

Chapter 7

Glass: Shattering Notions

THE WESTERN PENNSYLVANIA GLASS INDUSTRY: A CHRONOLOGY

Historians acknowledge the importance of Western Pennsylvania as a center of industrial production. As Walter Licht recently noted in *Industrializing America*, "...there in Pittsburgh and its environs, emerged an emblematic American late-nineteenth-century hub of industry." The iron and steel industry has received significant attention. Yet, the region's glass industry which produced 45 percent of the nation's output by the Civil War and more than 80 percent by the 1920s, has never been studied in depth. This exhibit presents the first detailed examination of this major industry that integrates an understanding of business development, industrial production, technological innovation, design, marketing strategies, and patterns of consumption. Both the exhibit and the accompanying publication contain new research relevant to scholars in the disciplines of social history, labor history, business history, architectural history, the history of technology, and material culture studies.

Pittsburgh's strategic location on the inland river system, with the Allegheny Mountains to the east, made the city a natural location for the manufacture of glass. In 1797, two factories began production in the region, the New Geneva Glass Works of Albert Gallatin and the Pittsburgh Glass Works of James O'Hara and Isaac Craig. The Pittsburgh factory took advantage of the locally abundant supply of coal for fuel and both factories utilized the network of rivers for trade. Between 1800 and 1850, the western market for glass swelled as population in the interior of the United States grew from 300,000 to over five million. Pittsburgh glassmakers experimented with marketing their glass in the east, and as early as the 1820s, even tapped into the markets of Central and South America. The Allegheny Mountains provided some protection from cheaper European imports and the products of eastern glasshouses, but growth in the industry was by no means constant and business partnerships in the region formed and dissolved constantly.

In the period 1797-1825, glassmakers were concerned with establishing and stabilizing their industry. After 1825, major changes came from the application of new technology. As with other industries in the region and the nation – textiles, printing, and steam engine manufactories – the mid-nineteenth century was a time of innovation and invention in the glass industry. The first major change in production methods in almost 2,000 years, the introduction of pressing techniques, reordered the factory floor. The design of new machines and metal molds made the skilled machinist and mold maker an integral part of the industry. The American innovation of pressing found wide application in the factories of Pittsburgh; the city would eventually become the pressed glass capital of the nation. By 1837, 26 factories called the region home, with 13 located in and around Pittsburgh and another 13 found along the rivers in the outlying counties of Fayette and Washington.

Glass production exploded during the Civil War years when William Leighton of Wheeling substituted cheap, plentiful soda lime for lead in the formula for colorless glass. This chemical innovation meant that colorless glass could be produced more cheaply. When coupled with the technological innovation of pressing, it ensured that decorated or patterned glassware could be made inexpensively, opening the market for a new class of consumers. By 1865, there were 45 glass houses in Pittsburgh, many utilizing these new technologies. They produced a wide range of glass that could be shipped to markets far and wide using the rail system.

Other innovations – in chemistry, in furnace design, in the mixing and melting of batch, in the application of new fuels such as natural gas, in the annealing process, and even in the design and scale of factories – followed. By the 1870s, conditions allowed for the large-scale industrial production of glass. Just ten years later, in 1880, Pittsburgh had no rival in glass production. The stacks of 51 factories loomed over the landscape of Allegheny County. One quarter of all the factories in the nation, producing almost 30 percent of all the glass in the country, were found in this one county, with another 10 in the larger region of Western Pennsylvania. The volume of glass pouring forth from these factories was astounding.

The discovery of natural gas and the spreading tentacles of the rail lines opened the region in the late nineteenth century. Factories sprang up where once there was farmland; new glass towns with names like Ford City and Jeannette were born. The larger Ohio Valley region – Western Pennsylvania, West Virginia, Ohio, Indiana, and Illinois – courted factory owners with offers of free gas and open land. Furnaces were fired throughout the Midwest, and by 1920, Western Pennsylvania, West Virginia and Ohio accounted for fully 80 percent of national production. As the *National Glass Budget*, a trade publication, reminded its readers in 1921, “If we had no steel mills or electrical concerns, we might be known as the ‘glass city’; for historically and also in point of the volume of our manufactures, Pittsburgh has been the leader in the glass business.”

In the early 20th century, automated machinery was developed for the glass industry. Bottles and containers, lighting, tableware, flat glass – by 1925 the technology existed to manufacture all these products in a semi-automatic or automatic process. Some of these processes were developed in the increasingly vital R&D centers of the region; others were developed elsewhere, but purchased and applied by local manufacturers. While technological innovation spurred production, it also generated complex struggles between workers and owners over issues of technological change, workplace authority, and job security. These issues have been playing out ever since.

At the same time that Pittsburgh became the leader in the production of glass, the city also assumed a central role as the marketplace for glass. In 1880, the national trade show for glass tableware was established in Pittsburgh. Held for two weeks each January, the show attracted wholesale and retail buyers from around the nation and Canada. With displays set up in the rooms of downtown hotels, glass companies premiered new lines, and by 1924, booked one-quarter of their yearly orders (about \$40,000,000) at the Pittsburgh Show. Eventually superseded by the establishment of competing housewares shows in Chicago and New York and the building of merchandise marts, the Pittsburgh Show ended its reign of importance in the 1950s.

Forces of change – in the organization of the national and international marketplace, competition from new materials such as plastics and aluminum, and in political, cultural and social life – reordered the industry. Although no longer the center of the national industry, Western Pennsylvania is still home to over a dozen manufacturers. Some, such as PPG Industries and Glenshaw Glass, have an international presence; others like Youghioghenny Glass serve a national niche market. Whether producing a million bottles a day, or singular objects of art, Western Pennsylvanians continue the 200-year tradition of transforming sand to glass substances.

AMERICAN GLASS

Glassmaking was America's first industry. When the Jamestown colony was established in 1607, the settlers brought glassblowers with them. However, the efforts to manufacture glass at Jamestown – and later attempts near Philadelphia and Boston – failed despite the abundance of fuel and good sand. Throughout the seventeenth and eighteenth centuries, the colonists imported most of their glass.

In 1739, more than a hundred years after the failure of the glasshouse at Jamestown, Caspar Wistar established a factory in southern New Jersey. Despite a British ban on manufacturing in the colonies, Wistar, a German, hired German glassmakers to produce window glass, bottles, and tableware. Benjamin Franklin used Wistar's scientific glassware in his electrical experiments. Wistar, the first commercially successful glass manufacturer in this county, began the German domination of the American glass industry that continued until the nineteenth century.

The second German to manufacture glass on a large scale in the New World, Henry W. Stiegel, operated a glasshouse between 1763 and 1774 in Manheim, Pennsylvania. Stiegel, too, employed foreign workmen, both from Germany and from England, and sometimes he lured glassmakers away from Wistar. The demand for all kinds of glass in the colonies was huge, and though most of the colonists' glassware came from England, Stiegel sold enough to prosper handsomely for several years. According to legend, he styled himself a baron and lived in a manner befitting nobility, even employing musicians to strike up a tune whenever he arrived home in his coach. He was an active churchman and deeded land to the Lutheran church in Manheim, asking in return only the annual payment on one red rose – forever. This “rent” is still paid by the church the second week of every June to one of Stiegel's descendants.

A third German, John Frederick Amelung, opened a large glass factory in Maryland in 1784, the year after the War of Independence ended. (This was also the year Benjamin Franklin used glass in a new way – to make bifocals.) Over the next ten years, Amelung invested more money in glassmaking than anyone in American before him. He produced large amounts of impressive table glass, much of it engraved. Yet he, too, failed, eleven years later. However, Amelung left us the best of early American glass, some of it signed and dated.

An ironic contemporary view of the situation indicates that Amelung and other eighteenth-century glassmakers failed to establish a lasting glass industry because they overestimated the market: “Most new works have been begun too large in this county. If we built a glasshouse, it was at the expense of thousands and calculated to cover all that part of the county with glass which was not covered by houses.” It was not until foreign competition was halted by the War of 1812 that glassmaking really flourished in the United States.

Despite many financial difficulties, problems stemming from the War of 1812, and competition with the English, American glass production increased during every decade of the nineteenth century. Most of the glass was still primarily for bottles and windows. Tableware produced in bottle and window glass factories was usually made by the individual worker for his family and friends, often on his own time and at the end of his

shift. This glass was frequently decorated with superimposed bits of glass and threads in the German tradition, with variations according to the whim of the workman.

As settlers moved west of the Alleghenies, they constituted a new market. However, because glass was difficult to ship overland, most western settlers did without it until the industry, too, moved westward. A traveler in the Western Reserve in the early nineteenth century commented:

The furniture for the table is scanty and inconvenient, articles of crockery are few and indifferent. For want of a glass from which to drink, if you are offered whiskey (which is the principal drink here) the bottle is presented to you or a bowl or a teacup containing the liquor.

Another traveler, Henry C. Knight, wrote in a letter, "They have no cider or common beverage for table drink; but, instead for the ladies water unqualified, and for the gentlemen, either whiskey, or apple or peach brandy."

Early in 1797, the first glasshouse on the frontier was started south of Pittsburgh by the financier Albert Gallatin, later cofounder of New York University and Secretary of the Treasury under Jefferson and Madison. Later that year, James O'Hara and Isaac Craig of Pittsburgh started a bottle manufactory (The first bourbon whiskey had just been distilled by a Baptist minister in the bluegrass county of Kentucky). In Pittsburgh, river transportation to the entire western frontier guaranteed a ready market. Nearby coal deposits provided ample fuel. By 1818, when President Monroe wanted American cut glass for the White House, Pittsburgh was the place from which to order it. From Pittsburgh, the industry spread down the Ohio River to western Virginia, Kentucky, and Ohio.

Skilled glassmakers were frequently on the move, seeking either better wages or the free land available in the western territories. This created a labor shortage and stimulated a need for greater productivity. Obviously, one way to speed production was to blow glass into a mold, as the Romans had done, producing shape and surface pattern in one operation. It was an idea already in use in England. The earliest American molded glass imitated cut glass. A housewife's book, published in New York in 1815, suggests: "Those who wish for Trifle dishes, butter stands, &c. at a lower charge than cut glass may buy them in moulds, of which there is a great variety that looks extremely well if not placed near the more beautiful article."

Bottles and flasks for liquor were also mold-blown; after the War of 1812, they were often embellished with patterns, scenes, Masonic symbols, the American eagle, and portraits of celebrities. George Washington's face appears on more than sixty different types of flasks. When Jenny Lind, the "Swedish Nightingale," was brought to the United States by P. T. Barnum in 1850, several glasshouses were ready with bottles bearing her portrait.

While the use of molds speeded production, it was the development of the mechanical pressing machine in the 1820s that led to the mass production of American tableware. In fact, the greatest contribution of America to glassmaking, and the most important development since the Romans discovered glassblowing, was the sudden speed-up in the manufacturing process made possible by machine pressing.

At a pressing machine, two men with minimum experience could produce four times as much glass as a team of three or four trained glassblowers. A bowl came out of the press completely formed and decorated in a few seconds. However, because contact of the hot glass with the cold mold produced a network of wrinkles on some pieces, mold makers turned from imitating cut glass to creating lacy patterns with a background of tiny dots; this way the wrinkles were “hidden” by the patterning. Technological innovations finally eliminated the wrinkles, and patterns became simpler in the 1840s.

Pressing was used for candlesticks, vases, and table glass, and it facilitated the production of matched sets. It also made oil lamps cheaper and more widely available. At that time, whale oil was the most popular lamp fuel because it was abundant and gave what John Adams described as “the clearest and most beautiful flame of any substance that is known in nature.” Whale oil lamps burned more brightly with glass chimneys, while the improved oil lamps invented by Ami Argand employed both a chimney and a glass shade to diffuse the light. At 10 candlepower, these lamps were considered too harsh by the standards of the day. Count Rumford, a scientist writing in 1811, said, “No decayed beauty ought ever to expose her face to the direct rays of an Argand lamp,” and doctors warned of eyestrain for users. (It would require five Argand lamps to equal the light provided by one modern 60-watt bulb.)

A new lamp fuel, kerosene, began to replace whale oil in the mid-nineteenth century. Kerosene lamps *required* glass chimneys to burn properly, and so a whole new glass industry to make them was born. Despite the introduction of gas lamps, kerosene lamps were the major home lighting device until Edison developed the electric bulb in 1879. The first light bulb blanks were blown for Edison by Corning Glass Works the following year, but electricity did not supersede kerosene lamps in the countryside until rural electrification began toward the end of the Great Depression.

By the mid-nineteenth century, American railroads and industry were growing, and the country was rapidly expanding westward. Economic prosperity increased steadily; Mark Twain called the period after the Civil War the “Gilded Age.” With prosperity came a taste for complex decoration and ornate styles, greatly influenced by fashions from abroad. Some glass imitated silver, tortoiseshell, or Chinese porcelain. New shaded color effects were greatly admired, as were applied decoration and enameling. By the 1880s, American glass styles had exotic names such as Amberina, Burmese, and Peachblow. Said the *Crockery and Glass Journal* (1886), “Just at present, art glass is all the go.”

Patterns in glass cutting were also becoming more and more elaborate; a decanter and wineglasses made for the Philadelphia Centennial Exhibition in 1876 were so profusely cut that not a half-inch of surface was left undecorated. (At the exhibition, there was also a glass fountain 17 feet high, ornamented with cut crystal prisms, lighted by 120 gas jets, and surmounted by a glass figure of Liberty.)

Glass containers continued to be an important part of the American glass industry. In 1880, more than 25 percent of the glass made in the United States was for liquor flasks, patent medicine bottles, and the home preserving jars perfected by John Landis Mason in 1858. These were all produced by blowing into molds and hand-finishing the necks and lips. Patent medicines, promoted as cure-alls and often highly alcoholic, were a polite substitute for the liquor so frowned upon by the temperance movement. The bottles were usually distinctive and identified the contents: Turlington’s Balsam of Life,

Swain's Panacea, Perry Davis's Pain Killer, Lydia Pinkham's Vegetable Compound, and Hostetter's Celebrated Stomach Bitters. Just as in Roman times, glass was, and still is, the preferred container material for many substances – from food and beverages to scents, cosmetics, and panaceas.

In 1903, Michael Owens invented an automatic bottle blowing machine. For the first time, bottles could be made mechanically rather than by hand. The container industry was revolutionized. Later, other machines were perfected to make tableware, cookware, and fruit jars, putting more and more glass objects within the budget of most people. In 1926, the Wellsboro, Pennsylvania, plant of Corning Glass Works installed a ribbon machine, an automatic blowing device used primarily to manufacture light bulbs and, after 1939, Christmas tree ornaments. It could blow 2,000 bulbs a minute, nearly three million in a day.

ONE HUNDRED YEARS OF MODERN GLASS

Of the many critical moments in the history of glass, five are of particular importance: first, the discovery of glass itself, more than 3,500 years ago; second, the invention, shortly before the time of Jesus, of glassblowing, allowing for glass to be available in larger quantities; third, the development of lead crystal, with its greater weight and brilliance; fourth, the development in America of the mechanical press, resulting in lower production costs. At each juncture, glass was significantly improved.

The fifth turning point was of a different, nontechnical sort. It occurred a little more than 100 years ago, when designers and artists – who had not been glassmakers themselves – began to work in glass. Before then, glass design had usually been dictated by the skill, taste, and ingenuity of the artisan who actually made the glass or by the man who made the mold. By the 1870s, at least two artist-designers were working in glass, but it was not until the twentieth century that the designer and artist became important in many of the world's best glasshouses.

This involvement of artists and designers in glass manufacture led to the emergence of “art glass,” what the French called *vases de delectation*. Designers created styles to be made by craftsmen in workshops or factories. Artists, including painters, designed glass objects too, and some also formed the objects at the furnace.

