 1886 map of Knoxville (Beck and Pauli 1886).

Thus, Jones may have purchased Fulcher's brickyard. This would explain why Fulcher's name disappears from the City Directory as well as the 1886 reference to a "Jones Brickyard" before he went into business on the south side of the Tennessee River.

In 1887, Jones bought a 10 acre tract off Silver Avenue on the south side of the Tennessee River from his brother, James, for \$5,000. He owned at least 10 more acres by 1890 and set up his brickyard near the Baptist Church and across the road from the slaughter house (Figure 8).

The Knoxville Daily Tribune article of September 8, 1889 states that Jones made both bricks and mortar. At that time, he reportedly

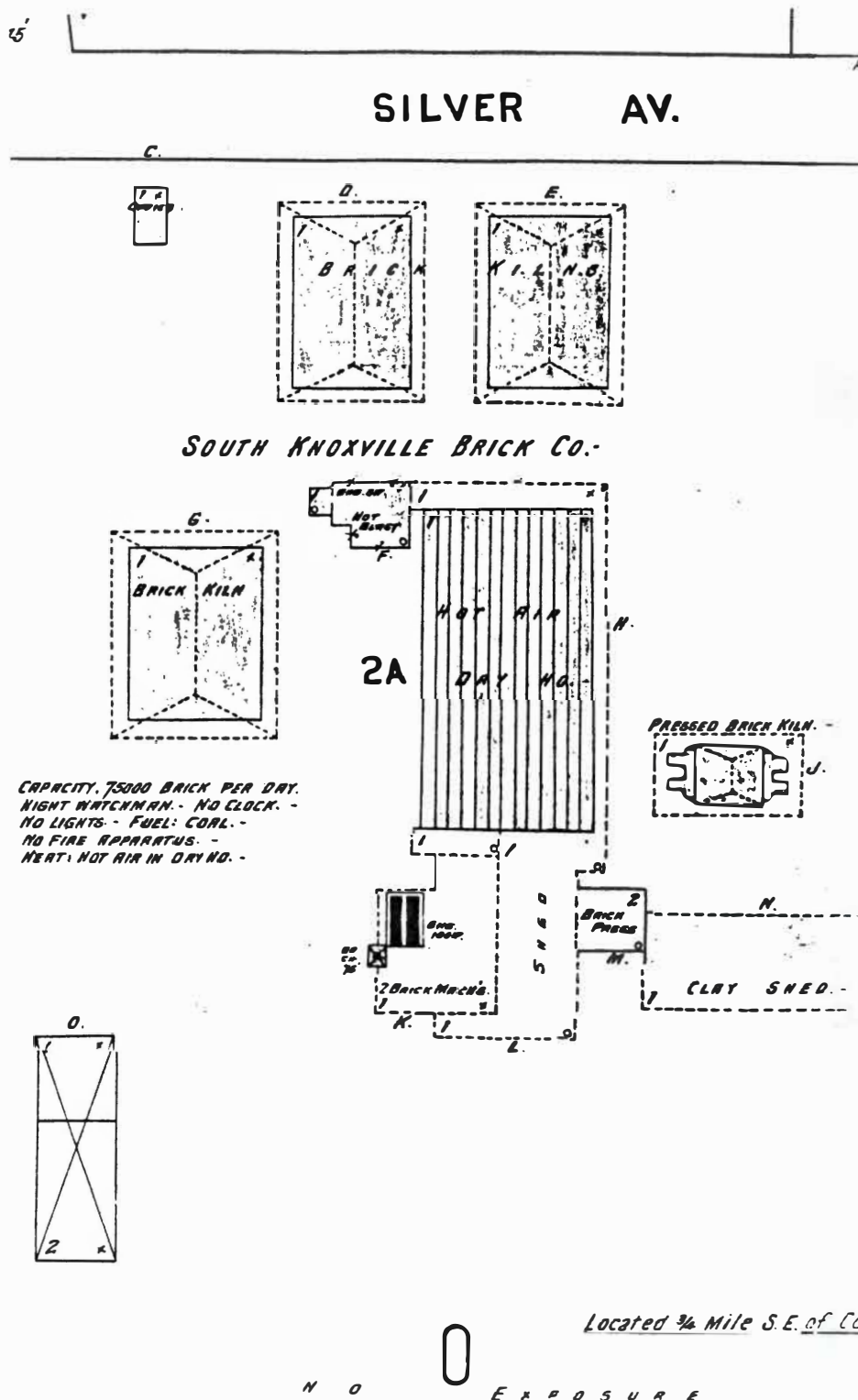


Figure 8. Layout of the brickyard Jones sold to H.B. Branner (Sanborn Insurance Map 1903).

had \$10,000 capital and produced an annual product worth \$20,000 with 20 employees on a \$6,000 annual payroll.

Goodspeed's biographical sketch of Reps Jones provides some additional information about his brickmaking activity in Knoxville (1974:988):

Among the many fine and substantial buildings recently constructed by him may be mentioned the Lyon's View Asylum, girls' high school and the new Knox County courthouse. . . . He also built the Knoxville woolen-mills, and the new Catholic Church. He employs about 125 hands during the building season, and his contracts for 1886 amounted to over \$80,000.

Until the Panic of 1893, Jones' brickyard produced seven or eight million pressed bricks annually. By 1900, this figure had dropped to three million.

Sometime between 1900 and 1903, Jones sold his operation to H.B. Branner who renamed it the South Knoxville Brick Company. The 1903 Sanborn Insurance Map shows the layout of this brickyard (Figure 9). The South Knoxville Brick Company went out of business between 1911 and 1917.

The site of the South Knoxville Brick Company is across the street from the East Tennessee Packing Company and is currently the location of Knoxville Bolt & Screw, Inc., and a parking lot. Construction of buildings on the property and paving of the area surrounding these buildings have doubtless disturbed if not erased all archaeological evidence of kilns and structures.

The Knoxville Brick Company founded in 1888 by Daniel A. Carpenter was Knox County's largest and most successful 19th century



Figure 9. Location of the South Knoxville Brick Company (Sanborn Insurance Map 1903).

brick company. Carpenter purchased 750 acres of land at Powell's Station lying along Emory Road and the Southern Railroad tracks as the site for his brick plant.

Carpenter's family was also in the coal business and he was able to use the large yard at 63 Jacksboro Street as a shipping facility for his bricks via the ETV & G Railroad whose tracks ran past the coal yard. Carpenter also had access to the family's coal to supply his plant's fuel needs.

The Knoxville Brick Company got started with \$100,000 capital and offices at the Jacksboro Street yard as well as at the rear of 148 Gay Street (Knoxville City Directory 1890). J.A. Galyon and Sons served as agents for the company.

Carpenter hired between 70 and 90 men year round and purchased the most modern equipment available for his plant. The machinery was powered by steam generated by wood and coal. The bricks were fired in eight (nine by 1903) kilns housed in wooden framing. Each kiln was covered by a roof which was removed whenever the kiln was in use.

When he started in 1888, Carpenter manufactured only red dry-pressed common brick and his daily production was a mere 75,000. By 1892, production had jumped to 200,000 per day. As the operation grew, new types of brick were added to the production line. By 1903, the Knoxville Brick Company was producing dry-pressed common brick, facing brick, terra cotta, roadway brick, and sidewalk brick (Rule 1900:218). Eventually the product line included red dry-pressed common brick, buff and gray front (facing) brick, terra cotta,

vitrified roadway (paving) brick, and sidewalk brick (Goodman n.d.; Morrison 1891:73; American Journal of Commerce 1903:30). The Knoxville Brick Company supplied the local building industry and shipped by rail to almost every point in Kentucky, Virginia, North Carolina, South Carolina, Georgia, and Alabama (Goodman n.d.).

As shown by Figure 10, Carpenter had eight kilns and several clay sheds. Due to the variety of bricks produced by the Knoxville Brick Company and the two 65 h.p. engines which the Sanborn Map indicates were present, Carpenter had to have at least three or more machines.

Even though it was one of the largest brick manufacturers in the South, the Knoxville Brick Company was a victim of the downturn in the market after the early 1900s; in 1904, daily production had fallen to 135,000. The company was purchased by General Shale in 1934 (Rule 1900:218; Bruce and Mead 1964).

Today nothing remains of the Knoxville Brick Company on Emory Road except a large rectangular depression covered by grass. This site has apparently lain undisturbed since the buildings and kilns were dismantled.

Economics of Brickmaking

During the mid and late 19th century, several books were published by men who had spent their lives as brickmakers and heads of brickmaking companies. These books contained the detailed steps involved in laying out the yards, methods and techniques for manufacturing, and discussions of countless other aspects of

