AFD Ep 391 Links and Notes - Industrialization of Glassware [Bill/Kelley/Rachel] - Recording Aug 1

I. **[Bill] Pre-Industrial Glassware Background**

A. The history of glassware production in the United States goes back to the earliest mainland English colony at Jamestown, Virginia, although that production was mostly a failure, much like the colony. By the early 1600s, when Jamestown was established, the English had become a significant producer market for knockoff Venetian-style glassware, a wildly expensive, closely guarded, and highly skilled craft production for centuries. The colony at Jamestown built a "manufactory" for glassware. It was a primitive facility, difficult to heat to the required molten temperatures, and staffed by German-Polish glassblowers. The Jamestown Glasshouse would have been a proto-factory of the type just beginning to emerge in Europe in the transition from urban craft economies to a proto-capitalist combination of urban consolidation or rural distribution of piece work. Manufactories represented the interim step between putting out piece work to a literal cottage industry and mass production of identical goods. As we discussed in our episodes earlier this year on early 19th century American shoe and boot production and on early 19th century arms manufacturing, there was quite a long process of change in production of things before the development of interchangeable parts with which to genuinely mass-produce identical goods and dramatically reduce costs. And this was especially true in a more complicated industry like glassblowing, which couldn't evolve toward a mass-scale not only until the technology was ready but also until the advent of coal-fired furnaces. **Broadly speaking, however, the production of glassware in the Americas followed a similar arc of change to many of our other topics: first the de-skilling of a craft production where possible and the consolidation of at least partially interchangeable labor under one roof, next the mass production of interchangeable parts and products during the first industrial revolution, and finally the mechanization and automation of that production process during the second industrial revolution.** As we'll see, this industry was one that resisted the de-skilling and mechanization processes longer than most, but in the end the same trends arrived there as everywhere else under industrial capitalism. The change in the mode of production made glassware a cheap, replaceable, ubiquitous good instead of exclusively a costly luxury. In particular this week we'll be talking about the American consumer goods revolution that was the Mason Jar. But we'll also be talking about the shocking labor implications of mass production of cheap glassware and its automation. I'm also going to note here that we won't really be talking much this time about flat glass, such as windows, or about optical glass or lightbulbs and vacuum tubes, because we had more than enough content just on glassware.

1. This is a dodgy source for the Venetian knockoffs point: http://www.historyofglass.com/ This is a better source: https://www.cmog.org/article/beyond-venice-glass-venetian-style-1500-1750
2. Here is a much more serious history article on industrial glass: https://www.britannica.com/topic/glass-properties-composition-and-industrial-production-234890/History-of-glassmaking

II. **[Kelley] Mass industrial production of glassware**

A. Technology changes to allow for identical glass products - https://www.britannica.com/topic/glass-properties-composition-and-industrial-production-234890/History-of-glassmaking

1. The ancient crucible, or the pot in which materials were melted, was made out of clay. The limitation to this was that caly can not withstand very high temperatures, which is obviously a problem if you are trying to melt things in it. This was replaced by the blowing iron, which is what most of us picture when we think of glass blowing, how the glass is kind of gathered around the iron and then blown into to make it round. This technology has largely remained unchanged.
2. In the 17th century, cone shaped or "English" glass furnaces were introduced. In these furnaces, the material to be melted was placed slightly underground, above a tunnel that brought in high velocity air drafts, which greatly increased the temperature.