Among the first designer-artists to work in glass were Eugene Rousseau and Emile Galle, both of whom became known for their glass at the Paris Exposition Universelle of 1878, one of the many international fairs that followed the 1851 Crystal Palace Exhibition.

The United States had opened Japan to trade with the West in 1854, and, by the time of the 1878 exhibition, Japanese art was much admired in Europe. Rousseau was greatly influenced by Japanese pottery and landscape paintings and prints. His work was characterized by flame like colored streaks and contrasting overlays. Sometimes he added crackle effects and metal particles. The objects were decorated with enamel, cutting, and engraving. Rousseau derived his forms not only from Oriental art but also from German *Humpen* and Italian Renaissance shapes. He made a significant contribution to glass design, although his career was short and his output small.

Emile Galle is considered the mainspring of the Art Nouveau style in glass. During the 1880s and 1890s, Art Nouveau was a graceful style widely used in the fine and decorative arts: architecture, painting, posters, book illustrations, furniture, wallpaper, fabric, embroidery, jewelry, and glass. It developed at a time when intellectuals and artists, rebelling against industrial production and historic revivals, were glorifying both the draftsman and the high standards of the medieval guilds. Richly ornamental and often asymmetrical, it employed long, sinuous lines, weaving tendrils, and flowing rhythms. Art Nouveau was a style particularly suited to the liquid, flowing qualities inherent in glass.

Like Rousseau, Galle admired Japanese art – an admiration he expressed using themes from nature and a poetic mood in his glass work.

To Galle, nature was the source of all beauty. He stated this belief in a sign on his workshop door that read, "Our roots lie in the soil of the woods, in the moss by the rim of the pool." Throughout his life, he was a practicing gardener and a learned writer on horticulture. He said the "each kind of plant possesses its ornamental style." He did not limit himself to elegant flowers, such as the orchids and lilies used as fashionable motifs at the time, but often used more homely plants, including the thistle and the pine. His natural themes were enlivened by stylized insects, especially dragonflies.

Galle was also inspired by many of the Symbolist poets, and he often decorated his vessels with ornamental lettered quotations from Paul Verlaine, Charles Baudelaire, Stephane Mallarme, Victor Hugo, and Edgar Allan Poe, among others. The poetic quotations were always appropriate to the form and decoration of the vessels. Called *verrieres parlantes*, these "talking glasses" were in the spirit of artists such as William Morris, Aubrey Beardsley, Dante Gabriel Rossetti, and – much earlier – William Blake, all of whom combined drawing and painting with poetry. Galle made one such vase for presentation to Louis Pasteur, who originated the process known as pasteurization; it is inscribed with the following lines by Victor Hugo:

*I move about in meditation,
And at all moments a certain instinct obliges me
To seek and find what lies behind the suffering of men.*

As Galle's work grew in popularity, his establishment gradually developed into a large organization of craftsmen whom he carefully supervised. They carried out his designs in his personal, lyrical style. (After Galle's death in 1904, the firm mass-produced numerous designs that did not receive the amount of care that had been customary in the making of his early works.) Galle's glass was always signed, giving it the cachet of an art object and adding to its value for collectors. Other glassmakers soon began to sign their wares, too. Many other factories, such as Daum in France, Val-Saint-Lambert in Belgium, and Kosta in Sweden, produced glass in the Galle style.

When Louis Comfort Tiffany, an American painter, visited Paris in 1889, he saw Galle's fantastically colored glass at the Exposition Universelle and was deeply impressed. Tiffany was the son of the founder of the famous New York jewelry store, Tiffany and Co. He, too, brought a fine arts background to the design of functional objects – and he, too, was affected by the arts of Japan. His initial efforts in glass were in making stained glass windows, beginning in 1878. Like Galle, he was a nature lover. He was also a leading interior decorator, with such eminent clients as the Union League Club in New York and Mark Twain, whose home in Hartford, Connecticut, he decorated. Tiffany was invited to redecorate the White House when Chester Alan Arthur was president.

Tiffany's first collection of blown glass strongly expressed the Art Nouveau style. It was exhibited at the World's Columbian Exposition in Chicago in 1893, where it was an immediate success. The metallic iridescence, its chief characteristic, was inspired, he said, by the iridescence resulting from decay on excavated Roman glass. Tiffany's glass had a silky, delicate patina over luminous colors. The metallic luster was a film of metal produced by exposing the glass to chemical sprays. It was believed, erroneously, that \$20 gold pieces were dissolved in acid and used as a source for the gold in the metallic film.

Tiffany's blown forms were often sensuous flowers on attenuated stems or other shapes that had rarely been used in glass containers before. These forms were decorated with

lines and motifs that seemed to swell and narrow. One of his favorite patterns imitated that of a peacock feather. He also used many ancient techniques, such as millefiori inlay, intaglio, and cameo carving. Tiffany named his glass "Favrile"; according to a brochure, the word was derived from the Old English word *fabrile*, meaning "belonging to a craftsman or his craft." In Tiffany's catalogue for the 1900 Paris exhibition, he declared that "in none of the specimens of this glass is there any application of decoration by painting. Such designs as are found are in all cases produced by the combination of different colored glass during the operation of blowing the piece."

A French glassmaker, Rene Lalique, first became famous as a designer of Art Nouveau jewelry. Subsequently, he received a commission from the French perfumer Coty to produce special bottles for Coty's costly scents. He ultimately devoted himself completely to glass, which he called "an enchanted substance." The style most associated with his name is reflected in vases, bowls, and jars decorated in high relief produced by molding, sometimes accentuated by enamels, stains, or acid frosting. Among his most frequent decorative motifs were the human figure, birds, fish, insects, and flowers, usually treated as elements in a formal pattern. Sometimes the pattern was purely abstract. Sharp and icy, Lalique's later style was the opposite of the flowing Tiffany glass and seemed at home in the roaring Twenties, the age of the Charleston, the flapper, the first talking pictures, and sleek Art Deco interiors. Lalique's urban style was related to the logical, sophisticated functionalist concept of beauty, which state, among other ideas, that materials should be used "honestly," according to their nature, and that forms should be simple, and ornament geometric.

Maurice Marinot, who also believed in the functionalist definition of beauty, was originally a painter, one of the influential *Fauves* or "wild beasts" who also included Matisse, Rouault, Dufy, and Braque. In 1911, after visiting a glass house belonging to friends, Marinot became captivated by the qualities of glass as a medium. He tried enameling on glass shapes he had designed but not actually made; soon enough, however, he turned to making the vessels himself in a factory. He was the first artist we know of to choose glass as his medium and to work it himself. His massive vessels were deeply cut, heavily etched, and decorated with clouds of bubbles and subtle color effects. Unlike Galle and Tiffany, he did not draw his inspiration so much from nature as from the qualities inherent in the material and from the process of working it.

At the furnace, Marinot worked by himself or with one helper. Working at the furnace was essential to him; it was there that his ideas developed. Echoing the experience of glassmakers past, he said:

To be a glassman is to blow the transparent stuff close to the blinding furnace, by the breath of your lips and the tools of your craft, to work in the roasting heat and the smoke, your eyes full of tears, your hands dirtied with coal dust and scorched. It is to produce an order of simple lines in the sensitive material by means of a rhythm which matches the life of the glass itself, so that in due course you may rediscover in its gleaming stillness that life of the human breath which will evoke living beauties.

Marinot gave up glassmaking in 1937 and returned to painting, but his work in glass had in impact on all the art glass that followed.

Another interpretation of functionalist esthetics, a style called Swedish Modern, came to prominence in household furnishing. This style is characterized by strong, clean lines

and a natural use of materials. In glass, it emphasized the substance's "frozen liquid" character. It was first developed at the Orrefors Glassworks, then a small, little-known glasshouse in the forests of southern Sweden. In 1913 and 1917, Orrefors hired two painters, first Simon Gate and then Edward Hald, to design glass and to work directly with the craftsmen. This was the first time a glass company had hired artists. The style developed by Gate and Hald influenced glass design for many years. Hald was later to describe the role of the glass artist-designer thus: "An artist working in glass is primarily the director of a drama featuring the master and his colleagues plus a glowing lump of semi-molten glass."

Orrefors, with the help of Gate and other artists, produced a form of cased glass called *graal*. In *graal* glass, colored relief decorations like those used by Galle were covered with clear crystal, thus acquiring a smooth outer surface over what then became an inner relief. The glass was then blown, expanding the trapped decoration. Under the direction of Gate and Hald, Orrefors also produced luxurious engraved works, some deeply carved and others with shallow engraving. Eventually, the Swedish style and the hiring of artists as designers were adopted by other Scandinavian factories such as Kosta and Boda.

At about the same time in Vienna, designers led by the architect and designer Josef Hoffmann were producing simple, functional wares based on geometric shapes, the forerunners of much glass made today. Among the firms for which Hoffmann designed was J. & L. Lobmeyr, which made glass of a dignified classical style in Vienna for three generations. In 1918, Stefan Rath, a Lobmeyr nephew, founded a branch of the company that made glass engraved according to the designs of artists.

In 1903, a glassmaker named Frederick Carder founded Steuben Glass in Corning, New York. He had emigrated from Stourbridge, England, at the invitation of T. G. Hawkes & Co., an American firm noted for cut and engraved glass. Though Hawkes intended that Carder would produce only blanks for cutting and engraving, Carder immediately also began to make a variety of lustrous lead glass in many colors and styles, including Art Nouveau. In 1918, Corning Glass Works bought Steuben Glass from Carder, who continued to design for the company until about 1936. When Arthur A. Houghton, Jr., great-grandson of the founder of Corning Glass Works, became Steuben's president in 1933, he brought together architects and artists, including John Gates and Sidney Waugh, as designers. Corning scientists had just developed a new optical glass for lenses; it was of such unusual brilliance, purity, and workability that Houghton decided to use this material exclusively, thus ending Steuben's production of colored glass. Almost immediately, the Steuben design team established a new, distinctive style in a material virtually free of flaws. Within a few years, Steuben glass was being exhibited at expositions, galleries, and major museums. The company has continued to use only clear, highly refractive lead crystal and to employ and commission designers and artists to produce new designs – functional and ornamental, abstract and representational. Steuben glass has been presented as state gifts by every United States president since Harry S. Truman.

In Czechoslovakia, the great tradition of Bohemian engraving continued until World War II. After that war, the Bohemian technical tradition burgeoned into a sculptural style, still evolving today, that has had an important effect on contemporary glass around the world. The sculptures are usually one-of-a-kind works made in private studios or under the supervision of glass artists during factory time set aside by the Czech government.

Special programs in Czech schools train students in glass design and production. Among the important contemporary Czech glass artists are Frantisek Vizner, Bretislav Novak, Jr., Rene Roubicek, Stanislav Libensky, Jaroslava Brychtova, Pavel Hlava, and the engraver Jiri Hrcuba.

In Venice, many well-known designers, including Tapio Wirkkala of Finland and the American glass artist and teacher Dale Chihuly, have worked at the firm of Venini.

Artists, especially those in Europe, have a long tradition of working with glass, using such techniques as cutting, engraving, and enameling. However, until the late 1960s, the vast majority of blown art glass was still made in factories. In 1962, the artist Harvey Littleton led two workshops at The Toledo Museum of Art; there it was demonstrated that glass could be efficiently melted in a small furnace suitable for a studio with limited space, yet still hold enough glass for the needs of a single glassblower. By using such furnaces in their studios and by forming the glass themselves, artists became technically independent of the factory. They had become free to experiment with molten glass as an artistic medium. The idea of studio-made glass was soon introduced into advanced art education programs, and it spread rapidly from the United States to Europe, Japan, and Australia.

Today, not much more than 100 years after Rousseau and Galle began to make art glass, glass is recognized as one of the materials of fine art, taking its place in the studio alongside paint and the sculptor's clay and stone. Glassmaking is now taught in art schools, craft schools, and universities around the world. Sculpture executed in glass is displayed in museums and galleries. While some glass objects made in factories have always been non-utilitarian works created for ritual, ornamental, or esthetic purposes, today most works that are esthetically experimental or sculptural come directly from the artist's studio. In the past two decades, a number of factories have recognized this and they are increasingly employing studio artists.

In tracing the flow of glassmaking through history, we have seen glass begin in ancient times as a wondrous transformation: ordinary sand turned into a precious substance. This substance was regarded with awe as a magical manifestation, and glassmaking's secrets were jealously guarded. In modern times, glass has retained its traditional fascination – its magical ability to capture and reflect light and its solid transparency, or being and not being at the same time. In *Remembrance of Things Past*, the French writer Marcel Proust said that glass is “real without being actual, ideal without being abstract.”

Now, toward the end of the twentieth century, more than three millennia after its discovery, glass seems to have only begun revealing its magic and its marvels. New forms of this versatile material are enabling man to journey to the frontiers of science, not only in the laboratory and in industry, but also in space. In the 1990s, the American space shuttle – a vehicle containing critical parts composed of glass – is expected to put into orbit a telescope whose glass mirror will be capable of capturing light from stars 14 billion light years away. Since some scientists believe our universe was formed about 14 billion years ago, this glass mirror may provide a view of the creation of the first stars.

In the era when glass is taking us to the very edge of outer space, it has become a medium for exploring inner space as well – as an art medium with which the artist may transform a personal vision into a statement of universal meaning expressed in terms of

transparency and light. In the coming decades, glass may well reveal not only more about our world, but also, as art must, about ourselves.

Chapter 1: Overview

While the story of glass in America began at Jamestown in 1608, almost 200 years passed before skilled glass workers crossed the Allegheny Mountains to begin production in Western Pennsylvania. Since 1797, when the region's first two glasshouses were founded, the conical furnace stacks of glass factories have been a defining feature of the region's skyline. Scores of glass houses followed, producing rivers of glass for an abundant variety of uses sold throughout the nation and, in time, around the world. By the Civil War, Western Pennsylvania was the center of the nation's glass industry.

A generation later, Pittsburgh glass was everywhere: as tile for the walls of New York's great transportation tunnels; in searchlights on the Panama Canal; as insulators for endless miles of telephone and telegraph wire; in "Liberty lens" headlights of Ford automobiles; yet, in addition to the countless industrial applications for Pittsburgh's products, glassmakers in the city were also commissioned to make fine tableware for five presidents in the 19th century. From the magnificent to the mundane, from intricately engraved tumblers designed as singular presentation pieces, to bottles by the boxcar, Pittsburgh made it. The city's gas and electric streetlights, lamps, and lamp chimneys lit the world. Its railway and traffic signals brought order to an industrializing nation's frenzy. Its plate glass provided windows for many countries and helped make possible the department store and the shop fronts of our consumer economy. Store windows of Carrara glass, basement windows of glass block, plate glass windows for the great palaces of consumption -- the uses for glass were endless.

The very creation of glass seems miraculous. As Samuel Johnson remarked in 1752, "Who[,] when he first saw the sand or ashes...melted into a metallic form...would have imagined that, in this shapeless lump, lay concealed so many conveniences of life?"¹ The miracle occurs when tiny grains of sand are melted at heat approaching 2,500°F, forming the molten mass from which glass is shaped. The process can occur in nature -- when lightning strikes a beach, or in a volcanic eruption -- but it is man who harnessed the formula for art and industry. In an intricate ballet performed for thousand of years, man alone, using the hot breath of life and simple metal tools, man has teased from the fiery mass a multitude of forms. While the interplay of fire and form has occurred in Western Pennsylvania for just 200 years, the region's impact on glass history has, nonetheless, been enormous.

Pittsburgh's strategic location on the inland river system, with the Allegheny Mountains to the east and the nation's future to the west, positioned the city ideally for the manufacture of this fragile product. Both of the earliest glass factories in the region -- the New Geneva Glass Works of Albert Gallatin, 45 miles southeast of Pittsburgh in Fayette County, and the Pittsburgh Glass Works of James O'Hara and Isaac Craig -- relied on the river network for trade. While Pittsburgh glasshouses experimented with marketing products in the East and, as early as the 1820s, even shipped goods to Central and South America, it was the Louisiana Purchase of 1803 that dramatically stimulated markets in the western half of North America. (The 1803 land deal with France brought an additional 885,000 square miles under American control.)