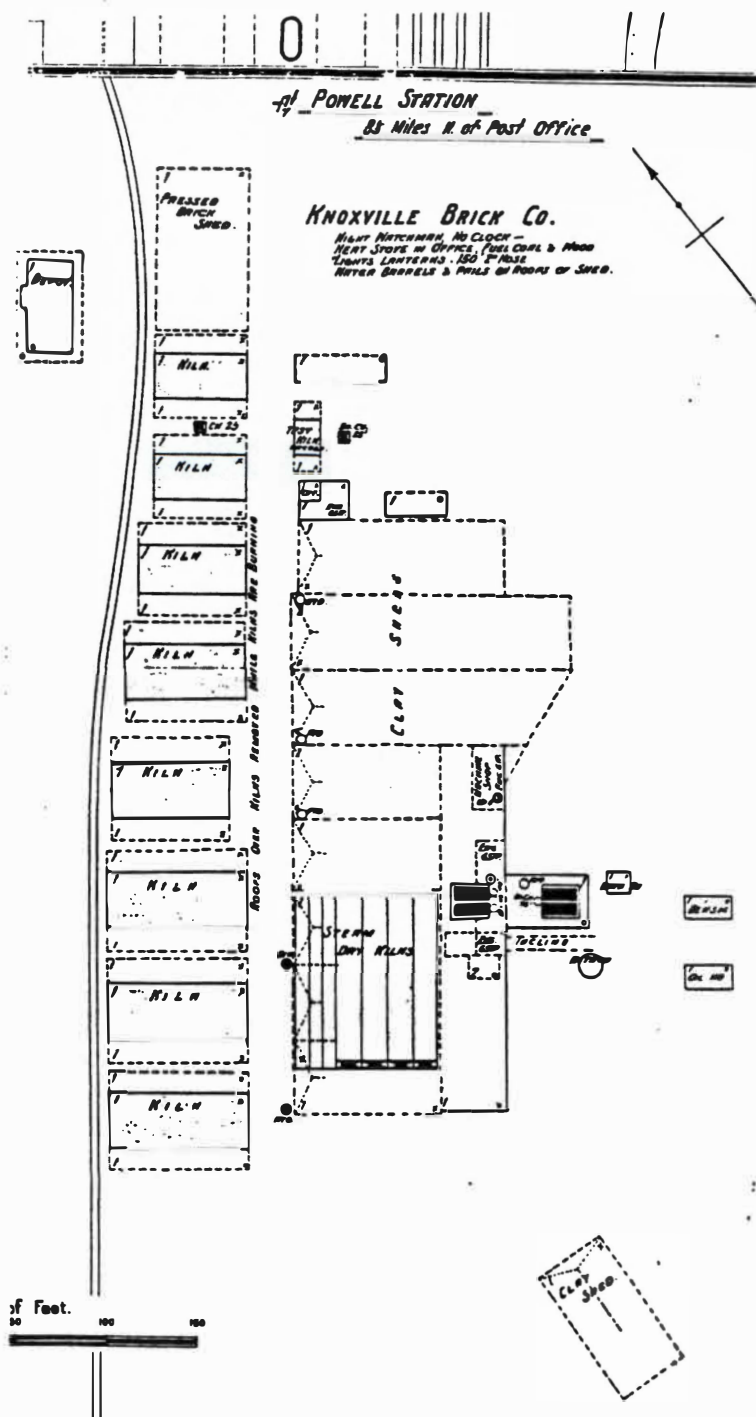


Figure 10. Layout of the Knoxville Brick Company (Sanborn Insurance Map 1903).

brickmaking. The information contained in these books was vitally important to anyone who sought to establish a brickyard in the late 1800s since success depended on location, proximity and type of clay resources available, access to rail shipping, capital, skill of key laborers, and business acumen of the manager or president of the company. These factors functioned as links in a chain; a weakness in any one could cause the company to fail.

A portion of the information from a few of these books is included here as a basis for examining the layout of the South Knoxville and Knoxville Brick companies and discussing how well Jones and Carpenter applied these guidelines in setting up their companies.

The ground surface should be leveled as much as possible before any construction even begins since small irregularities in the surface reduce efficiency when workmen must push loaded wheelbarrows across these areas or horses must pull loaded wagons uphill. Similarly, ramps may be deliberately constructed at strategic locations to facilitate the handling of materials outside the buildings themselves.

The actual arrangement of the buildings of a brickyard may vary but the overall layout should minimize unnecessary labor and all the steps in the manufacturing process should also move toward the kilns. The drying sheds should also be as close to the kilns as possible (Dobson 1868:60-61).

Another important variable in the economics of brickmaking is the location of the clay itself. Ideally, the brickyard should be constructed as close to the clay bed as possible to minimize

transportation costs. Size and quality of the bed is also important: "If a substantial 'plant' is to be made for the manufacture of 'dry press brick' it is necessary to have a bed of considerable depth, homogenous in character from top to bottom" (Crary 1890:10).

With these points in mind, how well did Jones and Carpenter follow these guidelines?

The 1903 Sanborn Map of the Jones and Russell Brickyard does not show the location of the clay shed; however, the clay bed utilized was more than likely adjacent to the Tennessee River. Therefore, Jones' operation would have been more efficient had it been located on the north side of Silver Avenue rather than the south side.

The drying racks used by Jones could have been placed much closer to the main structure where the bricks were made. The use of racks indicates that the bricks were transported by wheelbarrow from the main building to the racks for drying. Before being fired, the bricks had to be moved again from the racks to the kilns--again some distance away.

This layout necessitated handling which could have been reduced and in some instances, eliminated by the use of a conveyor system. Any time the bricks had to be handled, the opportunity for damage to the edges increased. Damaged bricks would have reduced Jones' margin of profit.

The yard arrangement was good in that the kilns were situated adjacent to Silver Avenue. The finished bricks could be loaded onto wagons and shipped without being moved from one end of the plant to

the other. Jones was without access to shipment by rail until 1903 when the Southern Railroad extended its tracks across the Tennessee River adjacent to the brickyard. Until then, Carpenter had a tremendous marketing advantage which may be the reason Jones sold his company to Branner. At some point, an office was constructed off Silver Avenue which made the handling of orders and other business more convenient.

After the brickyard changed hands and became the South Knoxville Brick Company, some money-saving improvements were made. The clay shed was attached to the main building which reduced time and labor. The drying racks were eliminated altogether and the hot air dry house was enlarged. This tactic enabled the plant to use the waste heat from the boilers to dry the bricks. This insured more uniform drying temperatures and enabled the plant to run year round since weather was no longer a factor to consider in drying the bricks.

The 1903 Sanborn Map layout of the Knoxville Brick Company (Figure 10) shows a single clay shed approximately 100 feet from the main building. Several clay sheds were located within the building which kept the clay out of the weather and eliminated the need for hauling from any great distance to supply the machines as long as the sheds were filled. Although no information has been found regarding the location of the clay source used by the Knoxville Brick Company during the late 1800s, it may have been Beaver Creek which runs parallel to Emory Road on the east.

Horses or mules were probably used to transport the clay from the bed to the brickyard. No stable is shown on the Sanborn Map but it could have been located nearby. The presence of the blacksmith's shop also suggests that animals were used for some portion of the operation.

In addition to a large starting capital, choice location adjacent to a railroad, and modern equipment, Carpenter further demonstrated his business acumen in the physical placement of his kilns. Unlike Jones, Carpenter placed all his kilns within 50 feet of the main building where the bricks were made.

A total of 200 horse power was available to run the machinery at the Knoxville Brick Company. According to Lovejoy (1913:69-70), each horse power hour requires three and one-half pounds of coal. A 200 horse power plant would use 16,800 pounds of coal every 24 hours. Carpenter's fuel cost in 1903 was approximately \$8.50 per day. (His actual cost was probably even less due to the fact that J.P. Carpenter was a coal dealer and fuel could be shipped directly to the Powell Station brickyard by rail.)

Only one photograph of the Knoxville Brick company has been located; however, both the South Knoxville and Knoxville Brick companies probably closely resembled the 1884 illustration of the Western Brick and Tile Company of Chicago (Figure 11) (Davis 1884:180).

This illustration clearly shows the layout of the buildings of a late 19th century brickmaking plant where brickmaking machines were in

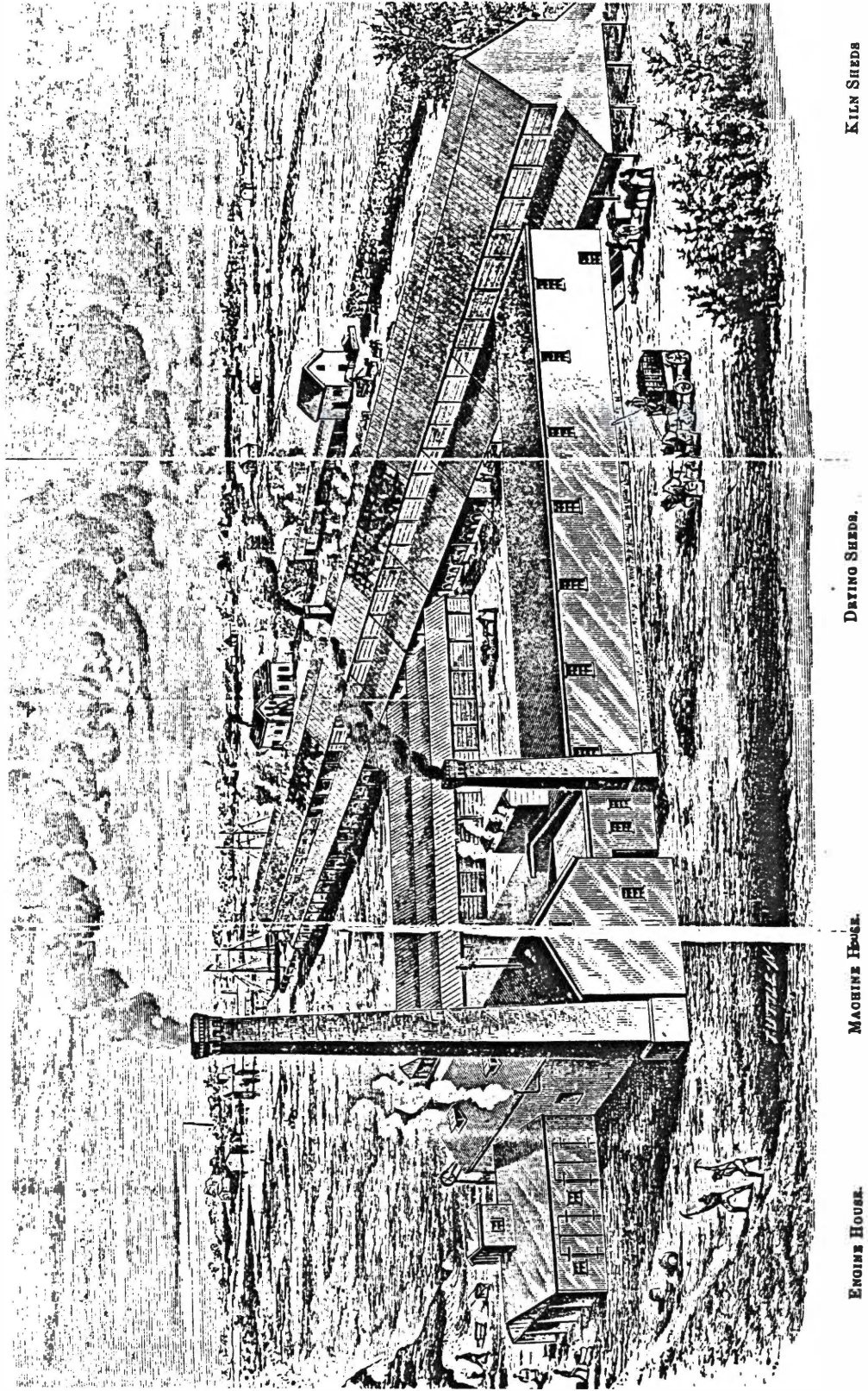


Figure 11. The Western Brick and Tile Company of Chicago (Davis 1884:180).

use. It also provides a view of the wooden structures bracing the kilns and the removable wooden roofs.