B. Science (18th & 19th century research into the laws of thermodynamics … and a better understanding of how glass is formed in the heating and cooling process, as opposed to just guessing)
    1. The first law of thermodynamics - that energy can neither be created or destroyed. So, when you're trying to heat or cool something, you can be really precise about determining the temperature by controlling the amount of energy you put into changing the temperature. It's not random.
    2. The Siemans Brothers and Chance Brothers worked together in England and in 1860 they were able to create a re-generator equipped furnace that used about 1/10th the fuel of old furnaces. This system essentially kept the hot air moving from one chamber to the next, rather than letting it escape.
    3. In 1867 Freidrich Seimans took this technology to the next level by creating a cross-fired furnace equipped with regenerators. This system had three chambers - one for melting, one for refining, and one for working.
C. Caspar Wistar and the American Bottling Industry: The beverage bottling industry, beyond traditional and expensive wine bottling, began early efforts at mass production by the end of the 1730s. But they found, much like 19th century lightbulb manufacturers, that they really still weren't able to mechanize the craft process and could not avoid using skilled glassblowers to produce each bottle carefully, even if they could at least ramp up the number per worker per day. A few decades later carbonation made this a potentially huge market and apparently soda or pop drinks in glass bottles were popular by the 1850s. But you can imagine this was probably still more of a skilled, labor-intensive craft manufactory industry than a true mass-production factory system.
https://www.britannica.com/topic/glass-properties-composition-and-industrial-production-234890/History-of-glassmaking
https://www.utoledo.edu/library/canaday/exhibits/oi/OIExhibit/Batch%2CBlow.htm
[This citation is for the production method of bottles but don't quote further here because we're quoting more from it later.]
https://en.wikipedia.org/wiki/Caspar_Wistar_(glassmaker)
https://wi101.wisc.edu/2014/10/01/history-of-soda-bottles/
D. 1859: John Landis Mason & the rise of the screwtop Mason Jar and its effect on the American home
    1. https://en.wikipedia.org/wiki/Mason_jar
    2. The process of heat based canning, in which food is pressurized and heated to destroy bacteria, was Nicholas Appert, a French cook during the Napoleonic Wars who saw value in preserving food for long periods of time. He originally used champagne bottles sealed with cheese and lime,

but the poor seal made this process prone to error. He later switched to wider mouth glasses and distributed food successfully to the French Navy, but it was still an imperfect process. Mason's design with the screw top made canning a much more widespread and successful way to store food.

3. Home Canning is an essential way for farmers in areas with short growing seasons to store food. Imagine you have a garden in Maine, it's really only going to produce vegetables for a few months. What are you going to eat the rest of the year if you have not stored any food?
4. Mass production of mason jars in the 20th century, particularly by Ball Corporation made this canning technology available to all.
5. Interestingly, Mason neglected to patent the lid of his jar, including the rubber ring which makes the seal possible, for nearly a decade and by the time he thought to do it, it was too late. He allegedly died penniless in 1902.
6. https://www.theatlantic.com/technology/archive/2015/09/mason-jar-history/403762/

E. Ball Brothers Glass Manufacturing Company (1880): Another iconic Second Industrial Revolution corporate titan that began producing one thing (paint cans) and then began buying up all the other supply chain components (like glass liners) until they were an enormous one-stop-shop. The patent on Mason Jars expired and the Ball Brothers seized on the opportunity and began ramping up to produce tens of millions of Mason Jars per year by the end of the 1890s! The firm eventually produced all the various components of jars like the metal lids and rubber seals, as opposed to just the glass itself. By World War II, Ball produced an outright majority of all American canning jars and after the war they faced antitrust restrictions handed down by the US Supreme Court. Nevertheless, they expanded into producing glass for aerospace uses, such as in satellites. The Ball Corporation today is a global conglomerate, but in 1993 they actually sold off the division that makes Mason Jars, although the Ball trademark was so recognizable that the new company licensed the name for continued use on new jars.

1. There was a failed IWW strike in 1910 against the Ball Corp in Muncie. (This was a period when socialists were particularly strong in Indiana, as we've alluded to on a number of past episodes.)
2. https://en.wikipedia.org/wiki/Ball_Corporation

F. Glassware in the food and beverage industry also became critically in demand for pasteurization. The process of pasteurization is not so different from the process of canning. The basic premise is that you put the liquid in glass, drop it in hot water to kill the bad bacteria and yeast, and then cool it. Keeping it sealed prevents any additional bacteria or yeast to enter the container. Luis Pasteur, the namesake of pasteurization, established the "germ" theory of fermentation, asserting that a germ (or microorganism) within whatever was being fermented, caused the fermentation.