¹ Samuel Johnson, in *The Rambler*, -- this publication is an English newspaper published 1750-1753; exact date of essay unknown -- as quoted in Chloe Zerwick, *The Short History of Glass* (Harry N. Abrams, Inc., 1990), 13.

Between 1800 and 1850, the population in the western U.S. grew from 300,000 to over 5 million, while the population nationally exploded from 5.3 million to 23.3 million. As Pittsburgh assumed its position as outfitter to settlers bound for the nation's interior, the rugged Allegheny Mountains to the east also provided some protection from cheaper European imports and the eastern glasshouses. Growth in the industry, however, was by no means constant, and business partnerships in the region formed and dissolved continually in the early years.

Exploding demand for glass coincided with the introduction of press mold technology to the factory floor in the late 1820s, revolutionizing the industry. Using these hand presses, glass could be made more quickly and the forms could be standardized. This American innovation found wide application in Pittsburgh factories, and the city would eventually become the pressed glass capital of the nation. By 1837, 28 factories called the region home, with 15 sited in and around Pittsburgh, and another 13 found along the rivers in the outlying counties of Fayette and Washington.

Glass production expanded again during the Civil War years after William Leighton, Sr., of Wheeling, in present-day West Virginia, substituted cheap, plentiful soda lime for more expensive lead in the formula for colorless glass. When coupled with the technological innovation of pressing, his chemical innovation ensured that decorated or patterned glassware could be made inexpensively, opening the market for a new class of consumers. The quality of some of this pressed ware was fine enough that a British craftsman remarked,

J.B. Lyon and Co., Pittsburgh, U.S. exhibit articles in molded glass superior to any I have ever seen. It is impossible to detect the marks of the mould. The wine-glasses are as thin at top as if made by hand, showing that it is possible, by careful manipulation in pressing to make molded glass equally fine as by handwork.²

By 1865, there were 45 glasshouses in Pittsburgh, many utilizing these new technologies. They produced a wide range of glass that could be shipped to markets far and wide using the rail system. Only 15 years later, in 1880, Allegheny County – specifically, Pittsburgh – had no rival. The stacks of 51 factories loomed over the landscape. One-quarter of the nation's glass factories, producing almost 30 percent of America's glass, was found in the county, with 10 other factories in the region surrounding it. The volume of glass pouring from these factories was astounding. The Rochester Tumbler Co., northwest of Pittsburgh in Beaver County, boasted in 1886 that it was the "largest pressed glassworks in the world." The firm turned out 45,000 *dozen* tumblers a week – 540,000 drinking glasses from just one factory in one week. Contemporary accounts of the region's bottle works, flat glass houses, and glass novelty producers read much the same:

There has just gone into operation at the corner on 27th and Smallman streets, this city, a glass factory for the manufacture of glass balls for trap shooting. Messrs. Brown & Agnew are the proprietors...Working three shops at present, the output of the factory is 8,000 to 10,000 balls per day of as fine amber glass

² George Wallis, *The Art Journal, The Illustrated Catalogue of the Universal Exhibition* (Virtue, 1868).

as is made in the county. The working forces will be increased next week, and the product will be raised to 16,000 balls per day.³

The discovery of natural gas and the spreading tentacles of rail lines fueled the region's growth even more in the late nineteenth century. Factories sprung up where once there was farm land, as new glass towns with names like Ford City and Jeannette were born. The larger Ohio Valley region – Western Pennsylvania, West Virginia, Ohio, and even Illinois and Indiana – courted glass factory owners with offers of free gas and open land. To advertise plentiful gas, the town of Findlay, Ohio, went so far as to hang a banner proclaiming, "Findlay women chop no wood." Furnaces were fired throughout the Midwest, and by 1920, glass output in West Virginia and Ohio, when combined with Western Pennsylvania's, and accounted for fully 80 percent of national production. As the *National Glass Budget*, a trade publication, reminded its readers in 1921. "[I]t is desirable that the rest of the world should know – that the Pittsburgh district is predominant in a number of industries. If we had no steel mills or electrical concerns, we might be known as the "glass city"; for historically and also in point of the volume of our manufactures Pittsburgh has been the leader in the glass business."⁴

As new arenas opened in American life, as the urban landscape enlarged upwards and outwards, as humans charted the seas and explored the heavens, uses for the region's glass skyrocketed; windshields for automobiles, lighting for airport runways, night vision goggles, television tubes, and microchips – glass appeared in places never dreamed of. The industry grew and expanded, researchers in development laboratories feverishly tried to imagine and then to invent new uses for glass or new types of glass.

PPG Place (the corporate headquarters of PPG Industries, Inc.) is a monument to glass that defines the modern skyline of downtown Pittsburgh. Yet, the city is better known as the "Steel City." The region and the country retain little consciousness of the pivotal role Pittsburgh played as the national center of production, innovation, and marketing for the glass industry.

While artifacts of the built environment – the glass cathedral of PPG, the stack of factories now gone quiet – stand as silent reminders of a rich and complex past, audible reminders of that past are still heard in the region. Visit the industrial sites of the few independent producers or the factories of the national and international conglomerates that still dot the landscape of Western Pennsylvania and the surrounding region; from their parking lots one can hear the roar and practically feel the heat of the furnaces. Step inside PPG Industry's factory in Meadville, Pennsylvania, for example, and the interplay of man, material, and machine unfolds – glass history being made today.

There is in glassmaking a sense of continuity with the past. The material is still formed using the same basic ingredients of sand, soda ash, and lime. The major means of production used in the past 200 years – blowing, pressing, and machine operations – are still employed. And the workforce is still largely white and male. Many of the products bear, in form or use, a resemblance to those of the past. What has changed most of all is where glass is or is not made. The region with Pittsburgh as its center, though still home to glass companies, no longer forms the core of the industry nationally.

³ *American Pottery and Glassware Reporter*, May 13, 1880 (indexed in the J. Stanley Brothers Files, Corning Museum Library, Corning, N.Y.)

⁴ *National Glass Budget*, Jan. 15, 1921, 2.

A modern glass factory may introduce us to the past, but the products of the factory floor connect us most immediately to the story of glass. Each piece of glass made during the last two centuries was part of a process incorporating a functional or decorative concept or design with a system of production that included owners, workers, and a site to house the tools and machines for manufacturing. Equally important to the process was an economic system of market, demand, and sales, and a social and cultural context in which the glass object was used. The material objects provide entry to the history of their manufacture, to the history of the place they were made, and to the lives of those who used them and saved them. This book is about the glass made in Western Pennsylvania, but it is also about the millions of people who bought, used, and collected that glass. The objects connect the threads of these composite stories; they represent and reflect American life and culture.

Most of us rarely think about the glass in our own lives, much less glass in the lives of those from the past. Perhaps this is partly because glass is usually transparent: we look through it, not at it. Yet, the physical property of transparency makes this miracle material desirable for a variety of uses and circumstances. Chemistry that allows for the clear or colorless property in glass means, of course, that glass can transmit light. The earliest products of the Western Pennsylvania region, window glass and bottles, were valued not only because they provided protection, but also because they were transparent. The word “window” itself denotes this: it comes from the roots “*vindr*” or “wind” and “*auga*” or “eye.” Glass windows provide a protected view. Security window glass invented in the late 19th and early 20th centuries (wire glass and glass block) further capitalized on this property. They transmitted light – there was an element of transparency – but they were secure or stronger than regular flat glass. Transparency also made glass containers especially desirable in the early 20th century when the purity of food became a national public concern. Glass, non-porous and transparent, was perceived as a pure container. Glassmakers capitalized on this concern, marketing their wares with slogans such as, “But it in glass, see what you buy.”⁵

The public/private dimension of glass has always been important to its structural and architectural applications. The Crystal Palace in London, built for the Great Exhibition of the Works of Industry of All Nations in 1851, represented a revolutionary use of glass in construction. This all-glass building with an iron skeleton demonstrated the ability of glass to bring the outside in, while the inside of a building is protected from exterior elements. One could see in from outside and out from inside. What fun and what marketing possibilities! With the ability to manufacture large sheets, or plates, of flat glass, this principle could be applied to department stores. Customers could preview wares without ever stepping inside and sales could be made from the sidewalk.

Glass can also be silvered or its surface coated so it becomes reflective, or more “private.” In applications to eyeglasses, architecture, and automobiles, privacy glass ensures that the viewer sees out, but no one sees in. The optical properties of glass mean it can be bent or shaped so that it magnifies vision: worlds so private (small or far away) that they would never be visible to the naked eye are revealed through the use of glass.

⁵ Used often as a column insert in *National Glass Budget*; also used in a similar form, “Purity. Glass says it. Glass sells it.,” by the Glass Packaging Institute in its publications, c. 1996.

Glass permeates worlds beyond the physical, imbuing objects made from it with powerful symbolic and contextual possibilities. Glass, a physical material, is also a verbal metaphor. In language, its physical properties (transparency, reflection, transmission of light and color, durability, and fragility) and physical forms have symbolic meaning. Glass exists in the metaphorical world as both a positive and a negative...

The glass may be half full or half empty.

A world of possibilities is glimpsed through a window of opportunity.

To achieve total understanding, things must be crystal clear.

Being overly optimistic is to see the world through rose-colored glasses.

Broken glass has symbolic meanings that share this dynamic of positive and negative. Mirrors and crystals both have a mystical association; they reflect truth and capture reality. A broken mirror represents seven years bad luck... yet broken toasting glasses seal a pact, preserving a moment forever. Christening a ship with a glass bottle is a similar act of commemoration. In this instance, it is the fragility of the glass container, the fact that it can be broken, that guarantees the success of the christening. The custom at Jewish wedding of the bridegroom stepping on a glass to mark the end of the ceremony is believed to recall the destruction of the temple in Jerusalem almost 2,000 years ago. Broken glass reminds us that the world is a fragile, sometimes terrible, place. That concept was immortalized in Germany on November 9 and 10, 1938, when Nazis terrorized the Jewish population, breaking into homes and destroying businesses. That terror is now known as "*Kristallnacht*" – "the night of broken glass."

This symbolic construct of glass as metaphor has also been used in literature and in popular culture. We understand implicitly the meaning of Cinderella's glass slipper; it represents truth and honesty because it was made of glass – it will only fit its rightful owner. Deceit in ownership would be signaled by the shattering of the slipper. The transparency or clarity of the slipper further enhances the object as a symbol of purity and truth – as the slipper slides on, its rightful owner is revealed for all to see.

So, too, with the mirror in *Sleeping Beauty*. In glass, especially the silvered glass of a mirror, the reflected image indicates the real. Mirrors, we all know, do not lie.

Glass is similarly used as a symbolic device in the movies and in television. It allows a glimpse of a private dimension, peeping through windows at night, or, when broken, signaling a seminal moment from which there is no turning back. Its physical qualities may be deployed as dramatic or symbolic devices.

Just as glass permits symbolic metaphors in language or literature or popular culture, so, too, may its physical attributes be assigned or inspire veneration. Beauty may be implicit in the object or imbued by the viewer; glass may be appreciated as fine art but also is often cherished or coveted for its symbolic meanings. Clearly the American public feels a special connection to the substance, as glass collectors form one of the largest group of collectors in the country. Many more people also identify with a single piece of group of objects that has special meaning to them alone. Glass given as a ceremonial gift for weddings or other celebrations, as a commemorative piece at proms or banquets, or purchased as a souvenir, is saved because it reminds one of a special event or place.

Glass also becomes infused with personality when it is passed person-to-person by those who share a relationship. The object's form and being are unchanged, but its value increases because it reminds one of the previous owner. Many collectors actively

seek out that which they remember seeing or using – on grandmother’s table, for instance, or in the cupboards of their childhood homes. Glass is sometimes saved by happenstance; it sits in the windows of old homes, or abandoned on telephone poles, or in the corner of the garage, or on a shelf on the basement. As often, it is saved or sought because of what it means to the seeker...

or because the colors calls us

or because it is rare and beautiful

or because it links us again to someone or someplace that matters.

In this way, glass frequently has value exceeding the sum cost of the ingredients and labor necessary to produce the piece. Value comes from the associations made with the object. Some associations, especially those of quality or rarity, make glass a valuable commodity. Both individuals and institutions seek to add to their collections that which is the best, or the only example of its type. Others collect because of the representative nature of the material, or because it tells a story rooted in people, place, and time. The Historical Society of Western Pennsylvania, for example, has built and preserved a collection of glass because of what it tells us about the region’s past. Such glass links us to the people who invested in, and built, the industry; to names such as O’Hara, Ihmsen, Frank, Bakewell, Pears, Ford, and McKee that hung over the glasshouse doors; to men and women who took pride in their wares and saw the economic potential of the region. As Henry Clay Fry states in 1901,

There is room for another first class factory and another works will not injure the business. The country is growing, is rapidly increasing in wealth and people’ more goods and constantly needed, especially good wares. I propose to demonstrate that the best and finest glass in the world can be produced here, and there is a market for still better things... I intend to start anew and produce a line of ware not now made in the country that will equal in every respect the fine crystal of Val St. Lambert or Baccarat.⁶

Glass also teaches us the names – Lee and Thomas, Hansen and Shaw, Schnupp and DeCrescenttis – who walked through the factory doors and created the objects. In addition, it connects us to the millions outside the region who bought and sold and used and saved the glass. The glass survives in the Historical Society’s museum setting because of collectors, families, and museum staff who found it, claimed it, and brought it home to Pittsburgh, from whence it originally came.

Glass has import or meaning that ranges far beyond the regional confines of Western Pennsylvania. We share as a culture an understanding of how to use the products that were and are made in the region’s factories. The products connect to a particular place, in a particular time, and the material serves as a starting place for understanding a system of manufacture and market. Use and shared understanding have created a cultural construct whereby the material is assigned symbolic meanings. By looking at the glass in our lives and in the past, we can begin to unlock those meanings.

Chapter 2: Beginnings

The year is 1803. Meriwether Lewis, trapped in Pittsburgh by the vagaries of a drunken boat-builder, is at last ready to set off on an adventure that will forever change the young nation. On August 31, with the Ohio River running low, Lewis steps into his Pittsburgh-

⁶ *National Glass Budget*, March 9, 1901, 1.

built keelboat and heads west. The Lewis and Clark expedition is the talk of the countryside, the imagination of farmers and Washington politicians alike captivated by its possibilities. To the west lies land uncharted by European Americans – land which holds the potential for great commerce and development.

Albert Gallatin, a friend of President Jefferson and a statesman of national prominence from Western Pennsylvania, was well aware of the West's potential. An ardent map collector, Gallatin had special interest in the regions drained by the Missouri River. "The future destinies of the Missouri country," Gallatin stated, "are of vast importance to the U.S., it being perhaps the only large tract of country and certainly the *first* which lying out of the boundaries of the Union will be settled by the people of the U. States."⁷ Gallatin had aided Lewis in his preparations for the expedition and even had a new map drawn for him that showed North America from the Mississippi River to the West coast, blending the little-known about the region into one document. The hopes of many men rode off down the Ohio with Lewis on that August morning.

The population of Pittsburgh was especially attuned to the promise of the West. Sited at the confluence of the Allegheny, Monongahela, and Ohio rivers, the town's growth and development were linked to the inland waterways. By 1803, the settled population was about 2,000, a number which swelled each spring as thousands of travelers streamed through on their way west. Pittsburgh was both a way station and a jumping-off point, a place to arrive at and a place to leave from.