In conclusion, Carpenter clearly made better use of the guidelines for laying out his brickyard than did Jones. Given the difference in starting capital between the two men, however, Jones did remarkably well in spite of Carpenter's financial advantage.

Other 19th Century Companies

J.F. Scott chose a site at Tipton's Station for the location of his new brickyard. The Knoxville Daily Tribune of March 20, 1888 reports that Scott ". . . will put in it all the machinery necessary to establish a yard, managed in the best style and fitted with all the recent improvements for brickmaking."

A few days later, more definite plans were made public. Scott chose the location to take advantage of the excellent freight rates on the Knoxville and Augusta Railroad. He started out with a Sword machine powered by a steam engine and hoped to begin production in mid-April. Even before this equipment was delivered, Scott planned to add a Penfield machine at a later date. Daily capacity of the Sword was 20,000 to 30,000 bricks per day while the more powerful Penfield produced 50,000 bricks per day. Since this machine used a different type of clay mixture, Scott hoped that future improvements to his operation would permit the use of the Penfield (Knoxville Daily Tribune, March 24, 1888).

Two years earlier, an ad for the Penfield Brickmaking Machine appeared in the Knoxville Daily Chronicle on April 2, 1886. The Penfield was manufactured in Willoughby, Ohio by J.W. Penfield and Son. The machine featured a vertical pug mill which extruded a horizontal column of clay. This column was cut into bricks at the opposite end of the machine by a hand-operated wirecutter. Dies for the Penfield made it possible to produce either bricks or tiles.

Apparently, J.F. Scott was successful in his efforts; the J.F. Scott Brickmaking Company was listed in the Knoxville City Directory through 1913.

At the same time J.F. Scott was going into business, J.U. Addenbrook started a brick company on the west side of Second Creek just south of Baxter Avenue. This location provided access to freight shipping on the ETV & G railroad which ran parallel to the creek. In 1890, the business was sold to S.A. Caldwell, William Graw, and S.A. Caldwell, Jr. Their operation was quite small with some machinery and six kilns. Daily capacity was 30,000 bricks.

Comparison of the layout of Caldwell, Graw, and Company with that of the Knoxville and South Knoxville Brick companies clearly demonstrates the former was in no position to compete with either Carpenter or Jones. Whether Caldwell, Graw, and Company lacked the capital to expand or ceased operation for other reasons is unknown. The company was out of business by 1895.

The Lonsdale Brick and Pottery Company which began operating in 1904 was much more successful. Established by H.S. Mizner, the

brickyard was located on two and one-half acres of land between the tracks of the L&N and Southern Railroads. Spur tracks ran to the yard from both rail lines and provided excellent shipping facilities. The site was located on the north side of Tennessee Avenue between Burnside and Stonewall immediately east of the Knoxville Iron Company.

T.C. Lundy managed the company which employed 30 men and used modern equipment. The bricks were fired in six down-draught beehive kilns.

The Appalachian Exposition of 1910 featured an exhibition of the product line produced by the Lonsdale Brick and Pottery Company where all colors of dry-pressed face brick, fire brick, and ground fire clay were shown.

The company specialized in ground arch work (shaped decorative brick) and mantel brick. Their advertising stated that Lonsdale bricks were used in the construction of the South's finest homes and were specified in building plans by the "best" architects.

With the wide range of color in addition to the production of fire and mantel brick, the Lonsdale Brick and Pottery Company had a ready market in the modern building construction boom which continued well after the turn of the century. Lonsdale bricks were shipped as far south as Jacksonville, Florida and east to Roanoke, Virginia.

Sometime between 1917 and 1920, the company went out of business (American Illustrating Company 1910:118); Knoxville City Directory 1919:576).

Around 1910, the Alex A. Scott Brick Company was located on the western outskirts of Knoxville in the Bearden area along Kingston Pike. A portion of the site is the present location of the latest eastward expansion of the Homberg Place shopping area. The northern edge of the brickyard reportedly extended to the north side of Kingston Pike at Forest Park Boulevard near the present location of Parker Brothers Ace Hardware (122 Forest Park Boulevard).

A sketchy picture of the operation has been constructed from information provided by the author's conversations with several persons who lived nearby when they were children.

There was a cinder road leading to the brickyard about where Homberg Drive is today. From Kingston Pike south to the Southern Railway tracks, there were rows of red shotgun houses where the brickyard employees and their families lived.

Mrs. Daisy Phillips remembers walking past these houses with her parents on the way to church services and overhearing the wives complaining about the constant noise and soot caused by the steam shovels, the big smokestack, and coal-burning kilns. One of her brothers worked at the brickyard and was a fireman for the kilns. Mrs. Phillips stated that the bricks were "cut off" by the machines which suggests that Scott used an extrusion method and wirecutters (Personal communication 1981).

The last residents to live in the area were Reverend and Mrs. Jackson Rodgers. In an article from the November 3, 1981 issue of the Knoxville News-Sentinel, Mr. Rodgers defines the limits of the

brickyard as: "the area east from Forest Park Boulevard to Mohican Street and south from 'where Kingston Pike is now sitting' to the Southern Railway tracks."

Although the Alex A. Scott Brick Process Company was no longer in business by 1922, Mr. Rodgers recalls playing in the abandoned wooden sheds and brick kilns. The western end of the brickyard property was used as a dumping area for cinders and waste brick that was broken or poorly fired. Mr. Rodgers stated the debris in this area was at least two or three yards deep (Personal communication 1981).

The extensive construction which has occurred in this area would have disturbed and/or destroyed any subsurface remains of kilns and structures from the Scott Brick Process Company.

Corporate Takeovers

The late 19th century period of economic growth and the resulting construction boom which created a market for the bricks produced by these local brick companies faded by the mid-1920s. Economic conditions during the early 1930s forced most of the heavy clay industries in Tennessee out of business. Continuing modernization of brickmaking machinery and tunnel kiln design required the use of shale clays. Many companies did not have access to this type of clay and could not afford the expense of modernizing their operations with new equipment. Companies whose locations were near their market area had a cost advantage over those outlying companies who had to ship their clay products to market (Yarbrough 1963:38).

Even though many small brick companies in Knoxville failed during this period, bricklayers who could find construction work fared well in comparison to other laborers. Their hourly wage of \$1.25 in 1929 was close to that earned by plumbers and far above the \$.30 per hour paid for common laborers (Knoxville Chamber of Commerce 1929).

In the years which followed, the number of independently owned brick companies in Knoxville steadily decreased as companies with vast amounts of capital such as General Shale systematically bought up the struggling local companies. With each takeover, the independents' share of the market steadily declined until it was financially impossible for the small businessman to compete. Thus, in the space of roughly a century, the brickmaking industry in Knoxville came full circle. Even though it was no longer a craft, brickmaking was again in the hands of a few men.

CHAPTER IV

COLLECTION AND ANALYSIS OF DATA

In meeting the last three objectives of this thesis, the following questions must be addressed: To what standard or standards were 19th and early 20th century bricks in Knoxville and Knox County made? Do these standards fluctuate in popularity over time? If there are changes in the popularity of brick standards in the study area, how do they compare with Walker's generalized sequence of changes for the entire United States? Do the factors unique to the study area affect these fluctuations and if so, how? How do the Index Numbers for bricks in the study area compare with those reported by South (1964)?

Thus, in addition to the history of brickmaking in Knoxville and Knox County, Tennessee, it is necessary to focus on the actual bricks made here in seeking answers to these questions. The procedure followed in collecting measurements from whole bricks in the study area is described below.

Data Collection

Length, width, and thickness measurements were taken from whole bricks contained in 31 commercial and residential buildings in Knoxville and Knox County, Tennessee. The temporal distribution of these buildings spans approximately 117 years: ca. 1794 to 1911. Selection of buildings for the sample set was not random but dependent

upon accessibility, owner cooperation, and date of construction.

Effort was made to have each decade between 1794 and 1911 represented by at least one building and whenever possible, by more than one (Appendix C).

Several of the buildings included in the sample set are considered to be historic landmarks in Knoxville and Knox County whose dates of construction and history are well documented by historical records. Information concerning the architect and/or the original owner is also available for most of the private homes which were included in the sample set.

Anthropometric calipers were used to take length, width, and thickness measurements on whole bricks. Where there was obvious variation on any given face, the measurement was taken in the middle of that face or from the portion which appeared to exhibit the least amount of variation from the observable norm. Since access to one header and one stretcher face of each brick was required for the measurements taken, only bricks forming corners were measured.

To minimize the effects of sampling bias, human error, and to compensate for lack of variation within individual courses (rows), 13 bricks were measured from alternate courses on each corner of every building wherever possible. In several instances the sample taken from an individual building falls considerably short of 52 (13 per corner) due to the placement of downspouts, cracked bricks, the proximity of shrubbery, or the presence of ivy. The sample for each

building represents the largest which could be taken when these factors are considered.