1. https://science.howstuffworks.com/life/cellular-microscopic/pasteurization1.htm -

III. [Rachel] Automated Industrial Glass Blowing (vs Child Labor)

A. Mechanization of glassblowing, regardless of its labor-saving or profit-boosting implications, was always going to be crucially necessary for the glass industry to be able to produce the sheer volume of glass necessary to feed the roaring American consumer economy of the late 19th and early 20th centuries – not only

for home and kitchen glassware, windows, and scientific equipment uses but also simply billions of lightbulbs and radio vacuum tubes. A single worker with a machine was eventually going to need to be able to produce hundreds of thousands of glass items per day, instead of just hundreds per day.

B. Change in production from a person to a machine: *The principles of the "press-and-blow" process for making wide-mouth jars were shown in the United States by Philip Arbogast in 1882, and the "blow-and-blow" process for making narrow-neck containers was demonstrated by Howard Ashley in England in 1885. These processes employed manual delivery; fully automatic jar forming by a suction-and-blow process was perfected by Michael Owens over the period 1895–1917 at the Toledo (Ohio) Glass Company, which subsequently became the Owens Bottle Machine Company. The automatic single-gob feeder was developed in 1919–22 by Karl Peiler at the Hartford-Fairmont Company in Connecticut. Fully automatic machines followed, but the true rugged survivor, utilizing fully automatic gob delivery to the maximum versatility, was the Individual Section, or IS, machine invented by Henry Ingle at the Hartford Empire Company in 1925.*
https://www.britannica.com/topic/glass-properties-composition-and-industrial-production-234890/History-of-glassmaking
https://en.wikipedia.org/wiki/Glass_production Gob: solid cylinder of molten glass sheared to weight specifications that will become final product. Blow and blow: The gob of glass is blown to fill out the details of the glass (screw threads, cap sealing surface, etc.); this intermediate stage is called a parison. The parison is then blown again to the desired dimensions. Press and blow: The container is pressed into shape by a long metal plunger, then blown to final dimensions.

C. Labor implications:

1. "Automation in the late 19th century is credited with displacing child labour, with the automatic glass bottle blowing machine (c. 1890) cited as an example, having been said to do more to end child labour than child labour laws. Years of schooling began to increase sharply from the end of the nineteenth century." https://en.wikipedia.org/wiki/Factory_system
2. **Management-friendly craft unions kept the peace between adult laborers and glass manufacturing companies, but they totally ignored and failed to protect the vast numbers of expendable and supposedly less skilled child laborers employed in the industry:** https://www.utoledo.edu/library/canaday/exhibits/oi/OIExhibit/Batch%2CBlow.htm *The manufacture of bottles and jars during the nineteenth century used the method of mold blowing carried out by shops consisting usually of five to seven people. Each shop employed two to three skilled blowers and finishers and three to four young boys who opened molds and carried the product from blower to finisher to cooling oven. The blower used much the same methods in creating cut glass pieces, but inserted the glass into a hand-operated mold and once closed, blew into the mold to create the final shape of the bottle.*
Although the glass industry remained fairly unaffected by mechanization during this time period, one significant development was the organization of the workers occurring during the latter half of the nineteenth century. Between 1877 and 1878, Local Assembly 300, Knights of Labor, was organized by window (flat) glass gatherers in Pittsburgh. By 1880, it merged with blowers, cutters and flatteners and became known as L.A. 300 Window Glass Workers of America. The formation of this national