Several travelers passing through in the early 19th century recorded their observations. Among them was Thomas Ashe, visiting in 1806, just three years after Lewis set off on his western travels. Ashe remarked:

No inland town in the United States, or perhaps in the world, can boast of a position superior to this... it being delightfully situated at the head of the Ohio, and on the point of land formed by the junction of the Alleghany and Monogahela Rivers... The spot on which this town stands, is so commanding (in the military phrase) that it has been emphatically called the key to the western country... It contains about four hundred houses, many of them large and elegantly built with brick; and about two thousand inhabitants. It abounds with mechanics, who cultivate most the different manufactures that are to be found in any other part of the United States; and possesses upward of forty retail stores, which all seem continually busy. To this place most of the goods conveyed in wagons over the mountains in spring and autumn, and destined for the Kentucky and Louisiana trade, are brought, to be ready for embarkation.⁸

In addition to its strategic location, Pittsburgh benefited from the geographical features of the region. The Allegheny Mountains made overland travel to cities on the Eastern Seaboard arduous. In the early 19th century, the journey from Philadelphia to Pittsburgh was seven days in duration over rough, muddy roads. Travelers paid dearly for each household item or treasured piece of a former life they brought along. Freight costs and travel conditions made the shipping of fragile or heavy items especially prohibitive. Even the well-to-do chose carefully when packing for the move across the mountains.

⁷ Stephen Ambrose, *Undaunted Courage* (Simon & Schuster, 1996), 94.

⁸ Thomas Ashe, *Travels in America Performed in 1806* (R. Phillips, 1809), 19.

Pittsburgh, where the smoother highways of the inland river system began, became a busy marketplace for western-bound travelers. The town, however, was more than just a retailer of goods, for it was also a producer. The great seam of coal that sliced through the region provided fuel for nascent industry. By 1806, when Thomas Ashe visited, he could report, “Many valuable manufactories have been lately established there; among which are those of glass, nails, hats, and tobacco. The manufacture of glass is carried on extensively, and that article is made of an excellent quality.”⁹ Though not yet 10 years old, the region’s glass industry was already worthy of note.

The two glasshouse partnerships established in the region during the 1790s were headed by entrepreneurs keenly aware of the region’s potential. Albert Gallatin, a Swiss immigrant, first came to Western Pennsylvania in 1784 to examine a tract of land to which he had acquired title. He built a small log structure on his land in Fayette County at the junction of the Monongahela River and Georges Creek, a few miles south of present-day Masontown. Four years later, he purchased a nearby estate, Friendship Hill, and took it as his home. In the 1790s, Gallatin expanded his tract to encompass land lying on both sides of the mouth of Georges Creek. Though often away in Washington, D.C., he maintained and expanded his holdings on the edge of the frontier – in Western Pennsylvania and throughout the Ohio River Valley.

In 1795, Gallatin joined in partnership with his brother-in-law James Nicholson, and three other associates, John Badollet, Louis Bourdillon, and Charles Anthony Cazenove. The purchase by the five men of land near Gallatin’s Fayette County holdings gave them access to the river system as well as proximity to the overland routes that linked Philadelphia, Baltimore, and the growing capital of Washington, with the West. The site, already home to three mills, seemed ripe for commercial development. The partners added a retail establishment and made efforts to establish a viable town, which they named New Geneva in honor of Gallatin’s Swiss heritage.¹⁰ Gallatin, fully realizing the commercial potential of the property, wrote to his wife:

[W]e have the town seat (which is the nearest portage from the western waters to the Potowmack and the Federal City, and as near as any to Philadelphia and Baltimore) and three mill seats....[T]he most valuable will be on the river-bank, so that we will be able to load boats for New Orleans from the mill-door, and they stand upon one of the best, if not the very best, stream of the whole county. The boat-yards fall also within our purchase, so that, with a good store, we will, in a great degree, command the trade of this part of the county.¹¹

The enterprise, known formally as Albert Gallatin & Co., was capitalized at \$20,000 in an agreement that bound the partners for three years. Their business fortunes waxed and waned in the first two years, being severely tested in the second year by a general depression. In 1797, Gallatin’s partners, intent upon initiating glass production in Western Pennsylvania, tried to persuade six German glass workers at the New Bremen Glass Manufactory in Frederick, Maryland, to come to New Geneva instead of seeking their fortunes on the Kentucky frontier. Gallatin’s partners were convinced that the tools were at hand for a successful business – fuel from forests they owned, plentiful sand from local rivers, and a market to the west hungry for glass.

⁹ *Ibid.*, 19.

¹⁰ Raymond Walters, Jr., *Albert Gallatin: Jeffersonian Financier and Diplomat* (Univ. of Pittsburgh Press, 1969), 133-43.

¹¹ Albert Gallatin Letters, Sept. 6, 1795, Gallatin Papers, New York Historical Society. (Hereafter “GP, NYHS”)

Gallatin was less enthusiastic, believing that success and profits lay in the acquisition and development of real estate. He described the glass business as a “lottery ticket.”¹² Eventually, however, he capitulated, and in September of 1797, an agreement was reached with five of the German glassblowers: George Kramer, Adolphus Eberhart, Lubowitz Reitz, Christian Kramer, and George Reppert. The Gallatin group paid to construct the glasshouse, and also covered operating expenses. Profits were to be split between the two groups, with the glass workers also agreeing to reimburse the Gallatin group, without interest, for half of the start-up capital.

Correspondence between Gallatin, who was often away in Washington, and his partners documents the problems encountered by the fledgling glass house. Production troubles arose – in the proper curing of the wood used for fuel, in cleaning the sand, in preparing the batch, in procuring clay for the furnace pots – that sorely tested Gallatin’s patience. In desperation, he instructed James Nicholson in March of 1798 to “rent or sell or abandon the works; but let us not melt everything we have in the attempt.”¹³ A reorganization of the business partnership resulted, with Gallatin buying out Badollet and Cazenove and splitting from Bourdillon. He retained ownership and control of the group’s enterprises, with his brother-in-law Nicholson acting as his deputy. Gallatin also brought in a friend, a Mr. Mussard, to manage the glassworks and to remedy production problems. Matters seemed to improve and the group reported sales of £600.¹⁴

Forty five miles to the north, in Pittsburgh, the O’Hara-Craig factory was encountering similar challenges. This partnership, too, began with great optimism. Isaac Craig reported in mid-1800:

Colonel O’Hara...as well as myself will be greatly obliged to you for assistance in procuring a man with the necessary qualifications for Foreman in a glass manufactory in which we have prospect of succeeding – the situation of our works being at least equal to any in the United States – being on the bank of a river at the foot of the Coal Hill (opposite the Point Bridge) out of which we are supplied with the best Coal I suppose in the world and at a trifling expence. The principal component materials of Glass are also conveniently obtained and our river a safe road of conveyance for brittle ware....¹⁵

James O’Hara, like Gallatin, was fully confident of the region’s commercial potential. An Irish immigrant, he came to America in 1772 at the age of 20 and found employment as an agent trading with Native Americans. That work brought him to Western Pennsylvania. It is believed that he began buying property in the region as early as 1773, eventually acquiring tracts across a wide area into what is now Ohio, Indiana, and Illinois. O’Hara served as an army officer during the Revolution, marching his troops as far as Vincennes (now in Indiana). In 1781, he was appointed assistant quartermaster, eventually being stationed at Fort Pitt. Eleven years later, he was promoted to quartermaster general of the Army of the United States, a position which aided in his development of business contacts in the West. O’Hara’s business and military careers

¹² Gallatin to J.W. Nicholson, Nov. 24, 1797, GP, NYHS

¹³ Gallatin to J.W. Nicholson, March 9, 1798, GP, NYHS

¹⁴ In addition to the Galatin Papers, several biographies exist on this subject, including the one cited. For an excellent and detailed account of the early years of the Gallatin factory, see also Ken Wilson and Helen McKearin, *American Bottles and Flasks and Their Ancestry* (Crown Publishers, 1978).

¹⁵ Craig Papers, July 18, 1800, Carnegie Library, Pittsburgh.

were complementary: he traveled widely both overland and on the rivers, developed networks of trade and commercial relationships, and became an apt negotiator.

His first business venture involved the salt trade. O'Hara conceived of a means to bring salt from a salt works in Salina, New York, that reduced costs by half. Making the route from New York to Pittsburgh viable required O'Hara to carry out a series of engineering improvements for river navigation, as well as to build the boats and wagons for portage. Shortly thereafter, O'Hara joined his fellow Pittsburgher Isaac Craig in establishing a glasshouse at the foot of Coal Hill (now Mt. Washington) across the Monongahela River from Pittsburgh. Available capital, business experience, and trade contacts notwithstanding, the partners struggled with their new venture. While entrepreneurship often is advanced as a pivotal force on the frontier, exploring in some detail the duo's obstacles and accomplishments reveals the complex web of activities that fostered commercial development in the new republic.

Unlike Gallatin, they did not have an immediate source of skilled glassworkers and had to recruit them in the East and abroad. To bolster recruitment efforts, O'Hara had worker housing built on the glasshouse site. In correspondence, O'Hara mentions the new frame housing with space for gardens available near his factory. In one letter describing his operations, he explains his offer to skilled men of "dwelling houses and the best coal fuel at their doors, all free from cost, and all traveling expenses paid from their places of residence...." ¹⁶

Worker housing also helped O'Hara and Craig's balance sheet, since part of a worker's wages could be "paid" in the form of free or reduced-cost housing. Such arrangements became commonplace once the glass industry began to expand in the early years of the 19th century. For example, workers at the Bakewell glass factory near downtown Pittsburgh, which after its founding in 1808 quickly earned an international reputation for leaded glass, clustered in housing around the manufactory in an area known as "Bakewell's Court." ¹⁷ Another glasshouse owner, George Hogg, who from 1827 until 1849 operated a glassworks in Brownville, some 30 miles south of Pittsburgh on the Monongahela River, had three frame dwelling houses built on the property for workers. The two-story homes appear in a sketch of his works. ¹⁸

At the Lorenz factory in west Pittsburgh and the McCully factory in south Pittsburgh, the city directory of 1856-57 neatly documents the addresses for glassworkers. From the directory, a fairly graphic picture of accommodations for early industrial workers may be drawn. Frederick Lorenz's factory succeeded glassmaking at the original O'Hara/Craig site, on what is now West Carson Street on the city's South Side, just below downtown's Point. In addition to the glassworks, Lorenz owned the lots extending up Coal Hill, probably for the mineral rights and not for development. Just east of the factory stood the Zug and Painter Iron Works, which had its own rows of worker housing. The city directory documents that glassworkers lived in a series of dwellings up to #49 in "Lorenz's Row." An 1830s deed suggests the "new frame houses erected by Mr. Lorenz" were made out of wood. ¹⁹

¹⁶ James O'Hara Papers, June 1810, Historical Society of Western Pennsylvania Archives (Hereafter "OP, HSWP")

¹⁷ Information gleaned from detailed reading of Pittsburgh city directories.

¹⁸ Hogg Family Papers, Historical Society of Western Pennsylvania

¹⁹ Pittsburgh City Deeds, Nov. 17, 1832. Allegheny County Recorder of Deeds, Pittsburgh.

It is unknown how the homes were laid out, but primarily skilled workers (blowers and cutters), and office staff, such as clerks, lived in the dwellings with low numbers – 1 to 29. Although few blowers are found in dwellings numbered 30 to 49, laborers accounted for over 50 percent of the residents. This would seem to indicate some advantage to living in the dwellings with lower numbers; perhaps they were closer to the factory – or possibly further away, distance from the plant perhaps being preferable – or perhaps the lower-numbered dwellings were large or in some other way more desirable.

A variety store operated by Frederick Lorenz was located at 15 Lorenz's Row. Workers boarded at several of the dwellings and five widows also resided in the row with both Mary A. Lauth and Annie Rehr at #6. From the few workers who appear in the 1856-57 city directory and in either the 1850 or 1860 census, households appear to have contained only immediate or extended family, and most workers, usually married with children, were in their 20s or 30s. Some of their children were born in other states – primarily New Jersey, New York and Maryland – where glass manufactories were located. Such birth patterns clearly indicate that skilled workers pursued opportunity, with one blower, David Edwards, moving in a three-year span from Pennsylvania to New York and then back again to Pennsylvania.²⁰

Data on the McCully factory housing is not quite as complete, but it replicates some patterns evident in the Lorenz operation. The McCully complex was on Washington Pike, upriver from Lorenz's at the foot of the Monongahela Suspension Bridge (now known as the Smithfield Street Bridge) over the Monongahela River. Workers lived in two rows of housing, one of brick and the other of frame construction. Though listings exist for only about half the housing, a pattern does emerge. For the most part, skilled workers such as blowers, flatteners, and cutters lived in the brick housing and laborers lived in the frame dwellings. In the 1850s, it appears, class distinctions found on the factory floor persisted in housing as well.

Recruiting skilled workers and providing for their needs were just small parts of establishing a viable business. James O'Hara and Isaac Craig, for example, struggled to make the first Pittsburgh glasshouse a going concern. In 1804, Craig resigned from the partnership, with O'Hara buying out his shares, which amounted to about three-eighths of the business. After that date, O'Hara managed the business on his own, occasionally turning away the offers of men such as P. R. Frieze, a Baltimore merchant, to buy in as partners.²¹ A great deal of O'Hara's time was spent managing the details of the business – recruiting workers, arranging for the shipment of raw materials, finding reputable sales agents, and collecting debts.

Even with coal literally at the glasshouse door, O'Hara labored to keep his works up and running. Securing the basic ingredients of production was a constant task. Local sand from the riverbeds was abundant, but as late as 1806, O'Hara explained to competitors to the south at New Geneva, "I send Mr. George Cochran to you for a sample of the Sand used at the Geneva works, being informed that it is cleaner than the bank sand that I have been using."²² When "cleaner" sand is melted -- sand without trace minerals

²⁰ 1850 Federal Population Census, National Archives, Washington, D.C.

²¹ OP, HSWP, July 1805. Frieze (Phillip R. I. Friese) was an investor in and proprietor of the Baltimore glassworks of Frederick Magnus Amelung at the time he wrote O'Hara.

²² OP, HSWP, Nov. 21, 1806

– untinted glass products are possible. In February of 1807, he sent a keelboat to retrieve sand from the river beds near Morgantown, in modern-day West Virginia.

As for necessary ash compounds, obtained from the burning of hardwood trees, demand was so great that O’Hara also purchased ash by wagonload from as far away as central Pennsylvania and upstate New York. During the War of 1812, two of O’Hara’s shipments of ash were lost when British troops burned warehouses holding his shipments in Buffalo and Geneva, New York, costing him almost \$1,000 in lost raw materials.²³

During this time, glasshouse furnaces contained individual receptacles made of a formed and fired clay, called “pots,” in which the batch of raw materials was melted. Locating clay that could withstand the intense heat of the furnace was a constant concern. O’Hara advertised in local papers offering a \$100 reward to anyone discovering local stores of suitable clay. Primarily he purchased clay from afar – deposits of white clay in New Castle, Delaware, and in Bordentown, New Jersey, and also imported from Germany. O’Hara’s instructions to his shippers note his increasing familiarity with the technology of pot production. He cautions Mr. Labes, the merchant shipping him clay from Baltimore, to wait until April 1 to send his clay, to avoid any chance of it freezing. Several workers were employed just in the pot rooms and it appears their skills were greatly needed, as production records for the nine months of September 1812 to June 1813 document 131 pots broken during manufacture.

The primary articles of manufacture from O’Hara’s glassworks, just as from Gallatin’s, were window glass and hollowware. Settlement of the expanding nation meant construction of houses, businesses, churches, and institutions. Window glass brought light into the dark corners of new homes, extending the days and warming the body. Glass lights or panes, some as large as 13-by-18 inches, sheathed new shops, allowing a preview of the treasure within. Hollowware – glass bowls and pans, jug and jars, bottles, flasks, tumblers, and decanters – provided the homemaker and shopkeeper with an indispensable, non-porous, utilitarian container for food preparation or storage. Glass also became a traveling companion – the bottle for the hip pocket – for countless Americans on their daily rounds. And it became the display item for salesmen seeking to entice shoppers into the stores. Transparent or darkest black, glass bottles and containers held equally well the promise and surprise to be found inside.