Measurements were recorded to the nearest tenth of one centimeter and rounded up if the measurement was .05 or above. Each set of measurements was recorded noting the corner of the building and course number above ground level making it possible to duplicate the data collection if necessary.

A rough outline of the building was sketched and directional corners indicated with the observer always facing North. Additions with different dates of construction were also noted on the sketch. Notes were made on the brick bond(s) used and in cases where there were loose bricks, whether any had impressed centers.

Each of the 31 buildings in the sample set was numbered consecutively in the order they were sampled. An addition or ell whose construction date differed from that of the main portion of the building (or was assumed to differ based on visible stylistic and/or structural differences) was given the main building number followed by consecutive letters of the alphabet. Thus, a single addition or ell to Building 1 built at a different date was numbered "1A". Subsequent additions or ells were numbered "1B", "1C", etc. The bricks from additions and ells with different construction dates were treated as separate buildings for all analysis performed on the data set.

Analysis of Data

In order to permit the comparison of the Knoxville/Knox County brick sample with those discussed by Walker (1971) and South (1964), it was necessary to calculate the Index Number for each of the 1,510 bricks in the sample and determine the standard to which each was made.

The measurements were converted from metric to linear, Index Numbers were calculated, and each brick was assigned to one of the following standards: standard common, English statute/modified English statute, or non-standard. The latter term was applied to those bricks whose dimensions fell outside the limits of the other standards.

Within each standard, each dimension was allowed to vary $\pm 1/4"$ (.25) in order to compensate for differences in types of clay, moulding, and firing conditions. The limits for each standard were:

1. Standard Common: $7 \frac{3}{4}" \times 3 \frac{1}{2}" \times 2"$ to $8 \frac{1}{4}" \times 4" \times 2 \frac{1}{2}"$ ($7.75 \times 3.50 \times 2.00$ to $8.25 \times 4.00 \times 2.50$).
2. English Statute: $8 \frac{1}{4}" \times 3 \frac{3}{4}" \times 2 \frac{1}{4}"$ to $8 \frac{3}{4}" \times 4 \frac{1}{4}" \times 2 \frac{3}{4}"$ ($8.25 \times 3.75 \times 2.25$ to $8.75 \times 4.25 \times 2.75$).
3. Modified English Statute: $8 \frac{1}{4}" \times 3 \frac{3}{4}" \times 2"$ to $8 \frac{3}{4}" \times 4 \frac{1}{4}" \times 2 \frac{1}{2}"$ ($8.25 \times 3.75 \times 2.25$ to $8.75 \times 4.25 \times 2.50$).
4. Non-Standard: $\leq 7 \frac{3}{4}"$ or $\geq 8 \frac{3}{4}"$ in length, $\leq 3 \frac{1}{2}"$ or $\geq 4 \frac{1}{4}"$ in width, or $\leq 2"$ or $\geq 2 \frac{3}{4}"$ in thickness (≤ 7.75 or $\geq 8.75 \times \leq 3.50$ or $4.25 \times \leq 2.00$ or ≥ 2.75).

Figure 12 shows the distribution of all the bricks in the sample by standard. A further breakdown of this information is provided in Table 3 which shows the same distribution by building as well as by standard.

Standard Common

There are two distinct periods when standard common bricks are found in the buildings sampled. Between 1794 and 1823, all except one of the eight buildings from this period contain two or more standard common bricks. In the James Park House (#29) and a portion of Statesview (#5) nearly half of all the bricks sampled belong to this standard. The highest concentration of standard common bricks (85.7%) is in the Craighead-Jackson House (#3).

From 1825 to the last quarter of the 19th century, standard common bricks are rarely present in the buildings sampled. A few are found in buildings constructed in 1842, 1849, and ca. 1850. During the last quarter of the century when the production of machine-made bricks began in the study area, the number of standard common bricks increases.

English Statute and Modified English Statute

English statute bricks are present in all but four of the buildings in the sample. The highest concentrations are in buildings constructed after 1850; however, their numbers fall dramatically after 1890.

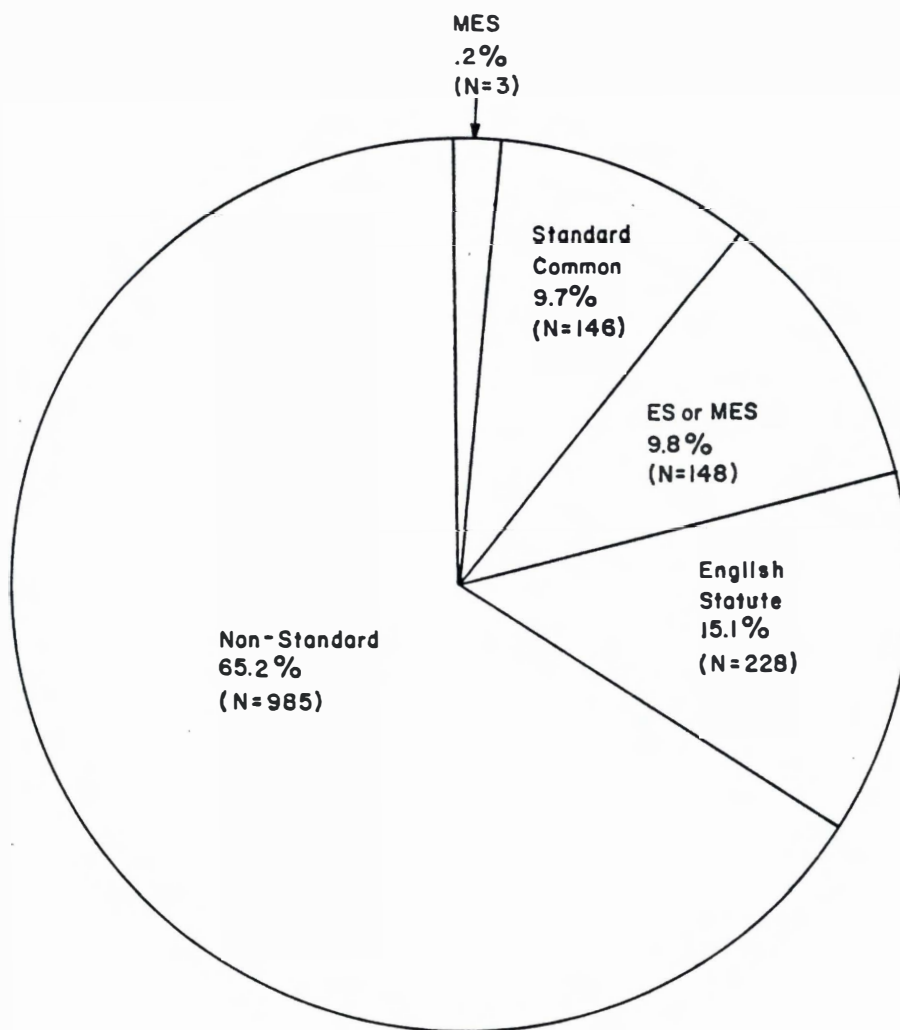


Figure 12. Distribution of the Sample Set by Standard.

Table 3
Distribution of Bricks by Building and Standard.

Building #	Total # Sampled	English Statute	Modified English Statute	ES/MES	Standard Common	Non-Standard	% of Total # Sampled
4	29	2	0	0	3	24	82.8
5	17	0	0	1	5	11	64.7
29	33	3	3	0	15	12	36.4
3	49	1	0	1	42	5	10.2
8	18	2	0	0	2	14	77.8
5A	52	0	0	0	24	28	53.8
24	29	2	0	0	0	27	93.1
13	24	0	0	0	0	24	100.0
10	35	20	0	0	0	15	42.9
21	38	1	0	0	0	37	97.4
14	26	2	0	0	0	24	92.3
9	52	1	0	0	0	51	98.1
8A	37	3	0	1	4	29	78.4
20	53	0	0	0	0	53	100.0
19	51	1	0	1	4	45	88.2
15	38	1	0	0	0	37	97.4
15A	15	0	0	0	0	15	100.0
25	46	9	0	1	0	36	78.3
7	51	16	0	0	0	35	68.6
2	73	16	0	0	5	52	71.2
31	34	7	0	0	0	27	79.4
16	52	1	0	0	0	51	98.1
18	52	6	0	0	0	46	88.5
12	47	19	0	0	1	23	48.9
25A	6	3	0	0	0	3	50.0

Table 3 (continued)

Building #	Total # Sampled	English Statute	Modified English Statute	ES/MES	Standard Common	Non-Standard	% of Total # Sampled
17	46	23	0	3	0	20	43.5
1	49	8	0	0	0	41	83.7
11	52	3	0	1	0	48	92.3
28	52	1	0	0	0	51	98.1
6	52	16	0	5	0	31	59.6
22	52	37	0	12	1	2	3.8
26	52	18	0	14	0	20	38.5
27	52	0	0	48	2	2	3.8
30	52	4	0	30	14	4	7.7
23	65	0	0	26	3	36	35.4
6A	29	2	0	0	21	6	20.7
Total		228	3	148	146	985	

Only three bricks are clearly modified English statute, i.e., their dimensions do not fall on the overlap between the limits of modified English statute and English statute bricks. All three are in Building #29 constructed in 1812 (James Park House).

Fourteen buildings contain bricks which could be classified as either English statute or modified English statute. In Buildings #27, #30, and #23, these bricks represent 92.3%, 65.4%, and 40% respectively, of all the bricks sampled in those buildings. The bricks from these three buildings are machine-made.

Non-Standard

The measurements of over 65% of the bricks in the sample fall outside the limits for standard common, English statute, or modified English statute and are classified as non-standard. All the buildings sampled contain non-standard bricks although the frequency in any one building ranges from a low of 3.8% (#22) to a high of 100% (#13, #20, and #15A).