union signaled the beginning of a rigid, detailed, and all-inclusive system of regulation of window-glass production that lasted into the early years of the twentieth century. L.A. 300 established production limits, restrictions and regulations of apprenticeships, and controls over wages. At the same time, the manufacturers of window glass also organized, forming the American Window Glass Manufacturers Association. Working with L.A. 300, the two groups kept industrial strife to a minimum despite fluctuations in the market. In similar fashion, the bottle and jar skilled laborers were under the jurisdiction of two unions depending on the type of glass used the Green (common) Glass Bottle Blowers Association formed in 1890 as a merger of several unions; and the American Flint Glass Workers Union of North America organized in 1878, which joined the American Federation of Labor in 1889.
The only unprotected workers in the glass industry were the young boys, sometimes referred to as "blowers dogs." Union restrictions on the number of apprenticeships (most often reserved for relatives of the skilled workers) resulted in few if any of these boys moving into more skilled positions. By the end of the nineteenth century, child-labor laws enacted in several states prohibited the employment of children less than fourteen years of age. The glass industry, however, was notorious for needing and using under-aged boys. Boys as young as eight were taken from orphan asylums and poorhouses by both men and women who claimed they were guardians, providing affidavits as to the boys being fourteen or older. These guardians lived on the wages of the children. Work was difficult and hard in the glass factories for these young boys. The earnings of the blowers depended upon the speed of the boys who fetched and carried for them, no restrictions existed on night work, and the sharp contrast between the heat of the ovens and the cold of winter nights resulted in many boys dying from pneumonia or other diseases. [...] Skilled workers and children were used in the glass industry, and although they worked together in shops, the separation between the skilled blowers and finishers, the batch mixers and furnace tenders, the apprentices, and the boys, was rigid. Each shop, depending on the size, included a gaffer or foreman, and one or more gatherers, blowers, servitors or helpers, carry-in and carry-out boys, and mold tenders. The factory also included batch mixers, furnace tenders, lehr tenders, box-makers, and packers. Factories even employed young girls to weave covers for hand blown bottles.

- *Glass container manufacture in the developed world is a mature market business. World demand for flat glass was approximately 52 million tonnes in 2009.[6] The United States, Europe and China account for 75% of demand, with China's consumption having increased from 20% in the early 1990s to 50%. A typical glass furnace holds hundreds of tonnes of molten glass, and so it is simply not practical to shut it down every night, or in fact in any period short of a month. Factories therefore run 24 hours a day 7 days a week. This means that there is little opportunity to either increase or decrease production rates by more than a few percent. New furnaces and forming machines cost tens of millions of dollars and require at least 18 months of planning. Given this fact, and the fact that there are usually more products than machine lines, products are sold from stock. The marketing/production challenge is therefore to predict demand both in the short 4- to 12-week term and over the 24- to 48-month-long term. Factories are generally sized to*

service the requirements of a city; in developed countries there is usually a factory per 1–2 million people. A typical factory will produce 1–3 million containers a day. Despite its positioning as a mature market product, glass does enjoy a high level of consumer acceptance and is perceived as a "premium" quality packaging format

https://en.wikipedia.org/wiki/Lead_glass Lead crystal is still prized for its clarity and refractive properties, but it is not recommended for daily use, extended storage of liquids or use by children.

In the European Union, labeling of "crystal" products is regulated by Council Directive 69/493/EEC, which defines four categories, depending on the chemical composition and properties of the material. Only glass products containing at least 24% of lead oxide may be referred to as "lead crystal". Products with less lead oxide, or glass products with other metal oxides used in place of lead oxide, must be labeled "crystalline" or "crystal glass".

It has been proposed that the historic association of gout with the upper classes in Europe and America was, in part, caused by their extensive use of lead crystal decanters to store fortified wines and whisky.[20] Lin et al. have statistical evidence linking gout to lead poisoning.

Related link we mentioned:
http://arsenalfordemocracy.com/2021/06/13/june-13-2021-sewing-machines-arsenal-for-democracy-ep-382/

Not necessarily for the show but LOL: It's very funny how Corning Inc, one of the titans of glass innovation, is totally mismanaged and constantly in dire financial straits despite inventing and producing glass for every possible application. But they keep doing things like selling off their entire kitchenware division (e.g. Pyrex) https://en.wikipedia.org/wiki/Corelle_Brands