O’Hara offered both lines of ware to customers around the nation, with window glass seemingly more requested than the hollowware. In this period, window glass could be produced in two ways. In the crown method, a gob of molten glass was gathered at the end of a blow pipe, slightly inflated, and then cut open. It was then spun rapidly until it flattened. After the piece was “annealed,” or slowly cooled, it was cut into panes. The center piece retained a bulls-eye or slightly thicker point from where the glass was attached to the metal rod. However, most window glass in Western Pennsylvania appears to have been produced using the cylinder method. O’Hara describes his glass in an 1811 letter as “...all the best cylinder glass I ever saw.”²⁴ In this method, a cylinder was blown and shaped, and then was swung back and forth to elongate it. The cylinder was then scored and its ends removed before being gradually reheated. During

²³ OP, HSWP, Reports.

²⁴ OP, HSWP, Letterbook, July 5, 1811.

reheating, it either slumped or was flattened with tools. After annealing, the piece was cut into finished panes.

Cutting of the panes was often a specialized task in the glasshouse. However, O'Hara's letters indicate that his blowers also became proficient cutters, giving them work when the furnaces were down. The cutting was done with diamonds, and in 1809 O'Hara searched for new bits, having used the original ones since 1798. '[Y]ou will confer a singular favor,' he wrote to a merchant named Davidson in Washington, D.C., "by purchasing one dozen or as many new diamonds as you can under that number and send[ing] them by mail. I cannot go on without them."²⁵ Panes were made in a variety of sizes. Studying orders, it seems the best seller was an 8-by-10 inch "light" (the other term for a pane). Several times, O'Hara laments that size being out of stock, and once in 1806, he even refers an order he was unable to fill to Gallatin in New Geneva.

The most prized worker in the window glasshouse was the master blower or "gaffer." The factory was generally organized into shops with a master craftsman at the head, assisted by journeyman workers, apprentices, and sometimes non-indentured boys. The apprentice often did the gathering, taking up the molten glass from the furnace pots and then sometimes shaping it on the "marver," or table, before it was delivered to the blower. The blower inflated and shaped the glass, often working at the bench or chair. If the piece needed an applied collar or lip (in the case of a bottle) or a foot or a handle (as with tableware) the blower would work those operations at the bench. The apprentice then helped remove the piece from the blowpipe and carried it to the annealing ovens, where it was slowly cooled to temper the piece and prevent breakage.

At any point, the boys in the glasshouse might offer assistance, sweeping up, stoking the furnace, providing tools to the workers. Journeymen had the skills to do some blowing, as well as other tasks, but were not as accomplished or as quick as a master craftsman.

The monetary value of the master craftsman is attested to by a production report from the O'Hara works. Charles Imsen (possibly "Ihmsen"), working two pots over nine months in 1812-13, delivered to the O'Hara warehouse 329 boxes of window glass. (A box contained 100 square feet of glass.) In the same period, he also blew 8,500 quart and porter (beer) bottles. A less skilled, possibly journeyman blower, John Hane, working one pot during the same nine month period, made only about one-third the window glass (91 3/8ths boxes and 3,550 bottles). O'Hara paid his master craftsmen about \$100 cash a month, plus lodging and free heating coal. With window glass selling at \$13 a box, O'Hara grossed about \$3,400 from the output of a single skilled worker like Imsen. The glass business had the potential to be quite profitable.²⁶

The market for Western Pennsylvania window glass and hollowware was extensive. It seems logical that O'Hara was himself a customer, requiring porter bottles to hold the product of his brewery, the Pittsburgh Point Brewery. He shipped window glass near and far, to Bedford and Chambersburg in Pennsylvania, and to cities from Ohio to New York. His glass went down-river to Lexington, St. Louis, Natchez, and New Orleans, and east and south over the mountains to Baltimore, Philadelphia, and Charleston. His bottles, too, traveled far and wide. While sending a Mr. William Morris of Carlisle an order of window glass in 1809, O'Hara slipped in a price sheet for his hollowware: "I

²⁵ OP, HSWP, Letterbook, Dec. 4, 1809.

²⁶ OP, HSWP, 1812-13, Production Report.

have annexed the prices of my hollow glass would this article do with you. I pack it in cases of \$20 value weighing about 100 pounds.”²⁷

While O'Hara's wares found a ready market, his retailers were not always prompt in holding up their end of the deal. In a series of letters in 1811, he endeavored to collect the “many balances due the glass works” that had exhausted his capital reserves.²⁸ Bills for glass to be sold on commission or credit were as much as two or three years overdue. His quality was undoubtedly high, and he bragged that his glass sent to Philadelphia had been judged a superior product by merchants there, as good as any but the finest New England glass. It wasn't that his glass didn't sell, O'Hara believed, but that his retailers did not pay.

By 1810, O'Hara also faced increased competition for the domestic market. The industry had expanded in Pittsburgh, as well as in New England and throughout the Mid-Atlantic states. Other entrepreneurs recognized the potential profits to be made, with an expanding national market and an improving transportation for reaching that market. The federal census of that year recorded 10 window glass manufactories in business employing about 140 glassblowers and producing 2.7 million square feet of glass. This production was exactly one-half the market, with an equal amount of imported glass filling the void. One Boston works provided a crown window glass described as “equal to any imported,” while other works made green or German (probably cylinder) glass.

Domestic production of hollowware and bottles was also expanding, and two recently established works in Pittsburgh supplied “decanters, tumblers, and every other description of flint glass of a superior quality.”²⁹

One of the most prominent flint (leaded) glass houses, as noted earlier, started as Benjamin Bakewell & Co. This firm still enjoys a reputation as one of the best-known and most-revered of the Pittsburgh factories, though it has been out of business since 1882. An insurance description from August 19, 1808, indicates that the glasshouse was completed and in operation by that date.³⁰ The lot fronted on the Monongahela River along Water Street, a central location with easy access to downtown Pittsburgh and the river. Like O'Hara and Gallatin, the company's production lines included bottles and window glass, but Bakewell was best known for its colorless glass.

Thomas and Benjamin Bakewell and their associate Benjamin Page brought capital and business acumen to the partnership, while for glass expertise they relied on workers such as Edward Ensell. As early as April 1809, the company advertised an “assortment of products,” which, as detailed in later ads, included decanters of three types, tumblers, goblets, wine glasses, jars, tinctures, lamps, butter and sugar “basens,” cream jugs, wine coolers, egg cups, and on and on.³¹ The firm was visited by the well-known and unknown alike, and numerous accounts of its operations found their way into print. Of

²⁷ OP, HSWP, Letterbook, Oct. 28, 1809. General information about the distribution of products comes from a complete reading of the Letterbook.

²⁸ OP, HSWP, Letterbook, July 5, 1811.

²⁹ James Leander Bishop, *History of American Manufacturers*, volume 2 (Edward Young & Co., 1864), 156.

³⁰ Christina H. Nelson, “The Pittsburgh Glasshouse of Blakewell and Ensell: A Contemporary Description,” *Glass Club Bulletin* 137 (1982), 10-13.

³¹ *St. Louis Gazette*, April 1809 (page number unavailable).

note are the positive comments on the cold processes of decoration executed at the firm, namely cutting and engraving. "I went through the flint glass works of Mr. Bakewell," remarked one Thomas Nuttal in 1819, "and was surprised to see the beauty of this manufacture, ... in which the expensive decorations of cutting and engraving ... were carried to such perfection."³² Of the glass made for President Andrew Jackson, it was said: "We think this specimen of American workmanship will vie with the best productions of the French and British articles."³³ Glowing reports abound. By the late 1810's, Bakewell clearly had established a reputation for quality and workmanship that attracted an enviable clientele, including the White House.

The Bakewell factory is also recognized as the training ground for the second generation of glasshouse owners in Pittsburgh. Men whose names would later be associated with their own major concerns – Thomas Evans, William McCulley, James Bryce, and others – began their careers at Bakewell. Following the fortunes of one of these families demonstrates the important role that Bakewell played in furthering Pittsburgh's industry; the exercise also exposes the sometimes brutal workplace arrangements of the early 19th century.

The Bryces were Scottish immigrants who came to Pittsburgh from Philadelphia in 1820. A young son, James, his father, and older brother William found work as common laborers at Bakewell, the father then advancing to the manufacture of lead, which probably contributed to his early death a year or two later. The family was poor and James' career at the glasshouse had begun at age 11. He describes himself as the "youngest boy about the place," proud to bring home his dollar and a quarter each Friday night to contribute to the family accounts. He worked directly for a blower, probably as a carrying boy, for he reports that he "was there nearly two years before I began to gather." Work was hard and long and James bore the brunt of a brutal master, recording his treatment with scant attention to literary convention:

He never beat me because he could find no reasonable excuse to do so, but he made me miserable by a continual system of petty annoyance and vexation and scolding and swearing at me After I left him he wished me to go back to work for him again. I refused, and from that time he became my bitter enemy using every means in his power to injure me. and even, with forecasting malice trying to hinder me from learning my trade. by falsehoods to the masters. As well as by endeavoring to destroy what little confidence I had in myself. but let it pass, I had the satisfaction of knowing him thoroughly and despising him heartily.³⁴

In 1826, James' father lay dying. On his death bed, he asked the Bakewell firm to apprentice his son. Within the year, James would sign a formal indenture to apprentice as a glassblower and learn the "art, trade, and mystery" of glass.³⁵ He began his career in the "small" department, where wine glasses, salts, cream jugs, and other table items were produced. He then progressed to working in the castor pots. He both came of age and completed his apprenticeship in 1833, but it was not until two years later, when the

³² Thomas Nuttal, *A Journey of Travels into the Arkansas Territory During the Year 1819*, vol. XII, 45 (Univ. of Oklahoma Press, 1980), 45.

³³ *Warren County Messenger*, July 30, 1829.

³⁴ All quotes from James Bryce's journals, transcript and copy, HSWP Archives, Pittsburgh.

³⁵ Copy of indenture reproduced in Lowell Innes, *Pittsburgh Glass 1797-1891: A History and Guide for Collectors* (Houghton, Mifflin, 1976), 37.

blower H. Whitehouse left, that he was offered a place as a master blower. James Bryce, age 23, had already spent 12 years in the glasshouse, yet was ambivalent about “the place I hold now,” a station in life that once was the “bound of my ambition but now when it is attained it gives me little pleasure.”³⁶

As James struggled on the factory floor to chart his future and determine his fate, so too did the Bakewells and all American glassmen struggle in the 1820s and ‘30s to navigate the ever-changing currents of their business. National economic conditions and international political realities buffeted the market. The American glass business had expanded during the boom years of the War of 1812, when an embargo on imported good had benefited the nation’s manufacturers by protecting them from cheaper foreign glass. As Benjamin Page recalled later in a letter:

[I]n the year 1813 ... we were then at war with England & by the tone of the communications of our Executive to the citizens of America – as well as by the feeling prevalent in the country & cherished by the Government, every body believed the prospect of peace was distant The demand for glass increasing rapidly in consequence of the restrictions on foreign importations of the article, induced us to exert ourselves to the utmost to ‘make hay while the sun shone’ – and when peace was restored in 1814 bringing the full tide of successful experience as Mr. Jefferson would express it we prosecuted the business with the greatest possible vigour not doubting the result would be singularly prosperous....³⁷

While pressure from imports was extinguished, glass manufacturers had also begun to enjoy unprecedented access to the nation’s western markets. Innovations in transportation, especially the introduction of the steamboat to western waters in 1811, made the movement of goods cheaper and easier. Several owners, O’Hara and Gallatin among them, recognized the value of better transportation, of all kinds, to the successful prosecution of business. They advocated public management and improvement of both roads and waterways, and the linking of the two to create a more unified system. Canals and bridges, they could see, speeded commerce.

O’Hara had seen the benefits first-hand when he reworked the transport routes from upstate New York to Pittsburgh to slash the cost of salt (an essential frontier commodity for preserving and curing). Albert Gallatin, meanwhile, traveled often between Friendship Hill and the nation’s capital, giving him long personal experience with the awful state of the roads. He further recognized that the country’s new markets lay principally to the west, and that being able to reach and develop the interior of the country would require drastic improvements in all systems of transportation known at the time. A substantial percentage of Gallatin’s writings and speeches before Congress was devoted to extolling how travel made easier would multiply the “national wealth.”

In response, the national government did embrace the cause of infrastructure-building, supporting the building of national roads and turnpikes, as well as canals. Pennsylvania also allocated massive financing for transportation in the first half of the 19th century. Of the 2,333 corporations chartered in Pennsylvania between 1790 and 1860, two-thirds were transportation companies. The state purchased more than \$100 million worth of

³⁶ Bryce Journal, HSWP Archives.

³⁷ Benjamin Page letter to John Hammond, HSWP Archives, Jan. 3, 1825.

shares in canal and railroad companies during that period. Pittsburgh, in the western corner of the state, was more often than not the western terminus of state-financed improvements.³⁸

Americans enjoyed a brief respite from European, especially British, competition after peace was declared in 1814. President Madison, aware of the beneficial effects of embargo on his nation's manufacturers, retained war-time duties on imports for two more years. During the keelboat days, before the war and the steamboat, when products could be moved most economically downstream, Pittsburgh glasshouse owners had been better positioned than Europeans to exploit the western markets. After the war, however, in 1816, with the steamboat allowing cheaper movement of goods to the nation's interior – upstream as well as downstream for the first time, via the port of New Orleans and the inland river system – the British began exporting huge volumes of glass. Having made glass for 400 years, they had remedied the production problems still shackling American manufacturers, and had a pool of skilled workers from which to draw. British producers devastated many American glassmakers, including those in western Pennsylvania.

In addition, domestic competitors to Pittsburgh glass improved their positions when one of the modernizations that Gallatin and O'Hara had begged for – the National Road (present-day U.S. 40) – opened in 1818, connecting both Mid-Atlantic and western cities with Pittsburgh. As other improvements in roads, bridges, and canals became operative in the 1820s, Pittsburgh's glassmakers found themselves throttled on all fronts.