The high number of non-standard bricks and their distribution throughout the sample set prompted new questions:

1. Which dimensions are consistently outside the limits of the other standards?
2. Is the variability in these dimensions fairly consistent throughout the period of time represented by the sample or are there patterns of variability linked to method of manufacture?

3. If the variability is fairly consistent, does it signify another standard or standards to which bricks were being made in Knoxville and Knox County?

The information presented in Table 4 partially answers these questions. As shown by the numbers in the English statute/modified English statute and standard common columns, every building in the sample set contains bricks having two dimensions within the limits of one of these standards.

Of the 985 non-standard bricks in the sample set, 311 have two dimensions within the limits for standard common bricks and 434 have two dimensions within the limits for English statute/modified English statute bricks. For each of these standards, the two dimensions within the limits occur in all three possible combinations: length and width, length and thickness, and width and thickness. The totals for these various combinations are listed at the end of the respective columns in Table 4.

The totals in the last six columns of Table 4 reflect the amount of variability in each single dimension. Thickness is the dimension most often outside the limits for each standard: 559 bricks are too thick while only one is too thin. Similarly, 147 bricks are too wide and 17 are too narrow. Length is the only dimension where more bricks are below the limit (102) than above it (45).

Even though variability is present in all three dimensions, it is inconsistent in the dimensions of length and width. In these four columns, bricks above or below the limits are concentrated in a few

Table 4

Distribution of Non-Standard Bricks by Building and Dimensional Pairs.

Building #	ES/MES L & W ^a	SC L & W ^b	ES/MES W & T ^c	SC W & T	ES/MES L & T	SC L & T	L > 8.75"	L < 7.75"	W > 4.25"	W < 3.50"	T > 2.75"	T < 2.00"
4	1	13	0	4	0	0	0	8	0	0	10	0
5	0	5	1	4	0	0	0	5	0	0	0	0
29	0	2	0	5	2	0	0	8	0	0	0	0
3	0	1	0	2	1	0	0	2	0	0	0	1
.8	1	1	4	0	7	0	0	0	0	0	0	0
5A	0	5	2	20	0	0	0	23	0	0	0	0
24	1	17	0	0	1	0	0	1	0	3	22	0
13	3	4	2	0	0	0	0	0	0	0	21	0
10	7	0	7	0	0	0	0	0	0	0	8	0
21	0	36	1	0	0	0	0	0	0	0	24	0
14	4	0	0	0	1	0	19	0	12	0	19	0
9	28	0	0	0	0	0	0	0	23	0	51	0
8A	9	1	2	0	1	4	6	0	11	0	20	0
20	0	29	17	2	0	0	0	21	0	0	9	0
19	5	22	5	5	0	0	0	11	0	0	12	0
15	1	30	3	0	0	0	0	0	0	0	16	0
15A	0	15	0	0	0	0	0	0	0	0	10	0
25	22	0	1	0	0	0	4	1	7	0	35	0
7	10	0	13	0	0	0	0	0	0	0	23	0
2	35	0	2	0	2	0	1	0	9	0	48	0
31	10	9	3	0	0	0	1	0	0	0	19	0
16	0	34	0	0	3	0	0	0	0	14	30	0
18	12	5	4	0	0	0	0	0	1	0	40	0
12	4	0	17	0	1	0	0	0	2	0	4	0
25A	0	0	0	0	3	0	0	0	3	0	0	0
17	11	0	2	0	4	0	1	0	5	0	12	0

Table 4 (continued)

Building #	ES/MES L & W ^a	SC L & W ^b	ES/MES ^c W & T	SC W & T	ES/MES ^d L & T	SC L & T	L > 8.75"	L < 7.75"	W > 4.25"	W < 3.50"	T > 2.75"	T < 2.00"
1	19	1	3	0	0	0	4	3	14	0	36	0
11	37	0	0	0	1	0	0	0	7	0	47	0
28	24	11	6	0	0	0	0	0	4	0	41	0
6	1	0	2	0	23	0	7	0	28	0	2	0
22	0	2	0	0	0	0	0	0	0	0	0	0
26	0	0	2	0	17	0	3	0	18	0	0	0
27	0	0	0	0	2	0	3	0	2	0	0	0
30	0	0	3	0	0	1	0	0	0	0	0	0
23	0	0	24	12	0	0	0	19	0	0	0	0
6A	0	0	5	0	1	0	0	0	1	0	0	0
Total	245	243	131	54	62	17	49	102	147	17	559	1

^aEnglish statute/Modified English statute length and width.^bStandard common length and width.^cEnglish statute/Modified English statute width and thickness.^dEnglish statute/Modified English statute length and thickness.

buildings rather than occurring throughout the sample. Consistency occurs only in the $T \geq 2.75$ " column where most of the buildings in the sample contain bricks which are above this limit.

The 102 bricks which are too short ($L \leq 7.75$ ") are concentrated in 11 buildings. Six of the 11 were built before 1826. Three of the pre-1826 buildings were within the city limits of Knoxville at the time they were constructed: Blount Mansion (#4), the James Park House (#29), and the Craighead-Jackson House (#3). Since there were so few house carpenters or brickmoulders in the study area during this period, the same man (or partnership) could well have been involved in the construction of two or all three of these houses. If so, it is also likely that some of the same brick moulds were also used. The five remaining buildings with short bricks were built in 1840, 1842, 1857, and 1911.

Bricks which are too long ($L \geq 8.75$ ") are in ten buildings which are scattered throughout the sample set and the study area.

The 17 bricks which are too narrow ($W \leq 3.50$ ") are in two buildings: the Robert Gray (Roddy) House (#24) and the Masonic Hall in Concord (#16). Although both were in west Knox County, a connection between the two based on the presence of these narrow bricks is unlikely due to their spatial and temporal distance.

Wide bricks are present in 14 buildings and appear more consistently during the second half of the 19th and early 20th centuries than before 1850. Wide bricks occur in three houses built ca. 1835: an ell of the Luttrell House (#8A), the Matt Russell House

(#14), and the Avery Russell House (#9). The last two houses are less than one mile apart on Kingston Pike and were built for two members of the same family. If the same brickmaker worked on both houses, this would account for the presence of the wide bricks in each one.

After 1850, wide bricks are present in almost every decade represented by the sample set. The latest building to have wide bricks is the 1921 addition to the Knox County Courthouse (#36A).

As stated earlier, the dimension of thickness displays the most consistency with most buildings in the sample set containing bricks >2.75" thick. There is a pattern in this column of Table 4 which is different from the others.

Since the buildings are listed in chronological order in Table 4, it is quite evident that large numbers of thick bricks are in almost every building beginning with the earliest (Blount Mansion [#4]). This pattern stops abruptly with Building #6 (Knox County Courthouse-1885 portion) where only two of the 52 bricks sampled are too thick. The last six building in the sample set contain no bricks >2.75" thick.

The sudden change in pattern coincides with the appearance of machine-made brick in the sample set. Numbers from Table 3 (pp. 91-92) and Table 4 indicate that this change is reflected by the number of bricks which fit each standard:

1. there is an increase in the number of English statute, English statute/modified English statute, and standard common bricks;

2. in over half the buildings with machine-made bricks, the number of non-standard bricks is close to zero; and
3. width, rather than thickness causes the bricks to be classified as non-standard.

How closely does the Knoxville/Knox County area of Tennessee parallel Walker's proposed sequence of changes in brick size? First, he suggests an early tradition measuring 9" x 9 1/4" in length, 2 3/8" to 2 5/8" in thickness, and 4" to 4 1/2" in width. This tradition lasted from the 17th century until the 1860s (Walker 1971:52).

Although none of the buildings in the sample set were constructed during the 17th century, the earliest (Blount Mansion) was completed before the end of the 18th century and the period from 1800 to the 1860s is well represented. Yet, none of the 1,510 bricks in the sample set are 9" to 9 1/4" in length, regardless of when they were made. The longest brick in the sample set is in the Matt Russell House built ca. 1835 (#14) and measures 8.976". The second longest brick comes from the opposite side of the county from the Armstrong House ca. 1850 (#31) and measures 8.795".

The thickness of bricks in the study area exceed Walker's proposed width until the appearance of machine-made brick around 1885. From 1885 to 1911, the thickness of Knoxville/Knox County bricks is close to 2 3/8" to 2 5/8".

There are two general widths for bricks in the study area: 3 1/2" to 4" and 4" to 4 1/2". Each of the these groups is

distributed temporally throughout the sample. Bricks 4" to 4 1/2" are just as common after the 1860s as before.

The second part of Walker's sequence concerns the distribution of modified English statute and standard common bricks. According to Walker (1971:52) these began to appear in the early 19th century, were very common around 1850, and replaced the earlier tradition by the 1860s.

Due to the nearly identical limits of English statute and modified English statute bricks, the distribution of both these standards must be considered. Table 3 (pp. 91-92) shows that the number of English statute and English statute/modified English statute bricks does increase toward the middle of the 19th century (Buildings #25 to #1). Standard common bricks, however, do not become more popular at mid-century. They are most common prior to 1825 and after 1900. (Even if the non-standard bricks from Table 4 [p. 95-96] having two dimensions fitting these standards are included, the trend in the sample set remains the same.)

The next part of Walker's sequence has the standard common brick replacing the modified English statute brick by the 1880s. This does not happen in the Knoxville/Knox County sample. In Buildings #6, #22, #26, #27, #30, #23, and #6A (1885 to 1921), the number of English statute/modified English statute bricks is consistently higher than any time before 1885 and with the exception of Building #6A, always exceeds the number of standard common bricks.

Walker's last point is fact not theory and is not of itself open to debate. The standard common brick was adopted as the standard brick size by the Common Brick Manufacturers Association prior to the 1930s. Although the sample set does not extend beyond 1921, the sudden reduction in the number of English statute/modified English statute bricks in Building #6A may reflect the trend toward the later adoption of the standard common brick size.

