CHAPTER 3

TECHNOLOGICAL BACKGROUND

PLANTS AT LEBANON were twice at the forefront of technological innovation, and twice the enterprises were less than successful. The Hunns' bloomery and nailery was proposed to be a state-of-the-art plant with a powerful head of water, but it lasted only a short time. The cannery burned twice and ended in the hands of the sheriff, but it was a major industrial plant while it lasted. Elsewhere along the waterfront, Lebanon supported a bark mill and a shipyard in addition to its many wharves.

Scattered industrial remains and waterlogged pilings are all that remain of the former port of Dover, which regularly dispatched steamers to Philadelphia and schooners to the West Indies. The river's natural channel remains deep and open, but fixed bridges restrict passage of all but the smallest boats.

Bloomery ironmaking

Lower Delaware's bog iron industry must have been extremely profitable, for it attracted some of the state's leading entrepreneurs and provided foundations for several sizable fortunes. Sussex County iron mines for several generations attracted investments by major New Jersey ironmakers, among them Walter Franklin and Samuel Richards of Batsto Furnace, as well as Philadelphia iron merchants (Heite 1974). While Kent County does not have the extensive iron mines that are found farther south, the ore is available; a stream called Iron Mine Prong flows through North Murderkill Hundred.

Bloomery, or direct-process ironmaking, is the oldest process for refining iron from ore. In a bloomery forge, a few workmen can produce a marketable bar of wrought iron during a day's work. Blast furnaces, or indirect-process ironworks, produce cast iron in large quantities, but the process must be maintained for months, with many workers and a huge capital investment. While blast furnaces were the dominant ironmaking method during the period, there is significant evidence to indicate that bloomeries remained popular and profitable under certain circumstances.

The 1793 Act that authorized the Hunns to build their dam on Tidbury Branch specified that the forge was to draw bars, which indicates that a bloomery was intended. At about the same time, several new bloomery forges were prospering financially in Sussex County where blast furnaces had failed. Bloomeries enjoyed several advantages over blast furnaces, since they required smaller outlays for capital,

fuel, workforce, and raw materials. Although bloomery ironmaking was an older technology, it continued to modernize and remained competitive throughout the nineteenth century (Egleston 1880).

While they needed water to power their blowers and hammers, ironworks required a dry working area, since water in the masonry of the hearth could turn to steam and cause an explosion. Ironworks sites therefore were commonly situated on low ground, but with extensive drainage structures. An ideal site, seldom found, would have a good head of water but a dry footing; long raceways sometimes were the result of this search for dry footings.

Sawmills

In spite of the fact that they have been obsolete for a century and a half, vertical or "up-and-down" sawmills have survived in significant numbers. Many of the surviving vertical mills appear to be based upon the designs published by Delaware inventor Oliver Evans, who certainly was known to the builders of the Hunn sawmill at Tidbury.

Well-preserved sawmills of the period have been found in other states. In Delaware, the machinery from such a mill has been preserved and re-erected in safe but inappropriate surroundings at the Delaware Agricultural Museum. A more accurate example, based upon archæological evidence, is the working reconstruction of the 1796 mill at the Straits of Mackinac, Michigan (Mackinac Island State Park Commission 1984). At the Daniel Boone homestead near Reading, the Pennsylvania Historical and Museum Commission in 1971 documented and restored a surviving example from Berks County that closely parallels the mill illustrated in Evans' 1795 *Young Mill-Wrights & Millers' Guide* (Dickey 1973). Other early surviving examples have been documented in Ohio, notably the 1831 Staley mill (Hutslar 1975; Simmons 1980). An up-and-down mill of circa 1840 is preserved in Madoc, Ontario (Ball 1977).

Sawmill foundations are not uncommon archæological remains; the cribwork foundation of the Upper Factory Brook mill in New England (Wilson 1977) lay largely submerged in the streambed, where the water preserved much technological detail. Similar conditions were found at a site in the upper Lehigh River (Heite 1984). A mill of the period stood until 1938 in New Hampshire, and was recorded by HABS (Penn and Parks 1975).

Nailmaking

Nails were a premium in early America, where wrought-iron nail rod was a costly necessity, often imported. In 1786 a machine was invented in New England to cut nails from flat bars of wrought iron, considerably reducing manufacturing costs (Pierce 1957: 72). In 1790, an Englishman patented a device for shaping nail rods. Between 1790 and 1825, Americans patented 120 nailmaking inventions (Fontana and Greenleaf 1962). Nails made by such machines within a few years completely supplanted the hand-wrought nail market.

The new machines made cut nails, which required a new kind of raw material. Nail rods for wrought nails were slender bars roughly the size of the nail's shank. Each nail was formed by hammering a point onto the rod, then cutting it off and forming a head. In the cut nail process, a plate was used. The width of the plate determined the length of the finished nail. The cutting machine trimmed each nail from the bar, leaving very little finishing to be done.

Since nailmaking technology was evolving rapidly during the period in question, a nail manufacturing site with short duration should provide significant temporal evidence for use in dating sites elsewhere. The exact chronology of this technology continues to be little understood. For example, it has been asserted by some authorities that machine-made nails before 1825 were generally hand-headed, although heading machines are documented in some naileries before 1820 (Michael 1974).