The 1820 U.S. Census of Manufactures records in detail complaints of local factory owners. From Fayette County: "[T]his institution would be in a flourishing condition – the sale & demand for the articles rapid & Extensive, but for the immense importation of Glass from Europe." Across the river from Pittsburgh, meanwhile, a window and hollowware manufacturer reported how imports drove down prices: "[A] Box of Glass would sell for \$14 Cash when at the present time a Box cannot command In Trade more than \$5 – If the demand for Glass does not increase all such Establishments must Shut up." Finally, the report from the esteemed Bakewell of Pittsburgh recounted in detail the difficulties facing glass manufacturers. The firm's use of raw materials had plummeted from the 80-100 tons of 1815, a boom year, to 20 tons in 1820. In the same period, the workforce shrank from 30 men and 30 boys earning about \$20,000 to 10 men and 12 boys earning about \$6,000. The value of the company's manufactured product had fallen by four-fifths to about \$20,000. Bakewell summarized the situation in clear terms for the government:

Since the year 1816 the establishment has been declining – partly owing to the embarrassed situation of the Western merchants – but chiefly to the incessant importation of foreign glass and the sales of it at auction much below its intrinsic value. The import (tax) on glass is at present less than it was 15 or 20 years ago[.] It is introduced into our markets by means of Steam Boats at less than one fourth of the former expence of transportation from the Seaboard - & the late allowance of bounty paid by the British Government on Glass exported to the United States is more than the amount of duty on Importation. To these causes combined is attributed the extreme depression of our business – and until they

³⁸ See Catherine Reiser, *Pittsburgh's Commercial Development 1800-1850* (Penna. Historical and Museum Commission, 1951) for a complete discussion of state transportation systems.

are removed, at least partially, no improvement in the demand for the articles of our manufacture can be expected.³⁹

Benjamin Page, describing the desperation many businessmen felt, lamented that “from the beginning of 1817 till about the middle of 1822 we were literally gasping for breath – & knew not from Tuesday to Friday & again from Friday to Tuesday how we should get money to support our workmen.” By 1818, the firm owed \$50,552 and carried an additional \$37,960 in accounts due that Page described as “very doubtful.”⁴⁰ The firm, which provided elegant cut decanters for President Madison in 1816 and was at work in November 1818 on glass for President Monroe, was in an “appalling situation.”⁴¹ All the manufacturers in the city of Pittsburgh felt the awful pinch, as employed workers in the city and vicinity decreased from 1,960 to 672 between 1815 and 1819. In the glass industry, in December 1819, the depression was evident: glass works and glass cutting workers had fallen from 169 to 40; product value from \$235,000 to \$35,000.⁴²

By this time, it was clear that the country’s economic future lay to the west. Yet, even those areas faced desperate economic conditions during the period, further handicapping U.S. manufacturers intent on expansion. As with transportation, the national government intervened. Spokesmen for Western Pennsylvania manufacturers were both politicians attuned to their concerns, such as Henry Baldwin, and men with national interests and reputations, such as Henry Clay. The two led the battle to enact a series of domestic tariffs in the 1810s and 1820s that provided a more favorable business environment.

In 1818, Baldwin, as chairman of the U.S. House Committee of Manufacturers, spearheaded passage of a duty increase on cut glass. The bill provided some protection for flint glass manufacturers such as Bakewell, but did little to help makers of window and container glass. Six years later, in 1824, with the support of protectionists such as Clay, a more comprehensive tariff known as “The American System” passed Congress. It incorporated not only Clay’s desire to shield U.S. manufacturers but also permitted the country to earn a measure of commercial independence from England. “The truth is, and it is vain to disguise it,” Clay had declared in 1820, “that we are a sort of independent colony of England – politically free, commercially slaves.”⁴³

The law was designed not only to provide a more fair international market for American goods, but also to develop the home market. Clay and many others believed that a strong manufacturing sector also provided a ready market for American farmers; those whose daily work was in the factory, the reasoning went, would rely on those whose work was on the farm, and vice versa. The tariff had the desired effect. By January 1825, Benjamin Page reported, “The country certainly is rising from the depression and oppression to which it has been subjected for so long a time.”⁴⁴ Although the tariff issue was not finally resolved – it would be revisited in the 1830s and again in 1842 – clearly government and industry had joined their interests.

³⁹ I am indebted to Arlene Palmer Schwind for providing transcribed copies of the 1820 U.S. Census of Manufactures.

⁴⁰ Page letter to John Hammond, Jan 3, 1825, HSWP Archives.

⁴¹ Ibid.

⁴² Bishop, 250.

⁴³ Joseph M. Rogers, *The True Henry Clay* (Philadelphia: Lippincott Co., 1904), 218.

⁴⁴ Page letter to John Hammond, Jan. 3, 1825, HSWP Archives.

In a little more than a quarter-century, great change had swept through the glass industry. Its owners and craftsmen wrestled locally with establishing and supplying the industry, while also involving themselves in issues of national import: building infrastructure, working with the federal government to stabilize the fledgling industry, and staking out the domain of technical expertise in which American manufacturing would excel. From two factories in 1797, the glass industry had expanded in Western Pennsylvania to include four factories in the city of Pittsburgh and five more in the surrounding region, with a total output valued at almost \$200,000 a year. The 1826 city directory reported:

In the manufacture of this article, Pittsburgh and the surrounding country, enjoys an extensive reputation. It is needless for us to repeat what we have said before, as to the advantages we possess – let it suffice, when we say, that the west, at least this part of it, is secure against any competition elsewhere in this branch of business. The glass of Pittsburgh and the parts adjacent is known and sold from Maine to New Orleans Should the waters of the east and west ever be connected, glass, of itself, will be an object of immense trade.⁴⁵

Entrepreneurs such as Albert Gallatin, James O'Hara, the Bakewells, Benjamin Page, and hundreds of glass artisans such as Charles Ihmsen, James Bryce, and many others who remain nameless, are the progenitors in Western Pennsylvania glass history. Pittsburgh's commanding location and the region's abundance of natural resources – its coal, its wood, and its rivers – spurred industrialization on an ambitious scale. The technological change that is always a key part of commercial development would have a new focus in coming decades. Technology would reorder the factory floor; indeed, factories would grow to become huge complexes, and be reconfigured again and again. Technology, in fact, would do much more: it would also recast the glass marketplace.

Chapter 3: Workshops

Textile factories and iron foundries, salt and shoe works, rolling mills and sawmills, steam engines and smoke stacks – the landscape of Pittsburgh vibrated with the sights and sounds and smells of industry. With people bustling, and machinery and man humming in concert, there was activity everywhere. Nuggets of black gold fired the furnaces, great volumes of black smoke belched into the sky. Pumps and pistons, spindles and stacks, rabs and rollers – workforces on factory floors orchestrated a syncopated dance of coal-fired, steam-driven machinery. This was the city at work, Pittsburgh, the Birmingham of America:

Ascend the hill around which the city lies and you may see hundreds of furnaces vomiting forth immense volumes of black smoke mingled with red flames. Among them are scattered little steam pipes peeping from the roofs & always snorting out their white steam like so many whales. There are foundries & glass houses & salt works & steam mills & steam factories without number...so full is the city of smoke from all these immense fires of mineral coal that one cannot

⁴⁵ 1826 Pittsburgh City Directory, p. 69.

see from one end of a straight level street to the other. The coal is dug as free as dirt all over the country for fifty miles around.⁴⁶

It was in this milieu that the glass industry came of age in the middle decades of the 19th century. Throngs of mechanics and machinists contributed greatly to a culture where commerce and industry were of one consciousness. A place where the intellectual capital of industry would prove as important as the material capital it generated, Pittsburgh became the glass capital of the nation.

Once the nation's and the region's economy cleared the post-war crises of the 1810s and early 1820s, factory owners, able to reply as always on the country's rich supplies of natural resources, could concentrate on organizing human and technical capacity to meet the demand for glass objects. In the early 1820s, the methods for producing glass in Western Pennsylvania were little different from those used elsewhere for hundreds of years. The factory floor was organized into shops with master craftsmen at the head, tools were simple iron and wooden forms – the blowpipe, shears, jacks, and punty iron, allied with the carved wooden molds for shaping and patterning the blown glass – and the factory building and the furnaces were of a set and relatively simple design. By no later than 1826, however, change was afoot. An American innovation, the mechanical pressing of glass, would revolutionize the industry.

It has long been thought that Pittsburgh's Bakewell company deserves the greatest credit for the innovation of pressed glass. As furniture knobs were the initial items known to be pressed, and a patent filed by John P. Bakewell on September 9, 1825, is known to have claimed an "improvement in making glass furniture knobs," Bakewell was assumed to have developed the pressing process. Because all U.S. patents between 1790 and 1836 were destroyed by fire, the original Bakewell patent has not been available to scholars. However, recent scholarship indicates that pressing was first explicitly described and patented by Henry Whitney and Enoch Robinson of the New England Glass Co. on November 4, 1826.⁴⁷

Previous to the Whitney-Robinson patent, small glass objects such as furniture knobs and chandelier drops could be pinched in simple hand-held presses or made using a hand-held plunger to force molten glass into a mold. In addition, for years pattern had been added to the surface of glass objects by blowing the object into a carved, sometimes hinged hold. However, the new mechanical process used a bench press, a machine with a levered arm that could force the plunger or die into the mold. The machine allowed for greater control of the pressing process and standardized the decorative ornament of the glass piece.

Pittsburgh factories moved quickly to capitalize on this invention after John Robinson of the Stourbridge Flint Glass Works filed a patent in October of 1827 for pressed glass knobs. Bakewell filed again in May of 1828 for, "an improved method of making glass furniture knobs or handles." Across America, glass companies joined the fray: at least

⁴⁶ Elizur Wright letter to Susan Clark, Library of Congress manuscripts division, Nov. 24, 1828, quoted in "The Black City: Elizur Wright Jr.'s View of Early Industrial Pittsburgh", *Western Pennsylvania Historical Magazine*, Vol. 55 (1972), p. 250.

⁴⁷ Kenneth M. Wilson and Kirk J. Nelson, "The Role of Glass Knobs in Glassmaking and Furniture", *Antiques* (May 1996), p. 753.

nine patents for pressing glass were filed by the close of 1830, and additional 24 patents by 1836.⁴⁸

It is not surprising that men such as the Bakewells recognized the potential of this new technology. They traveled widely throughout the Ohio River Valley investigating a variety of investment opportunities (oil wells in Cincinnati and saw mills in Kentucky, to name just two). They witnessed first-hand fledgling industry and the steam-driven, interlocking metal machinery that powered it. As travelers made it a habit to tour the fiery mills of Pittsburgh, it seems safe to suppose that native Pittsburghers often crossed the thresholds of their fellow industrialists. The Bakewells, like many Pittsburgh business owners, involved themselves in the civic life of the city. Thomas Bakewell who served appropriately enough as “Inspector of Pot and Pearl Ashes,” as well as on bank and insurance company boards, and as President of the Board of Trade shortly after its 1836 establishment, had cause to visit the city’s business and commercial establishments. A great deal of useful information on industry, machinery, and manufacture would have been available to a man in his position. Indeed, in the patent for a press machine filed by Thomas and John P. Bakewell on January 14, 1829, they described the design of this new glass press as, “very similar to several of the modern printing presses, to many seal presses, working with the toggle joint, and various other machines.”⁴⁹

While pressing changed the production possibilities of the glass factory, it did not immediately affect the types or forms of glass made. Molded glass continued to replicate known forms, such as plates, bowls, salts and other pieces of tableware. The advantage of pressing was speed and standardization: exact copies of the same object could be turned out by a pressing crew at a faster rate than if done by hand and each piece would look markedly alike. Deming Jarves of the Boston and Sandwich Glass Co. reported that a crew of five working a press could make, “a beautiful tumbler in about forty seconds, or about one hundred in an hour,” reducing the cost so much that by 1846, Jarves estimated that public demand for glass had increased tenfold.⁵⁰

While not changing the product – except to standardize it - the press did force a reorganization of the factory floor. A press shop generally required the services of at least three workers. The pressing machine, with a mold in place, was set near the furnace. The first worker, usually a boy, gathered the glass from the furnace on a metal rod, called a punty. The gatherer held the taffy-like molten glass over the mold and the presser cut off the exact amount of glass needed for the piece with large scissor-like shears. The glass fell into the mold and the plunger was pressed down into it, forcing the glass up against the sides of the mold. After the glass had cooled slightly, a third worker opened the mold, removed the piece and carried it to the annealing oven. If the shop had multiple molds for the same piece and was working them continuously, one worker removed the piece from the mold and another, often a boy, carried the finished pieces to the annealing oven. The technology of molding pieces with handles did not develop immediately, so hand-finishing of pitchers, mugs, etc., was still done. In general, however, those shops that were press shops no longer relied on the master craftsman or skilled hot glass worker. The primary skilled workers were those who understood the interaction of hot glass and machinery: the presser, who possessed hand eye

⁴⁸ Ibid. and Kirk J. Nelson, “Progress Under Pressure: The Mechanization of the American Flint Glass Industry, 1820-1840”, Master’s Thesis (University of Delaware, 1988) pp. 111-125.

⁴⁹ Quoted in Nelson, “Progress Under Pressure”, p. 116, from “Journal of the Franklin Institute” 3 (April 1829) p. 258.

⁵⁰ Nelson, “Progress Under Pressure”, p. 3.

coordination and manual skills, but did not hand form objects, and the mold maker who created and carved the metal molds in which glass was formed.

Of paramount concern when working with a mold made of iron or brass was maintaining its temperature. If it were too cold, the glass would stick to it, ruining the piece and slowing down the production schedule. If the temperature wavered, pitting and rough edges resulted. Pressed glass patterns were designed to disguise the imperfections caused by this interaction between the glass and the mold. Designs tended to cover the entire body of the piece, and backgrounds were filled with stippling. The early pressed glass of this type is known popularly to collectors as “lacy,” because the all-over design often resembles delicate lace patterns. The intricate and time consuming nature of the carving done to produce the molds for this glass may explain why most of the early pressed pieces were open bowls or flat pieces such as plates or window panes.

Mold-making was detailed work. Even in the early 20th century, when machinery and tools had been greatly improved, a single mold might take several hundred hours to complete, depending on the complexity of the piece.⁵¹ Mold work was probably initially done by the blacksmiths who produced the metal tools for the glass house. Fairly soon after the invention of pressing, glass factories included mold-makers or machinists on staff. Independent mold shops also were established, with the shop of Pittsburgh mold maker Joshua Laird in business by the late 1820s.⁵² Molds were provided both for tableware and for bottle manufacture, where the use of two-piece hinged metal molds was in widespread use by the 1830s. (All bottles were still blown into the molds, their narrow necks making mechanical plungers unworkable.)

Improved national economic conditions, the invention of pressing, and the growth of a national market that could afford glass products – now less expensive than ever - led to rapid expansion of the industry. By 1840, there were 28 glass factories in Western Pennsylvania; 15 were in Pittsburgh and its immediate environs, and the other 13 were in Washington and Fayette counties. The region was home to one-third of the nation’s glass producers, and its output was valued at 24 percent of the national total, which was \$702,000.⁵³

Industry expansion based on pressed glass technology increased demand for skilled machinists and mold-makers. A preeminent national mold shop, Washington Beck’s, opened in Birmingham (Pittsburgh’s South Side) in 1859. Beck’s skills and enterprises were wide ranging: his firm designed and produced molds, presses and machinery; he patented glass production methods, machinery and designs; he was a silent partner in glasshouse ventures; and he was a founder of South Side’s Iron and Glass Bank. From a small room of just 8-by-12 feet, his business grew to fill a two story building of 72-by-80 feet with 30 workers. By 1886, his products were in use throughout America, and in Europe and Japan.⁵⁴

In the decades after the Civil War, as the region’s glass industry burgeoned, so, too, did independent mold shops. In 1856, a number of such machinists appeared in the

⁵¹ This is attested to by a letter in the Archives of the Wheaton Village Museum of Americana Glass. Mold maker ?? documents his time in creating three molds for McKee – time ranges between 80-350 hours. Letter to ???

⁵² Helen McKearin and Kenneth Wilson, *American Bottles and Flasks and Their Ancestry* (), p. 411.

⁵³ Bishop?, Pitt. City Directory.

⁵⁴ *Pennsylvania Historical Review* (1886) p. 60.

Pittsburgh directories, some like Marshall & Brothers doubtless serving the glass industry as they included among their products hand and lever presses. Washington Beck' was the first to list his shop as a mold-making business and to mention specifically glass molds and presses in its advertisements. By 1880, three companies advertised themselves as producers of glass molds and presses, and one, the Pittsburgh Clay Pot Co., as a specialty producer of glass melting pots. By 1885, 12 companies just in Pittsburgh produced pots, presses, molds and glass production materials such as sand. There was significant integration of capital between the glass industry and its support industries. For instance, the Diamond Alkali Co. was founded by the directors of the MacBeth-Evans Glass Co. in concert with glassmaker C. L. Flaccus and Hazel Atlas Glass Co. Their investment guaranteed ready access to soda ash and other chemicals for glassmaking without going through an outside supplier.⁵⁵ As Western Pennsylvania became the center for glass production, support industries providing machinery, tools, and materials flourished.⁵⁶

A combination of other factors also spurred growth. An innovation in the chemical formula for glass was of central importance to the expansion, for instance, of the pressed tableware industry. William Leighton Sr., experimenting at Wheeling in 1864, developed a formula for producing high-quality colorless glass using soda lime in place of expensive and dangerous leads. Application of the formula meant that clear glass similar in weight and resonance to leaded glass could be produced less expensively, providing an ideal material for the mass production of patterned tableware. Since lime glass "set up" or became rigid more quickly than lead glass, advances in the production process were needed so that glass could be worked more quickly. Changes in furnace design, fuel source, and the annealing of glass followed.