To summarize, the sequence of changes in brickmaking in the Knoxville/Knox County area of Tennessee differs from that proposed by Walker in several ways. First, the dimensions of bricks from 1794 to the 1860s are not as long and are thicker than Walker's limits for the early standard. The width of bricks in the sample set does fit the early tradition; however, the width remains constant even after the 1860s. Width and thickness of Knoxville/Knox County bricks do not fit Walker's early tradition until the appearance of machine-made bricks in 1885. Thus, Walker's early tradition is not represented in the study area.

Secondly, standard common bricks do not become more popular at mid-century. Instead, they are the most popular before 1825 and after 1900. Standard common bricks also do not replace modified English statute bricks by the 1880s. In the study area, the popularity of English statute/modified English statute bricks exceeds that of standard common bricks in the 1880s.

The sequence of changes in brick size in the sample set agrees with Walker's generalized sequence on two points:

1. the popularity of English statute and modified English statute bricks does increase near the middle of the 19th century; and
2. in the early 20th century, the standard common brick was adopted as the standard brick size.

A Standard for Non-Standard Bricks?

Do the dimensions of the non-standard bricks from the sample set fit a different standard or standards or do their measurements merely reflect the moulder's inability to control certain variables such as shrinkage? Since it is impossible to question the men who moulded these bricks, attempts to answer this question must be based on further examination of the data.

Seven hundred forty-five of the 985 non-standard bricks have two dimensions which fall within the limits of either standard common or English statute/modified English statute standards; i.e., only one dimension causes these bricks to be classified as non-standard. This non-standard dimension occurs in all possible combinations with the two conforming dimensions. These combinations are shown as the headings for the six columns of Table 5. The numbers in each column are the average values for the non-standard dimension.

For example, the average thickness (the non-standard dimension) of bricks in Building #4 whose length and width fit the limits of standard common bricks is 2.662". The last number in each column represents the average amount that particular dimension deviates from

Table 5

Average Measurements of Non-conforming Dimensions.

Building #	$\bar{x}$ T of SC L & W	$\bar{x}$ T of ES/MES L & W	$\bar{x}$ W of SC L & T	$\bar{x}$ W of ES/MES L & T	$\bar{x}$ L of SC W & T	$\bar{x}$ L of ES/MES W & T
4	2.6620	2.7559	-----	-----	7.4311	7.6155
5	2.5827	-----	4.0945*	-----	7.5295	7.7165*
29	2.5984	-----	4.0158*	-----	7.6063	-----
3	1.9685*	-----	4.0158*	-----	7.0473	-----
8	2.6378*	-----	4.0776	-----	-----	8.1398
5A	2.5669	-----	-----	-----	7.5925	7.6378
24	2.8346	2.8346*	4.0551*	3.6614	-----	-----
13	2.7953	2.9265	-----	-----	-----	7.9331
10	-----	2.7840	-----	-----	-----	8.1777
21	2.6039	-----	-----	-----	-----	8.0709*
14	-----	2.7854	-----	4.2913*	-----	-----
9	-----	2.9949	-----	-----	-----	-----
8A	2.5591*	2.8346	4.1240	4.3701*	-----	8.5236
20	2.6880	-----	-----	-----	7.6378	7.7165
19	2.6449	2.8150	-----	-----	7.5276	7.8583
15	2.6391	2.7953*	-----	-----	-----	8.1234
15A	2.7559	-----	-----	-----	-----	-----
25	-----	2.8239	-----	-----	-----	8.1890*
7	-----	2.7707	-----	-----	-----	8.1526
2	-----	2.8538	-----	4.3898	-----	8.1102
31	2.7603	2.7913	-----	-----	-----	8.1365
16	2.7721	-----	-----	3.5696	-----	-----
18	2.7795	2.8478	-----	-----	-----	8.1988
12	-----	2.7690	-----	4.2913*	-----	8.6565
25A	-----	-----	-----	4.3570	-----	-----
17	-----	2.8275	-----	4.3307	-----	8.1890

Table 5 (continued)

Building #	$\bar{x}$ T of SC L & W	$\bar{x}$ T of ES/MES L & W	$\bar{x}$ W of SC L & T	$\bar{x}$ W of ES/MES L & T	$\bar{x}$ L of SC W & T	$\bar{x}$ L of ES/MES W & T
1	----	2.9507	----	----	----	7.6116
11	----	2.7963	----	4.3709*	----	----
28	2.7380	2.8642	----	----	----	8.1496
6	----	2.7559*	----	4.3495	----	8.7795
22	2.5394	----	----	----	----	----
26	----	----	----	4.3261	----	8.8976
27	----	----	----	4.3110	----	----
30	----	----	4.1732*	----	----	8.2021
23	----	----	----	----	7.3425	7.8597
6A	----	----	----	4.482*	----	8.0709
Total	2.6382	2.8289	4.0794	4.2359	7.4643	8.1087
Above(+)/ Below(-) Limit	+0.1382	+0.0789	+0.0794	within limit	-0.2857	0.1413

*Measurement based on one brick only.

the limits of the given standard. It should be noted, however, that these numbers are averages of averages and as such, are at best, only broad indicators of deviation in the non-standard dimensions.

As the numbers from Table 5 show, the averages for the individual buildings do not markedly deviate from the limits of the standards. Since two of all these 745 bricks' dimensions are within the limits of either standard common or English statute/modified English statute bricks and the non-standard dimension is only marginally above or below these limits, it seems reasonable to assume that these 745 bricks also represent attempts to produce bricks fitting these standards.

Table 6 shows the change in the distribution by building and standard when these 745 bricks are added to the totals from Table 3 (p. 91-92). English statute/modified English statute bricks increase to 53.8% of the total sample and standard common bricks increase to 30.3%. Non-standard bricks decrease from 65.2% to 15.9%.

Standard common bricks now appear in the sample set in far greater numbers. They occur in almost every building sampled until ca. 1850, which gives this standard approximately 25 additional years of popularity over the distribution shown in Table 3 (p. 91-92). As before, the second period of popularity occurs with the appearance of machine-made bricks in the study area.

English statute/modified English statute bricks occur in all buildings sampled with the exception of #15A, a rear addition to the Kearnes House. This single exception may very well be inaccurate due

Table 6
Revised Distribution of Bricks by Building and Standard.

Building #	Total # Sampled	ES/MES	Standard Common	Non-Standard	% of Total # Sampled
4	29	3	20	6	20.7
5	17	2	15	0	0.0
29	33	6	23	4	12.1
3	49	2	46	1	0.0
8	18	6	10	2	11.1
5A	52	2	49	1	1.9
24	29	6	18	5	17.2
13	24	5	4	15	62.5
10	35	34	0	1	2.9
21	38	2	36	0	0.0
14	26	7	0	19	73.1
9	52	29	0	23	44.2
8A	37	16	9	12	32.4
20	53	17	31	5	9.4
19	51	11	31	9	17.6
15	38	4	30	4	10.5
15A	15	0	15	0	0.0
25	46	33	0	13	28.3
7	51	39	0	12	23.5
2	73	55	5	13	17.8
31	34	20	9	5	14.7
16	52	4	34	14	26.9
18	52	22	4	26	50.0
12	47	45	1	1	2.1
25A	6	6	0	0	0.0
17	46	42	0	4	8.7

Table 6 (continued)

Building #	Total # Sampled	ES/MES	Standard Common	Non-Standard	% of Total # Sampled
1	49	30	1	18	36.7
11	52	42	0	10	19.2
28	52	31	11	10	19.2
6	52	47	0	5	9.6
22	52	49	3	0	0.0
26	52	51	0	1	1.9
27	52	49	2	1	1.9
30	52	37	15	0	1.9
23	65	51	14	0	0.0
6A	29	8	21	0	0.0
Total		813	457	240	
% of Total Sample Set		53.8	30.3	15.9	

to the small number of bricks in the sample from this addition. The highest concentrations are in buildings constructed after 1850 and they continue to dominate the sample into the early 20th century.

The remaining non-standard bricks represent from 0.0% to 73.1% (Building #14, ca. 1835) of all the bricks sampled in any single building. Virtually every building in the sample contains non-standard bricks in Table 3 (p. 91-92). In the revised distribution, there are no non-standard bricks in eight buildings and 14 others have five or fewer non-standard bricks. Buildings constructed of machine-made brick have extremely low numbers of non-standard brick. This is to be expected since machine-moulding is more precise than moulding by hand. Changes in the types of clay used as well as greatly improved firing techniques would also decrease the amount of variability in the dimensions of bricks produced near the end of the 19th and into the 20th centuries.

The revised distribution does not alter the statements made earlier with regard to Walker's proposed sequence of changes in brick size, however.

For the 240 bricks having two or more non-standard dimensions, average dimensions were calculated by building. The range for each dimension is:

length	7.559" to 8.866"
width	3.700" to 4.285"
thickness	2.677" to 2.925"

Allowing $\pm 1/4"$ (.25) variation in each dimension, this group of non-standard bricks requires three standards to encompass these ranges:

1. $7 \frac{3}{4}" \times 3 \frac{5}{8}" \times 2 \frac{5}{8}"$;
2. $8 \frac{1}{4}" \times 4 \frac{1}{8}" \times 2 \frac{3}{4}"$; and
3. $8 \frac{3}{4}" \times 4 \frac{3}{8}" \times 2 \frac{3}{4}"$

Some of the limits for these standards overlap with those for standard common and English statute/modified English statute bricks.

When the averages are arranged in order from smallest to largest by the dimension of length, the corresponding building numbers are randomly ordered. Thus, there seems to be no time when one of these standards replaced another. If they are valid, these standards were in use within the study area for over a century.

The individual bricks upon which the average dimensions are based have at least two dimension which are non-standard. A certain amount of this deviation is obscured by the process of averaging yet an interesting fact still emerges: In nearly all the buildings containing these non-standard bricks, at least one of the average dimensions is within the limits of standard common or English statute/modified English statute standards. Twelve buildings have two average dimensions within these limits.