Dam-building in eighteenth-century Delaware

All of the mill dams that survive in Delaware have been built or rebuilt relatively recently. Although many mill seats date back to the colonial period, the potential archæological record has been obscured by the natural process of industrial evolution. To gain an accurate impression of early dam-building technology, therefore, requires studying dams and mill seats that never were modernized.

Wooden hydraulic structures have been excavated and reported at many places in the eastern United States, including Patowmack Canal in Virginia (Dent 1986) and several ironworks in New Jersey. Submerged timber-cribbed hydraulic structures of a seventeenth-century mill in Britain were excavated and interpreted by Martin Petchey and Brian Giggins (1983). In the streambed of the River Ouzel they found well-preserved buried and waterlogged lower works of the Caldecotte Mill, sufficient to allow interpretation of the industrial process.

A hammer forge site was found on the Shell Brook at Ardingly, Sussex, England, in a situation similar to Tidbury. A wide, marshy, streambed was dammed by an impoundment that is now a causeway.

The forge driven by the impoundment was built on the marshy ground below. Owen Bedwin (1975) excavated the dam and forge, discovering considerable intact timberwork in the mud of the meadow. Timber-framed wheelpits, often containing fragments of water wheels or turbines, are known from many sites, especially where the mill was situated in lowgrounds (Crossley 1975).

Fruit and vegetable canning

The first canners in Kent County were tinsmiths by trade; indeed, both Stetson and Ellison of Camden, and Richardson and Robbins of Dover practiced both canning and architectural metalwork. Names of can inventors like Borden, Underwood, and Van Camp survive today as names of food processing companies. After the tinsmiths had developed the technology, entrepreneurs from other backgrounds entered the trade. These second-level entrepreneurs employed a simplified technology that followed the "American System" in which parts of the manufacturing process were assigned to relatively unskilled workmen who did not possess the full range of skills known to a professional tinsmith. Lebanon's canners fell into the latter category. Their relatively untrained workmen made only cans according to prescribed procedures, whereas the tinsmith-canners made other tin products and could be expected to innovate more readily

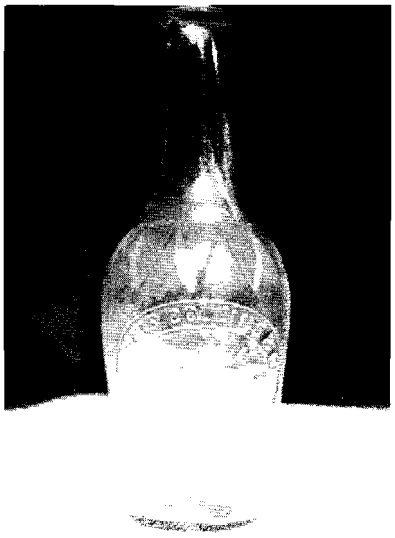
Tinware manufacture began in America around the time of the Revolution (Fontana and Greenleaf 1962). Tin-plated steel sheets had long been used for utensils, perhaps as early as the thirteenth century. Tinned cans for food packaging were patented in 1810 and marketed under the relatively unappetizing name of "embalmed provisions."

Early cans were more complex than today's. The cans were manufactured with a hole in the top, through which the product was inserted. A small cap was then soldered over the fill hole. The product was then cooked, while gases escaped through a pinhole opening in the cap that was soldered shut while the contents were still hot. As the can cooled, a vacuum formed; without an adequate understanding of bacteria, canners believed that the vacuum preserved the food.

Throughout the nineteenth century, canners tried to improve their product and their production methods, but most cans continued to be made individually by workers in the loft over the canning factory. Americans patented many different processes and machines, which may be used as dating evidence on sites where cans have survived. Some of the innovators founded canneries that produced their peculiar cans; Richardson and Robbins' famous tapered plum pudding can was made in Dover within living memory. By 1902, modern open-top cans had replaced most of the hole-in-top styles; these cans are made by machine in separate manufacturing plants. As the can manufacture and canning industries separated, unlabelled food containers became standardized and potentially less sensitive to archæological analysis.

Plate 19 (left) Catsup bottle, with the impressed label of John S. Collins and Company, one of two types identified in collections.

Plate 20 (right) Collins catsup bottle identical to the one shown at left, but made from variegated glass more typical of decorative glassware.



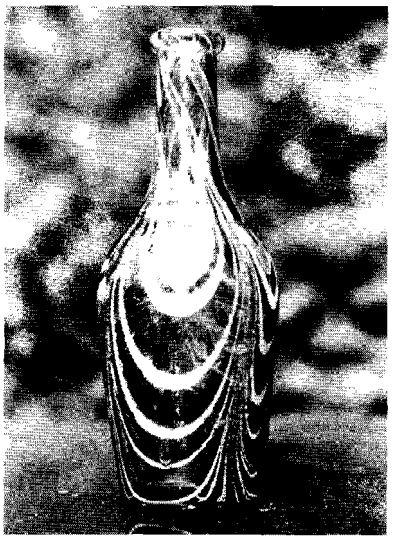


Plate 21 (left) A complete tomato can made and filled by Collins, Geddes and Company under the Star brand at Lebanon

Plate 22 (right) A similar peach can; all items on this page were collected by Dr. E. D. Bryan.