The same year that Leighton developed his soda lime formula, Pittsburgher Thomas Atterbury patented a continuous mechanical annealing furnace. Annealing was vital to glass production and quality control because as glass cools, the exterior cools most quickly, creating tension within the piece. Proper annealing, or slow cooling of the glass, resolves that tension and protects against brittleness, cracking, and breakage. Before 1865, annealing was done in kilns: glass was loaded in, the kiln was sealed, then heated, and later left to cool. Atterbury's mechanical "lehr," or oven, provided more control and management of the process, requiring less hand labor and production time. Atterbury's design was for a circular lehr, while innovations by others in Pittsburgh, such as Theodore Zeller, and elsewhere, led to the development of a linear lehr similar to that still in use today.

Furnace design and capacity were also crucial elements in achieving the full production potential of press mold technology. Pressing increased the speed of production, which demanded more melting capacity in the factory. In 1820, the average furnace pot held 700 pounds of melted batch – not sufficient to keep up with the needs of a press shop. Attempts were made to increase the size of the pots without decreasing the even melting of the batch, its ingredients, or the clarity of the glass. Philip Arbogast made an early attempt to develop a smokeless, cleaner-burning coal-fired furnace in 1873 when he

⁵⁵ *Minute Book of the MacBeth-Evans Glass Co.*, HSWP Archives, Evans Family Papers, February 10, 1910.

⁵⁶ Information based on unpublished research conducted by undergraduate intern Edward Slavishak for HSWP in city directories and period reviews of industry.

patented the process of combining hot air with the coal gases just before they passed into the pot chamber.

Arbogast was one of a generation of Pittsburgh innovators who gained his experience on the factory floor working hot glass. With his brother Alexander, he began his career as a glass blower in a South Side factory in the 1850s. The two were probably bottle blowers, for in 1860, Alexander began a bottle manufactory under the name Arbogast & Kappahn. The partnership dissolved in 1861, though the business continued under Arbogast's management as a black bottle manufactory producing wine, brandy, porter and schnapps bottles. Out of business by 1865, the brothers continued working as glass-blowers, Philip working side-by-side with his sons, J. L. and C. V. Arbogast.⁵⁷ In 1873, Philip Arbogast patented the process discussed above and assigned it to F. T. Plunkett and D. O. Cunningham, bottle manufacturers who were probably his employers. In 1881, he made a major technological contribution to the industry when he patented an early automated machine for blowing glass bottles.⁵⁸ The full application of automation would not be realized until the early 20th century, but Arbogast's machine signaled the future of glass production.

The discovery of rich sources of natural gas in the region and its application as a fuel brought changes to the factory floor and changes as well in the organization and location of factories. First used at the Rochester Tumbler Co. in Beaver County, natural gas became the industry's fuel of choice. It burned at a more constant and intense heat, was easier to control, and did not cause discoloration. There was much experimentation of the time with introducing gas as a furnace fuel and adapting furnace design to allow for the continuous production of glass. Movement was away from the smaller pot furnaces to larger tank furnaces, in which a new batch could be loaded at one end while the molten glass was worked continuously at the other. By ensuring a steady supply of glass, workers were not idle while an individual pot heated to a usable state.

Many patents were filed in the years 1865 to 1885 on continuous tank production – some workable and some completely inapplicable. The Atterburys, schooled in the rich industrial milieu of Pittsburgh, borrowed from the reverberatory furnaces used in iron puddling for their furnace design.⁵⁹ John Vogel, an inventor living just north of Pittsburgh in Sharpsburg, simply replaced the interior of a pot furnace with a single tank.⁶⁰ One widely applied and copied design was devised by Charles Siemens, who patented a regenerative furnace in England (1875) and then in the United States (1880).⁶¹ The Siemens continuous tank furnace was first used in the window glass industry. By combining continuous tank technology, the Wheeling soda lime formula of 1864, gas for fuel, and linear annealing lehrs, the full potential of pressing technology could be realized.

The annealing ovens may have been linear, but progress was not: technological innovation in the glass industry was a process of fits and starts, of forward and backward

⁵⁷ Pittsburgh city directories 1860-75; *Pittsburgh Press*, "Old Time Glass Blower Sighs as Plant is Razed," Aug. 23, 1931.

⁵⁸ Dennis Zembala, "Machines in the Glasshouse: The Transformation of Work in the Glass Industry, 1820-1915," doctoral dissertation, George Washington Univ., 1984), 192.

⁵⁹ *Ibid.*, 201.

⁶⁰ *Ibid.*, 203.

⁶¹ *Ibid.*, 194.

steps, of gains made and fortunes lost. Nor were innovations applied in all factories at once; in fact, hand manufacture continued to be used, and is in fact still used in Western Pennsylvania factories today. A balancing act occurred in the application of technology between finances, space, availability of fuels and raw materials, and acceptance by workers.

Change was a gradual and a not-always-agreeable or agreed-on process. What worked for one did not necessarily work for the many. Just as James O'Hara and Albert Gallatin struggled with the many facets of their businesses in the early 19th century, so too did the Cunninghams and the Atterburys and the glasshouse owners of the mid- to late 19th century battle to develop or buy or control the creative capital of their day.

Successful, overall, was apparent. Between 1840 and 1885, factories in the southwestern corner of Pennsylvania increased from 26 to 61, as Pittsburgh became the heart of the nation's glass industry. Allegheny County boasted 51 of the country's 211 glassworks, while Beaver County had four, Fayette County three, and Lawrence County two, with one also under construction in Armstrong County. No county in the country came close to having the concentration of industry found in Allegheny, its nearest competition being Kings County, (Brooklyn) New York, home to 12 glassworks.⁶²

Pittsburgh manufacturers, who for decades had benefited from strategic location and access to raw materials, were, by the 1880s, reaping the rewards of the perpetual interplay of ideas and industry in the nation's most renowned "Machine Age town."

Not all benefited equally and not all would survive the changes that lay ahead in the late 19th century. What can be said, however, is that many of the elements that made large-scale production of pressed glass possible were in place, and, further, that major change brought about by the spread of automation also was afoot in the container and window glass industries. Expansion in Pittsburgh was constricted due to geography and other limitations that industrial enterprises faced in urban areas, so before the industry would reach its zenith in Western Pennsylvania, entrepreneurs in numerous other counties in the region – and new workers, many thousands of them below the age of 16 – would make their impact.

Part II

To increase production of glass required a reliable and constant supply of raw materials. Companies turning out a half-million pieces of glass a week, such as Rochester Tumbler, needed huge stores of raw materials, and those materials took up storage space at the factory; in addition, space was needed for mixing the materials, to prepare them for the furnaces. As late as 1880, glass factories were still largely concentrated in the densely populated, urban landscape of Pittsburgh's South Side, cheek-to-jowl with homes, businesses, churches, and schools, and landlocked between the Monongahela River and the sheer rock bluff of Mt. Washington towering over the valley. Little space existed for factories to expand. Rising city taxes and prohibitive laws regulating the dumping of by-products generated in the manufacturing process also contributed to the restrictiveness of Pittsburgh's South Side.

It is during this period, as the interiors of factories were recast, that the distribution of the industry's manufacturing complexes also changed. Of paramount importance was the

⁶² Joseph Weeks, *Report on the Manufacture of Glass* (David Williams, 1883), 1048-1050.

railroad: its spread freed the industry from reliance on the rivers. Likewise, the discovery of natural gas – first used as a fuel for industry in Western Pennsylvania during the 1870s – loosed the half-century-old tie to coal seams and forests. Anywhere the railroad ran and gas was available became a potential factory site.

Owners had long realized the possible applications of gas. Thomas Bakewell served on the gas lighting committee for the city of Pittsburgh in the 1830s, and H. Sellers McKee served on a similar civic committee in the 1870s. A savvy businessman, McKee bought up farmland in outlying Westmoreland County described, in later accounts, as “3 1/2 miles west of Greensburg on the Pennsylvania Railroad and is the center of the grandest gas field in the state.”⁶³ It is to this property, in 1888, that he moved his factory from Pittsburgh’s South Side.

The Westmoreland County papers buzzed with the news about McKee and James A. Chambers building “an exclusive city of glass in Pittsburgh’s suburbs.” In this new glass city, named “Jeannette” for McKee’s wife, the Chambers window glass manufactory and McKee’s tableware factory rose alongside dairy barns and farmhouses. With investment backing from a cadre of local industrialists as well as New York and Philadelphia “money men,” McKee and Chambers built not only their factories but also a town, constructing houses and businesses and founding major institutions such as the bank. McKee’s factory occupied a spacious 4.5 acres, while the Chambers-McKee window glass complex sprawled over 35 acres. Taking advantage of the chance to build from the ground up, both factories were fully integrated and applied the latest technology: transmission of batch from the mixing room to the furnace using a belt system; the continuous tank; air cooling systems for the factory floor, and the latest in other machinery. The new factories bore little resemblance to those left behind in Pittsburgh.⁶⁴

The phenomenon was repeated throughout the region. Wherever natural gas surged below ground, factories rose above. By 1902, not only had the glass industry’s growth again exploded, with 115 glassworks in 17 counties in the western half of Pennsylvania – Allegheny County 29, Westmoreland 14, Beaver 12, and Washington 9 – but one county, McKean, had 18 works where there had been none in 1885. The industry had also grown further west, blooming in the gas-rich states of Ohio (20 factories in 1885; 35 in 1902) and West Virginia (4 in 1885; 27 in 1902).⁶⁵

In Western Pennsylvania, factory owners followed the lead of McKee and Chambers out of Pittsburgh and into the countryside, and new men entered the business. Glass became the main industry in new towns such as Jeannette and Ford City, and of vital importance to numerous other towns, such as Charleroi and Washington.

In Monaca, Beaver County, industrial plants included the Phoenix Glass Co., American Glass Specialty Co., and Opalite Tile Works, as well as Colonial Steel, the U. S. Sanitary Co., a brick works, the railroad and a host of small concerns. Glass supplied about one-third of the town’s workforce with skilled and unskilled jobs. Even in 1908 and later,

⁶³ *Greensburg Evening Press*, “A Glass City to be Built at Grapeville,” (Jan. 1888; exact date unknown), 1.

⁶⁴ HABS 6-8.

⁶⁵ Numbers based on research conducted for HSWP in the Dun Records, Baker Library, Harvard Univ., by Arlene Palmer Schwind; research in city directories and the *Crockery and Glass Journal* 1902 trade directory by Gary Pollock, Lauren Uhl, and the author.

Phoenix was a big producer of blown ware, lampshades, lighting devices, and vases; many of these products required skilled craftsman (blowers), while laborers, coopers, and teamsters founded out the factory's force. On the other hand, American Glass Specialty primarily dealt in decorated ware, and most of their employees were women.⁶⁶ Cold processes, hand-painted decoration and acid-etching, and finishing, washing and packing were often the purview of women workers. Rarely did a woman set foot in those areas of the factory where hot glass was worked and they always formed a small percentage of the total employees of the industry. In 1885, of 6,053 glassworkers in Allegheny County, only 141 were women.⁶⁷

Boys under the age of 16, however, were of crucial importance. Among those 6,053 glassworkers in 1885, 1,470 were "children and youths" under 16.⁶⁸ Boys had always been a part of the glasshouse workforce. Elbridge Gerry, visiting Pittsburgh in 1813, recorded in his diary: "Small boys with facility, completely formed a cruet, in the glasshouse in less than 30 seconds."⁶⁹ James Bryce, introduced in Chapter 2, documented his entry into factory life in the 1820s at the age of 11; his journals provide a startling glimpse at conditions for child laborers. As the industry grew, so, too, did the core group of children such as the mold boys in the bottle factories, crouching at the feet of their masters, opening and closing the blow molds hundreds of times a day. Others were gatherers and "carrying boys," "tending boys" and packers, "sticker-ups" and cleaning boys. They did the lifting and the placing and the sweeping -- the dozens of tasks small and large that no glasshouse owner wanted to pay a man's wages for. In James Bryce's day, they brought home \$1.25 a week, while in 1885 their pay ranged from 30 cents to \$1 a day.⁷⁰

Their work was hot and dirty, the tasks repetitive and dulling.

Glasshouses that ran 24 hours a day required the boys to work all shifts, through the day and all night. After work, they went to homes such as those in Sharpsburg's "Glass House Row" on Main Street, described by Elizabeth Beardsley Butler in 1914:

"Glass House Row" on Main Street, at the far end of town, was of the same type. Each of its eight houses was divided into two dwellings of two rooms each, and the tenants who lived in the front house had to pass through their neighbor's living room or walk around the square to reach the vault (outhouse) in the rear. There were four vaults (one overfilled and out of use) and but two outside hydrants for the 18 families in this row. Waste water was thrown into the street sewers. The basements of the houses were of little use as they were flooded when the river was high.⁷¹

Organizations founded to eliminate child labor pointed to the region's glasshouses as examples of the system's horrors. A full-page advertisement in the *Saturday Evening Post* placed by the National Child Labor Committee, began, "If you could look for a moment into the great glass factories of New Jersey or western Pennsylvania...and see

⁶⁶ Beaver county city directory, 1908.

⁶⁷ Weeks, 1050.

⁶⁸ Weeks, 17.

⁶⁹ *The Diary of Elbridge Gerry, Jr.* (Brantano's, 1927), 107.

⁷⁰ Weeks 6-7.

⁷¹ Elizabeth Beardsley Butler, *Wage Earning Pittsburgh* (Survey Associates, 1914), 282.

the pinched faces and the shriveled forms of little children who are doomed to spend their childhood years at work...your heart would go out to the children and your purse would be opened to the people who are trying to pass laws to rescue these little ones from disease and premature old age.”⁷²

Glass companies vigorously fought the child labor laws, often winning exemption from regulation. For instance, with the introduction of the continuous tank, most glasshouses worked three shifts. When regulations were passed to prohibit night work for children under 16 years of age, the glass industry fought the provision and was exempted. By 1908, two-thirds of boys employed in Pennsylvania glass factories were working nights. Often bonuses were offered to encourage night work, but some factories made it a condition of employment.⁷³ Boys also were subject to the same rotation in shifts as adult workers, working a week of days then a week of nights.

Glasshouse owners clearly recognized the value of this cheap labor. A letter sent by the Central Glass Works of Wheeling to 43 glass companies in Pennsylvania, West Virginia, Ohio and Indiana calls on glass companies to organize against a child labor reform law being considered in the U.S. Congress (the date of the letter is not known): “[W]e really believe this Bill would never have been reported out of the Judiciary Committee, had those vitally interested, shown the proper spirit, and counteracted the Propaganda in favor of it.”⁷⁴ The letter closes by making clear the interests of glass manufacturers: “A little money spent by each factory, would be nothing to compare with the Glass Factories’ being compelled to hire men to do boys’ work.”⁷⁵

Child labor increasingly became an issue of national concern. Glass factory owners, who battled to corral the reform movement in the state legislatures, in hopes of heading off federal action, lost to the journalists, documentary photographers, and social activists who took the issue directly to a national audience. Ironically, as the attention of Congress and the public focused on restrictive laws, machines were being conceived to replace the jobs held by children.