The averages which are above or below these limits range from .01" below to .44" above. Most are above the limit by less than .25". If the limits for these standards are extended only slightly, the average dimensions for this group of non-standard bricks come very

close to being with the limits for standard common or English statute or modified English statute bricks.

Index Numbers.

Figure 13 shows the average Index Number for each building in the sample set. The buildings are arranged in chronological order from bottom to top of the y-axis. Non-standard bricks are shown as a single group for the sake of clarity.

Using the same limits shown on page 88, Index Numbers for standard common bricks are 106 to 118 and 112 to 126 for English statute/modified English statute bricks. Index Numbers for non-standard bricks are ≤ 102 or ≥ 129 .

Each of the plotted averages for bricks classified as non-standard falls between 102 and 129 rather than below or above these numbers. There are 14 bricks in the data set whose Index Numbers are ≤ 102 or ≥ 129 . Building #29 and #3 each have one brick with an Index Number of 101. As there is over one inch difference between the lengths of these two bricks, they cannot represent a different brick standard. The remaining 12 bricks have Index Numbers of 129 and 130. They occur in Building #1, #14, #25, and #9. These bricks do fit a different single standard of $8 \frac{3}{4}" \times 4 \frac{1}{2}" \times 2 \frac{3}{4}"$.

Index Numbers of the bricks studied by South in 1964 formed two distinct clusters which were dependent upon the century they were made. Bricks moulded during the 17th, 18th, and 19th centuries had Index Numbers of approximately 116 to 128. Twentieth century standard common bricks are smaller with an Index of 110 to 116. There were

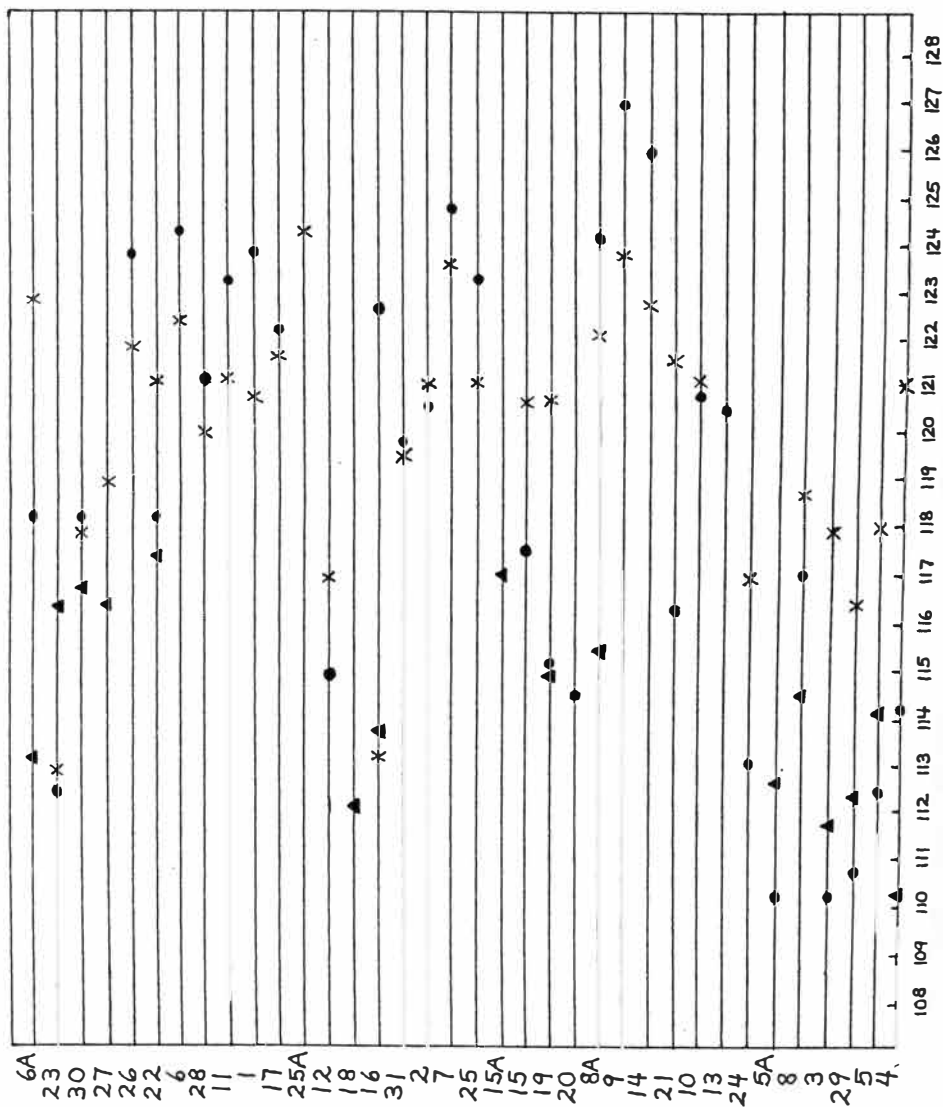


Figure 13. Average Index Numbers by Standard. (▲ = SC, X = ES/MES, • = NS)

also two outlying clusters identified by South as separate traditions. "Brunswick Town" bricks had Index Numbers of 99 to 110. The second tradition was comprised of Dutch bricks from 17th century sites in South Carolina. South Carolina Dutch bricks had an Index of 90 to 93.5 while those from Virginia sites were the smallest at 75 to 78.5.

The information presented in Table 7 aids in the comparison of Index Numbers from the bricks measured in Knoxville/Knox County, Tennessee with those from South's (1964) study. To represent the Index Number for each building, the mode or modes were used since these numbers represent the most common Index Number(s) for each building in the sample set. When these modes were compared with the limits established by South for various time periods and traditions, differences emerged.

First, the mode(s) for Building #5, #29, #3, #5A, #21, #20, #19, #16, and #6A are between 110 and 116 (the range South defines as 20th century) yet except for Building #6A, all were constructed during the 19th century. Secondly, in several buildings in the sample set, the number representing the low end of the range of Index Numbers falls within South's range for Brunswick Town bricks. The bricks in the study area with Index Numbers between 99 and 110 are clearly not of this tradition, however, since the dimensions of these individual bricks varies significantly from South's standard of 7 1/2" x 3 1/2" x 1 1/2" (Brunswick Town-small).

Finally, if the distribution of Index Numbers for the buildings with modes falling between 110 and 116 is examined, a trend becomes

Table 7

Ranges and Modes of Index Numbers in Chronological Order by Building.

Building #	Date	Range of Index Numbers	Mode(s)
4	1794-6	103-125	117
5	1806	108-118	113
29	1812	101-120	111
3	1818	101-120	111 & 114
8	ca. 1818	114-119	117
5A	1823	107-115	112
24	ca. 1825	111-121	117
13	1833	117-125	120
10	1834	118-124	121
21	1835	113-121	115 & 117
14	ca. 1835	123-130	126 & 127
9	1835	122-130	127
8A	ca. 1835	114-128	125 & 126
20	1840	110-118	116
19	1842	109-126	110 & 115
15	ca. 1846	114-120	117
15A	ca. 1846+	114-120	117
25	1848-51	111-130	128
7	1848	118-122	121
2	1849	113-127	123
31	ca. 1850	116-124	121
16	ca. 1850	111-118	116
18	ca. 1850	117-126	121
12	ca. 1850	112-119	119
25A	1851	124-125	124 & 125
17	1856	118-126	122
1	1857	106-130	124
11	1868	119-127	124 & 125
28	1872	114-128	121, 122 & 123
6	1885	120-127	124
22	1886	117-124	121
26	1889-90	119-126	124
27	1898	115-122	118 & 119
30	1904	114-120	117 & 118
23	1911	104-120	117
6A	1921	110-124	114

apparent. In Building #5, #29, #3, and #5A, bricks with Index Numbers of 101 to 115 constitute 88.2% to 100% of all the bricks sampled. In Building #21, #20, #19, #16, and #6A, the frequency of Index Numbers of 101 to 115 is much less: 28.9% to 75.9%. The first group of Buildings was constructed before 1825 while the second group spans the period of 1835 to 1885.

These figures demonstrate that over the period of time represented by the sample set, the Index Number of bricks made in Knoxville/Knox County gradually became larger even though the same standards were used; i.e., during the 19th century, the Index Numbers moved closer to the upper end of the limits for each standard.

It should also be noted from the figures shown in Table 7 that the use of brickmaking machines (as well as the small number of brickmaking companies) in the study area resulted in the production of much more consistently sized bricks after 1885.

CHAPTER V

CONCLUSIONS

The history of brickmaking in Knoxville/Knox County, Tennessee generally paralleled that of the rest of the country; however, certain factors were present here which made the local history of the industry differ. The geology and geography of the study area combined to produce ideal conditions for brickmaking. Three creeks ran through the town and its southern boundary was the Tennessee River. These waterways provided an excellent source of clay for many years as Knoxville continued to grow and prosper.

Geography also played a role in determining when the craft of making bricks was brought to the area. Since the mountain ranges to the east of the study area served as a natural barrier, settlement did not really begin until the end of the 18th century. Craftsmen followed these settlers but brickmakers and other skilled artisans were still scarce during the first quarter of the 19th century. Those brickmakers who came to the study area during this time were primarily from North Carolina and Virginia and their own traditions of brickmaking were introduced here through the work they performed and the young Tennessee apprentices to whom they taught their craft. Some of these men settled in Knoxville while others traveled the countryside building brick homes for the more prosperous settlers.

By the 1850s, Knoxville had become a wholesale center for the surrounding area. Ties with other regional markets were vital to the

survival and growth of an otherwise geographically isolated area. Early efforts to secure rail connections to these regional markets began to reap benefits by mid-century when the city experienced an economic boom. In response to the demand for construction materials, the number of brickmaking firms significantly increased in the study area.