The child labor issue had a special resonance for the bottle and container industry. In 1880, nearly one-third of the youths in the glass industry nation-wide worked in green glass (container) factories.⁷⁶ Just one year after that count was made, however, Pittsburgher Philip Arbogast introduced a semi-automated bottle-blowing machine. His invention worked particularly well on wide-mouth jars, such as fruit jars, and was put into operation in non-union shops in Huntington, West Virginia, and in Beaver Falls. The American Flint Glass Workers Union recognized the technology would replace skilled blowers, and prevented its use by Daniel Ripley of Pittsburgh, and in other union shops. Other companies, the Atlas Glass Co. (later Hazel Atlas Glass Co.) of Washington, Pennsylvania, and Greensburg Glass Co. among them, began experimenting to improve the Arbogast design or to develop similar machines.⁷⁷

⁷² *Saturday Evening Post*, Nov. 17, 1906.

⁷³ John W. Lerner, “The Glass House Boys,” *Western Pennsylvania Historical Magazine* 48:4, 362-262.

⁷⁴ Letter from Central Glass Works, HSWP Archives, no date.

⁷⁵ *Ibid.*

⁷⁶ Weeks, 1043-1045.

⁷⁷ Zembala, 336-339.

Argobast's work had built on earlier experiments by Michael Owens and his team of engineers and machinists at Libbey Glass in Toledo. Years later, in 1894, Owens and his team would develop a paste mold machine for mechanically blowing light bulbs. That breakthrough drove companies such as Phoenix Glass Co. of Monaca, where bulbs were hand-blown, out of the light bulb business. By 1895, Owens had adapted the machinery to the automated production of lamp chimneys and tumblers.⁷⁸

Pittsburgh firms, such as those run by Thomas Evans and George MacBeth - world leaders in the hand production of lamp chimneys - realized that without control of the Owens machine, their companies would fold. In 1899, Evans' and Macbeth's companies joined to bid for the exclusive rights to use Owens' patented machines. A handwritten account by Thomas Evans documents the negotiations. The chief bidder against Evans and MacBeth was the flint glass union. Founded in Pittsburgh in 1878, this powerful union was fully aware of the implications of automated technology. Michael Owens had cause to consider the Union's bid. Having risen from the factory floor, Owens had been intimately involved in the politics of the Union, and became a powerful leader in Local 9 out of Wheeling. But he also realized, as did his financier Edward Drummond Libbey, that the future of the glass industry lay with machinery, not skilled men. Still, purchasing the Owens machinery cost MacBeth and Evans dearly: each put up \$250,000 in cash for the rights and an additional \$50,000 each to purchase a Toledo factory operated by Libbey-Owens.

MacBeth and Evans were also careful to maintain their relationship with the men from Toledo. Libbey served as an officer in the newly formed company and as an investor in later ventures. He also encouraged the Pittsburgh company to continue to invest in the innovations coming out of his Ohio R&D center. In 1909, MacBeth-Evans purchased an automated bottle blowing machine from the Owens Bottle Machine Co. in Toledo.⁷⁹ The inventiveness of Michael Owens, with the venture capital of Thomas Evans, George MacBeth, and Edward Libbey, proved itself on several occasions to be a powerful and lucrative consortium.

The semi-automatic bottle machines borrowed key design features from pressed glass machines such as the rotary tables designed by Washington Beck and others. (Such equipment enabled one press machine to work multiple molds by rotating them to the plunger, speeding up the pressing process.) With Owens' innovations, a paste mold semi-automatic machine with a three-man crew could produce 4,300 jars a day, a 15 percent increase over hand production. The machine crew was also cheaper, as it could be formed of unskilled laborers rather than the more expensive skilled union hands.⁸⁰

In 1903, Owens introduced the first automatic machine that produced narrow mouth vessels, such as beer and soda bottles. Libbey and Owens established their new company (Owens Bottle Machine Co.) to build and license the machines. Unlike the semi-automatics, this machine gathered the glass, as well as mechanically blowing and forming the bottles. Once a belt was added to move the bottles to the Lehr, the machine could be run by just a mechanic who monitored and serviced the equipment. In 1906, the company reported that the Owens machine reduced labor costs on a gross of beer bottles to 10 cents, compared to 75 cents if made by a semi-automatic machine and

⁷⁸ Ibid., 339.

⁷⁹ MacBeth-Evans Minute Book, Nov. 17, 1909, Evans Collection, HSWP Archives.

⁸⁰ Zembala, 341-342.

\$1.47 if made by hand. Within seven years of introduction, 100 Owens machines were in use producing 360 million bottles a year.⁸¹

As a result, child laborers in the glass industry dropped nationally by almost half, from 6,435 to 3,561, with the manual work more and more done by conveyor belts and various other mechanical devices. Legislation did its part in removing children from the glasshouse, but so, too, did technology.⁸²

In the container industry, meanwhile, machines were introduced relatively slowly, both to prevent prices from plummeting and also to avoid inflaming the union. Owens Bottle licensed its machinery only to manufacturers already in business. It took a full 20 years for the industry to become automated, balancing increased demand with job losses. As late as 1924-25, national output stood at 25.9 billion bottles produced by 1,000 skilled blowers, 300 semi-automatic machines, and 1,500 operators using automatic machines. The automatic machine, while eliminating skilled work in one part of the factory, created demand for 1,500 new mechanics by 1925.⁸³

As might be expected, the Pittsburgh region remained near the forefront nationally in container manufacturing. In 1880, even before Philip Argobast's machine technology was deployed, New Jersey was first but Pennsylvania ranked second in output among all states. Bottles, one of the earliest items made in the western region of Pennsylvania, were a mainstay throughout the hand-production period of the 19th century, and also after the widespread application of machine operations in the early 20th century. Well-known concerns during this period included Cunningham Co. on Pittsburgh's South Side, J.T.A. Hamilton in the Strip District, and Thomas Wightman, with factories in Pittsburgh and around the region.

A similar process of gradually introducing automatic machinery also occurred in the manufacture of flat glass – first allowing less expense and high quality for making small pieces, such as window panes; eventually, however, technologies devised for making large plate glass pieces, such as department store windows, were applied to all flat glass production. Change was rapid after about 1885, the year that Pittsburgh furnace- and pot-builder Thomas Nicholson commented, "There has been no substantial progress made in the structure of window glass furnaces, no indeed in the window glass business, in the last fifty years."⁸⁴ An exception was the "swing pit," which allowed workers to stand above deep pits and swing the blown cylinders as gravity elongated and enlarged the forms. In addition, the continuous tank, and advances in both melting and annealing furnaces, provided a steady supply of high-quality glass; otherwise, however, Nicholson was right: production methods had changed little.

It took the work of John Lubbers at the research and development facility built for him by James Chambers at the American Window Glass Co. to revolutionize the trade. Lubbers, a window glass flattener, experimented for almost ten years with the design of

⁸¹ Zembala, 342.

⁸² Lerner, "The Glass House Boys," 355.

⁸³ Zembala, 344-45.

⁸⁴ Richard John O'Connor, "Cinderheads and Iron Lungs: Window-Glass Craftsmen and the Transformation of Workers' Control, 1880-1905," Ph.D. dissertation, Univ. of Pittsburgh, 1991, 31. This work is an excellent source for understanding the changes in work and workers' lives as automated technology was introduced.

his machine to replicate the blowing process of a skilled worker. The system involved a circular “bait,” attached to a source of compressed air and suspended over a pot containing enough molten batch to produce a single cylinder up to 40 feet in length. As the bait was raised, drawing the glass cylinder with it, air was pumped into the cylinder to prevent it from collapsing. When the pot was empty and the cylinder had cooled slightly, it was lowered onto a series of supports. The ends of the cylinder were removed, the cylinder was scored, and it was then transported to the ovens, where it was flattened and annealed. Panes were cut from these large sheets of glass, then packed and shipped to market.

The Lubbers process replicated hand technology -- flat glass still started its life as a cylinder – but the intricate ballet of hand production, of skilled blowers manipulating 8-foot-long glass balloons, was gone. Some displaced blowers and gatherers, many of them Belgian immigrants, found work in the remaining hand factories, but many more found no slots at all, their places filled by unskilled workers most often of Italian and East European ancestry. American Window Glass introduced the Lubbers machine slowly to factories in its consortium to temper reaction from the union, even though that machine merely presaged and even more revolutionary wave: the drawing of glass from a machine in a flat, rather than circular, form.

Three processes -- the Colburn, Fourcault, and Pittsburgh Plate processes -- differed in how the sheet was started (whether formed or annealed) but were all drawn continuously from a tank. The Colburn machines were developed by Irving Colburn. In 1912, Michael Owens convinced Edward Libbey to invest in the process and to purchase the patent rights; four years later, Libbey-Owens Sheet Glass Co., incorporated, and by 1920, the firm was selling sheet-drawing machines around the world. (The Colburn machines were first used in a Charleston, West Virginia, plant in 1917.) The Fourcault process was developed in Belgium and Czechoslovakia after World War I and was introduced in the United States in 1923, while Pittsburgh Plate Glass Co. developed a similar process at about this time.

Pennsylvania had been the nation’s unrivaled leader in window glass production for many decades, producing 44 percent of America’s output in 1880 (almost four times as much as the nearest rival, New York),⁸⁵ with glassworks on the western edge of the Keystone State dominating the flat glass trade, using cylinder technology. That technology had improved the quality of flat glass – whatever imperfections remained were not objectionable in small sheets and panes – but innovations in the manufacture of distortion-free glass in very large pieces was still to come.

Very little plate glass was produced in America until the late 1800s. (There were only five plate glass works in the entire country.) Most plate glass was expensively cast, ground, and polished, and imported from France, England, and Belgium. Raw materials were melted in regenerative pot furnaces, and the individual pots were removed from the furnace by crane, skimmed, and then emptied onto large iron tables. As the molten glass was poured, a large cast iron roller passed over it, producing a coarse flat sheet. After being annealed, then allowed to cool, the sheet was finished to the desired thickness on circular tables using an elaborate system of grinding machinery, sand, emery, and water; final polishing occurred using felt. During the last two decades of the 19th century,

⁸⁵ Weeks, 1048.

however, new players such as the American Window Glass Co. and Pittsburgh Plate Glass Co. (1883) entered the flat glass marketplace and the resulting changes were rapid and wide-reaching.

PPG's innovations in the 1920s opened a still newer chapter in the Pittsburgh region's eminence in flat glass – most notably, at PPG's Ford City and Creighton factories. The company's semi-continuous ribbon process for plate glass was first tried in 1922, while innovations after 1924 fully automated the creation of the plate-glass "blank" and the grinding and polishing operations. In 1928, PPG's "Pittsburgh Process," which vertically drew a continuous sheet of molten glass in a four-story-tall forming and cooling line, minimized imperfections and increased speed for making window glass. Glass made in this way was marketed as "PENNVERNON Glass." Continuous processes produced finished products from raw materials in just ten hours. They also allowed incredible control over the thickness and quality of the glass, and saved production time: to blow 50 square feet of glass took a man almost five hours, while sheet-drawn glass took only one-half of 1 "machine man-hour."⁸⁶

Continuous, automated production of plate glass was not instituted in the United States, however, until 1963, when PPG applied the British Pilkington Process. This patented process for "float glass" produced a ribbon of molten glass floating in a bath of molten tin. Produced in huge horizontal furnaces and linked to continuous lehrs, the thickness of the glass is controlled by moving the blank through a series of rollers as it cools and hardens. The glass is cut to the desired size while on the line, and then stacked and packed by machine or hand, depending on the factory. Quality control occurs directly in the line: flawed glass pieces are dumped into a chute, transported by conveyor back to the mixing room, and remixed. Human hands direct the computers which run the machinery, while ceramic and glass engineers monitor the line, but glass can be produced from start to finish and never touched by man.

In the other important sector of the industry, glass tableware, the technology for its automated production was in place by the 1920s. MacBeth-Evans, which had purchased the first developed automated process for lamp chimneys in 1899, put its engineers to work on applying that technology for tableware. Mechanical engineer Charles Schuck experimented with the development of molds that would coordinate with the automated machines, and by 1930, the tableware lines were fully automated. MacBeth-Evans advertisements celebrated the new technology with call lines such as, "A Quality Shape...for Quantity Sales," or "Styled for quality...priced for volume."⁸⁷

Other companies in the region also adapted automation. A 1928 *China, Glass & Lamps* article describes the automated lines at Jeannette Glass Co., where machines controlled the process from production of the ware to finishing and polishing:

[F]irst of all it was necessary to build two especially designed continuous tanks. With these tanks, new mould cooling and block cooling equipment also had to be furnished. It was also necessary to design new parts for the automatic machines and devise new methods for polishing the ware made, for it is in the polishing of colored ware that the brilliant luster and life is obtained. In order to do this, several especially built glazing and polishing machines were purchased from A.

⁸⁶ C.J. Phillips, *Glass The Miracle Maker* (Pitman Publishing, 1941), 206-209.

⁸⁷ *China, Glass & Lamps* advertisements, Feb. 1931, 9, and Aug. 1930, 7.

B. Knight of Fairmount, W. Va., and one was erected in the factory by the company's engineers who are experimenting at all times on improved methods of manufacturing. From the finishing machines the ware is carried to automatic lehrs where it is properly annealed.⁸⁸

This new machinery allowed the company to turn out 50 tons of glass daily. Though all of the work at Jeannette Glass was automated, this is not to say that automation replaced hand or pressing techniques throughout the industry. In fact, both techniques are still in use today, especially in the table glass industry.

Even in hand production, however, new technology made inroads, especially in replacing repetitive or dangerous tasks in the factory. A company such as Lenox, in Mt. Pleasant, Pennsylvania, which specializes in hand-made table glass, now uses belt systems to carry finished pieces to the lehrs for annealing. Bottle-makers such as Glenshaw Glass Co., headquartered in the Pittsburgh suburb of Glenshaw, use pneumatic lifts to move glass once moved by manual labor. American Video Glass, opened just in 1997, is not only fully automated, but makes extensive use of robots to lift, move and support the 50- to 75- pound pieces of glass produced for use in television sets. While automated machines do provide a savings in labor costs for the company, they also make the workplace safer. The recent innovations in automation – computer-driven systems and robotics -- also require better-educated or better-trained workers, forcing further change on the factory floor.

In considering the full sweep of technological change in the glass industry, we see that until 1830, evolution proceeded at a snail's pace. Some 2,000 years separated the two major advances in production-- the introduction of the blowpipe and then of mechanical pressing in 1830. Thereafter, however, change proceeded at a dizzying pace. Innovations, where developed in the advanced machine culture of Pittsburgh or elsewhere in the nation, were quickly adopted or adapted throughout the industry. The industry in Western Pennsylvania, which had faced a mighty struggle in its first few decades, came into its own in the mid-19th century. Blessed with plentiful natural resources, a growing cadre of skilled workers, and access to both the intellectual and financial capital of an industrializing metropolis, glassmaking flourished in the lands along Western Pennsylvania's three rivers.

Local industrialists financed the development and application of the machine technology that reordered the factory system. Within a century of the hand press' appearance, the industry bore little resemblance to the small shops of Gallatin and O'Hara. Every stage of production had changed, from the preparation and processing of the "batch," to furnace design, to the machinery needed for making and annealing glass. In size, layout, and location, the glass factory was wholly modern. Processes never imagined to be done by any force other than human were accomplished routinely without man's touch. The hands of the skilled craftsman were replaced first by the levered arms of presses and then by robotic arms. The craftsman's breath was re-created by mechanical lungs, his mind by computers and automated networks.

As the 20th century advanced, companies that invested in technology and in research into more technology were the ones that prospered. Machine and chemical technology

⁸⁸ *China, Glass & Lamps*, Feb. 20, 1928, 14.

not only transformed production in the glass industry but also made its mass-produced objects available for vast new markets and an entirely new breed of individual consumer.