In the last quarter of the 19th century, the number of rail lines through the area continued to grow and Knoxville began to rival Memphis and Atlanta as a Southern trade and manufacturing center. Again, in response to the economic prosperity, the city continued to grow and become industrialized. This prosperity produced several men who believed they had sufficient capital and business expertise to establish automated brickyards. Thus, even though various types of brickmaking machines were in use much earlier in other parts of the country, automation of the industry did not begin here until 1885.

In addition to the presentation of historical facts, it was also necessary to collect data from bricks in the study area since this data would contribute additional information about brickmaking in Knoxville/Knox County.

The analysis of measurements taken on 1,510 bricks from 31 buildings throughout the study area has revealed the following with respect to the objectives of this thesis:

1. the study area differs from Walker's proposed sequence of changes in brickmaking primarily in that the

popularity of the different standards does not change when he suggests;

2. the same standards were in use in the study area throughout the 19th and early 20th centuries;
3. even though many of the bricks are slightly wider or thicker than allowed by the limits of these standards, local brickmakers were using these standards as guides;
4. the determination of the temporal distribution of "impressed center" bricks will have to be made in the future after a greater number of individual bricks have been collected and examined; and
5. the Index Numbers of bricks from the sample set reveals that bricks gradually became larger during the 19th century while remaining within the limits for the standards and that variability in individual brick dimensions decreased significantly after the introduction of brickmaking machines in the mid-1880s.

The group of bricks which was originally classified as non-standard now seems most likely to be standard common or English statute/modified English statute. This conclusion is based on several trends in the data. First, the majority of these bricks have two measurements which do fit the limits of one of these standards and in most instances, the third measurement is only slightly above or below the limits. Secondly, the Index Numbers for these bricks are within the range determined by the limits of the standards. If they were

truly non-standard, the Index Numbers would be outside this range. Finally, the average dimensions are within or extremely close to the limits of the standards.

Attempts to formulate new standards for these bricks yields dimensions which differ only slightly from those of standard common or English statute/modified English statute bricks. Three standards are required to encompass the range of variability of these bricks and their temporal distribution is entirely random.

Thus, it appears that the data set shows a range of variation in brick size which is slightly greater than the $\pm .25$ " imposed on each dimension by Walker and this author. To put it more simply, all but 14 of the bricks originally classified as non-standard are a product of these somewhat arbitrary limits as well as measurements which are too exacting.

Nineteenth century brickmakers moulding by hand lacked the control over the amount of clay thrown into the moulds and shrinkage during drying and firing necessary to produce bricks which are consistently within $.25$ " of a standard in any given dimension.

It is this author's contention that these bricks represent 1,510 attempts to produce a standard common or English statute/modified English statute brick. Some of these attempts hit the mark on length, width, and thickness but the vast majority are a little too long or short, wide or narrow, or thick. By the end of the 19th century, however, machines and other improvements in firing gave brickmakers enough control to turn out a remarkably consistent product.

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APPENDIXES

APPENDIX A

MANUFACTURERS OF BRICKMAKING MACHINERY

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MANUFACTURERS OF BRICKMAKING MACHINERY

Chambers, Brother and Company Philadelphia, PA

horizontal pug mill and wirecutter

Gregg Brick Machine Company Philadelphia, PA

circular pug mill, extruder, moulder, Gregg No. 2 double press, Gregg Triple press

Lancaster Iron Works, Inc. Lancaster, PA

AutoBrik machines, Martin-Lancaster Steam Pipe Rack Brick Dryers, granulators, pug mills, crushers, disintegrators, mould sanders, moulds, sand dryers, winding drums, clay cars, elevators, belt conveyors, portable cable conveyor systems, kiln castings

The Bunnot Company Canton, OH

dry and wet pans, pug mills, auger machines, clay feeders, elevators, conveyors

J.C. Steele & Sons Statesville, NC

side cutters, brick machines, dump cars, disintegrators, feeders, hoists, end cutters, lift cars, crushers, hollow ware machines, pug mills, dry pans, dragline excavator

The Hadfield-Penfield Steel Company Plymouth, OH

auger brick machines, blowers and fans, brick dies, dry press brick machinery, fire brick machinery, floor tile machinery, the Haigh Continuous Kiln, sand-lime brick machinery, soft mud brick machinery

The Fate-Root-Heath Company Plymouth, OH

brick, hollow ware, and drain tile machines, cutters, crushers, disintegrators

Eagle Iron Works, Des Moines, IO

Eagle Shale Planer and Eagle Dry Pan

The Marion Machine Foundry & Supply Company, Marion, IA

clay feeders and mixers, Scottdale grates, portable kiln grates, soot blowers, conveyors, elevators, wheelbarrows

The Baltimore Cooperage Company, Baltimore, MD

wood or metal tanks and size or shape, steel towers

W.E. Caldwell Company, Inc., Louisville, KY

tanks and tank towers

Sources: This partial list of manufacturers was compiled from McKee 1973 and Guigon, et al. 1924.

APPENDIX B

CHRONOLOGY OF KNOXVILLE BRICKMAKERS

APPENDIX B

CHRONOLOGY OF KNOXVILLE BRICKMAKERS*

1869

Luke Wilds
W.T. Lowery
J.C. Kinzel
Middleton & Weatherford
Joseph Mabry

1876

J.C. Kinzel
Middleton & Weatherford

1882

E.D. Kinzel
T.W. Flannigan
T.J. Grubb
Middleton & Weatherford
W.C. Fulcher

1888

J.U. Addenbrook
J.H. Galding & Son
Lusby & Davis
Middleton & Weatherford
Reps Jones
J.A. Umbarger

1890

Caldwell, Graw & Caldwell
Daniel A. Carpenter
Davis & Lusby
Furry and Company

1895

C.D. & E.W. Crozier
Knoxville Brick Company
Jones Brick Company

1900

Arlington Brickyard
Knoxville Brick Company
Jones Brick Company
Garland Brick Company

1903

J.F. Scott & Son
Knoxville Brick Company
South Knoxville Brick Company
Garland & Weaver

1904

J.F. Scott & Son
Lonsdale Brick & Pottery Company
Knoxville Brick Company
South Knoxville Brick Company

1905

J.F. Scott & Son
Weatherford & Davis
Lonsdale Brick & Pottery Company
South Knoxville Brick Company
Knoxville Brick Company

1910

Alex A. Scott Brick Company
J.F. Scott & Son
South Knoxville Brick Company
Knoxville Brick Company
J.L. Cooley & G.W. Woods

1913

Cooley & Woods
W.M. Davis & Son
Knoxville Brick Company
Lonsdale Brick Company
Alex A. Scott Brick Company
J.F. Scott & Son
South Knoxville Brick Company

1917

Alex A. Scott Brick Company
Lonsdale Brick & Pottery Company
Knoxville Brick Company
Kingston Pike Brick Company
W.M. Davis & Son

1919

Alex A. Scott Brick Process Company
Lonsdale Brick & Pottery Company

1920

Scott Brick Process Company
Scottsville Brick Company
Knoxville Brick Company
Southern Brick Company
W.M. Davis & Son

1922

Riverside Brick & Tile Company

1924

General Shale Brick Company
Cherokee Brick Company
Knoxville Brick Company
Southern Brick Company

1929

General Shale Brick Company
Arrow Brick Company
Scottville Brick Company
Knoxville Brick Company

1935

General Shale Brick Company
Cherokee Shale
Scottville Brick Company

*Listings taken from Knoxville City Directories and are subject to errors of omission for any year listed.

APPENDIX C

BUILDINGS MAKING UP THE SAMPLE SET

APPENDIX C

BUILDINGS MAKING UP THE SAMPLE SET

<u>Building #.</u>	<u>Date(s) of Construction</u>	<u>Historic/Common Name</u>
1	1857	Humes House/St. John's Episcopal Parsonage (razed)
2	1849	Samuel McCammon House/ Engert Plumbing and Heating
3	1818	Craighead-Jackson House
4	1794-96	Blount Mansion
5-5A	1806, 1823	Statesview
6-6A	1885, 1921	Knox County Courthouse
7	1848	Knollwood
8-8A	ca. 1818, ca. 1835	Luttrell House
9	1835	Avery Russell House
10	1834	Fox-Reuben House
11	1868	Old Methodist Church- Masonic Hall
12	ca. 1850	Dowell House
13	1833	Scott Ledgerwood-Ogle House/Steven's Mortuary
14	ca. 1835	Matt Russell House
15-15A	ca. 1845, 1846+	Kearnes House
16	ca. 1850	Masonic Hall-Concord
17	1856	Bleak House
18	ca. 1850	Plummadore House-Concord
19	1842	Colonial Hall/ Richards House

<u>Building #</u>	<u>Date(s) of Construction</u>	<u>Historic/Common Name</u>
20	1840	Baker-Peters House/ Hawkeye's Too
21	1835	Boyd-Harvey House
22	1886	Lyon's View Asylum/ Lakeshore Mental Health Institute-Administration Building
23	1911	L & N Station
24	ca. 1825	Robert Gray House/Roddy House (razed)
25-25A	1848-51	Tennessee School for the Deaf/Knoxville City Hall
26	1889-90	Church of the Immaculate Conception
27	1898	Estabrook Hall-UT Campus
28	1872	South College-UT Campus
29	ca. 1812	James Park House/Knoxville Academy of Medicine
30	1904	Southern Railroad Terminal
31	ca. 1850	Twin Maples/Armstrong House

VITA

Gail L. Guymon was born in Decatur, Illinois on October 10, 1951.

In June 1973 she received a Bachelor of Science degree with honors from the University of Illinois. After teaching for several years, she entered the University of Tennessee in 1981 and began study toward a Master's degree in Anthropology.

While working on this degree, she has pursued her interest in historic architecture and preservation. As a member of the staff of the Knoxville/Knox County Metropolitan Planning Commission, she assisted in the completion of the Knox County Historic Architecture Survey. She is currently self-employed as an historical researcher and preparer of National Register nominations.

The author is a member of the National Trust for Historic Preservation and the Society for Historical Archaeology.