

AFD Ep 438 Links and Notes - The Industrial Nail and Nail Guns [Bill/Rachel] - Recording Aug 21, 2022

- Intro (starts below)
- Rise of modern nails (wire nails)
 - [Bill] In [our December 2021 episode on bungalows and workers' cottages](#), we cited (as we often do) Robert J. Gordon's 2016 book "The Rise and Fall of American Growth" – which gets into the weeds on the material factor costs and consumer retail prices of goods over the course of the Industrial Revolution and its various phases – and he mentioned that cheap nails dramatically cut the cost of building single-family homes, with one study finding that the price of nails in the United States fell by 90% in real terms between 1830 and 1930. A once-precious material input for construction, prior to the 1870s, [became cheap and ubiquitous](#) over the course of the early 1890s to the early 1910s. In that episode, #402, we said we would probably return to the topic to take a closer look. And that brings us to today's episode on the industrialization of nail fasteners over the 19th century and eventually the rise of nail guns in the late 20th century.
 - [Rachel] <https://monroeengineering.com/blog/nailed-it-the-history-of-nails/>
 - Nails have been around for thousands of years, with the oldest discovered nails dated back to around 3400 BCE, found in Egypt. These earliest nails were made out of bronze, and they had the same basic design as modern nails: long, straight, narrow metal shafts, with a point to drive into materials, and a flat head on the other end.
 - Throughout much of history, nails were manufactured by independent blacksmiths or by even more specialized skilled craft workers called nailers. Metalworkers would hammer out the shafts of metal, and nailers would create the final nail shape. This made nails relatively scarce and expensive compared to modern nails.
 - During the American Colonial era, nails in the Colonies were sourced from Britain. When the American Colonies declared independence and kicked off the American Revolution, Britain cut off the supply of nails to the former Colonies. As a result, nails were so hard to come by, that older buildings and houses would be burned down to salvage the nails for new builds.
 - In 1795, an American named Jacob Perkins invented the cut-nail process. This process involved cutting nails from sheets of raw iron. This process allowed companies to manufacture nails much more quickly and efficiently, and required much less skill than the traditional work done by nailers.
 - [Rachel] Ancient nails vs early modern nails vs early industrial nails vs later industrial wire nails:
 - <http://www.glasgowsteelnail.com/nailmaking.htm>
 - How the cut-nail machines worked: Large sheets of metal of around 2 feet in length and with a width slightly longer than the desired nail length were fed into the machine. One lever cut a triangular piece that would form the shaft of the nail, a second lever held the nail in place, while a third lever put the head on the nail. The sheet of metal is then flipped 180° to repeat the cutting process. ([cool demo video!](#)) There is still a lot of human labor involved in feeding the strips into the machine.

- Wire nails greatly reduced the human labor involved in nail manufacture. Giant coils of steel wire can be cut down into the desired length and shaped by machine with the only human interaction required setting up and turning on the machine. Because of less hands-on time during nail production, people switched their focus to quality assurance/control, looking over the finished product and making sure they meet specifications, and inspecting the cutting blades and keeping them sharp. The nails produced are a lot smaller than cut nails and have weaker holding power, but wire nails came around when thinner timbers were starting to be used in construction and other forms of fastening were available if stronger fastening was needed.
- <https://www.nps.gov/articles/watch-those-thumbs.htm>
 - *With the rapid development of the Bessemer process for producing inexpensive soft steel during the 1880s, however, the popularity of using iron for nail making quickly waned. By 1886, 10 percent of the nails produced in the United States were made of soft steel wire. Within six years, more steel-wire nails were being produced than iron-cut nails. By 1913, 90 percent were wire nails. Cut nails are still made today, however, with the type B method. These are commonly used for fastening hardwood flooring and for various other specialty uses.*
- Video from Discovery Channel of Wire nail production: <https://youtu.be/CUTTmtLKD2g>
- [Bill] Dating old buildings based on nail era:
 - [for listener reference, but essentially superseded by later research as in the paper below] National Parks Service document (1968) titled "Nail Chronology as an aid to dating old buildings": <http://npshistory.com/publications/nail-chronology.pdf>
 - "Machine Cut Nails and Wire Nails: American Production and Use for Dating 19th-Century and Early-20th-Century Sites" by William Hampton Adams in Historical Archaeology Vol. 36, No. 4 (2002), pp. 66-88 (23 pages) <https://www.jstor.org/stable/25617025> *"Nails are among the most commonly occurring artifacts found at 19th- and 20th-century sites, and, as such, nails are an important data source, often overlooked by some historical archaeologists."* The abstract alone is pretty interesting: *The commonly cited sources used by archaeologists for dating nails have been rendered outdated by later research. Machine cut and headed nails date from 1815 onwards, while wire nails date from 1819 onward. Historical archaeologists need to avoid the simplistic use of invention dates and patent dates and focus instead on the mass-production dates. There can be a significant amount of time between an invention and its first production, and even greater time until production figures are significantly high enough to affect the archaeological record. Usually wire nails are ascribed an 1850s beginning date, but that date is both too early and too late. While some wire nails were produced in 1819, no significant quantities were produced in the United States until the mid-1880s. Thus, we need to extend the manufacturing date back some 30 years with the caveat that the effective manufacturing date range begins in the 1880s. By examining production figures for wire nails, a model is generated for dating sites built of machine cut nails. This model is then examined using*

data from dozens of sites in the USA and Canada. Just as important, the model provides clues to recycling activity and access to different manufacturing sources.

- The paper details that a lot of different aspects of a nail found at an archaeological site can help narrow down the potential range of years it was produced. Little changes in the production methods and styles affected the cross-section, grain, sides, burrs, neck, head, and end of a nail.
- Another important detail noted in this paper is that the wire-nail industry depended on the rise of the wider wire industry, with things like telegraph lines and barbed wire contributing to that in the period of the 1850s to the 1870s: *The rise of wire nails depended upon the broader technology of wire production. Once wire was made in quantity, then wire nails could become a common spin-off industry. The invention of barbed wire in 1873 and the production of wire nails "probably accounted for the rapidity of the rise of wire" itself (Temin 1964:227). "Wire had been made before steel became a mass-produced article, but the quantities had been small" up to 1890 (Temin 1964:226). So, while the development of a wire industry had to precede the mass production of the wire nail; in the end, the wire nail – and barbed wire – stimulated further usages of wire. This is a classic feedback loop in technological development between such seemingly unrelated industries as the cattle industry, the building industry, and the telecommunications industry.*
- French patents for wire nails as far back as 1819 did not translate into mass production in France until the 1840s; mass production in Britain began in the 1850s; and wide-scale mass production in the US began in the 1880s, although there were some imported production machines in the US by the late 1870s.
- *The earliest American-made wire nails were not used in building construction, being limited to use in making small items like cigar boxes and for packing crates made from soft woods (Priess 1973:88).*
- *"Wire nails were replacing cut nails for two reasons, their different shape and their different material. ... They were widely criticized for their lack of holding power, but this was offset by their greater ability to penetrate wood without splitting it. They also weighed less than cut nails of equivalent length, which meant a larger number of nails in a pound and consequent lower freight charges. For these reasons, the production of cut nails reached a peak in 1886 and fell thereafter, and the production of wire rods for wire nails rose" (Temin 1964:227).*
- *The transition from iron to steel happened in the mid-1880s. "Steel was of increasing quality and cheapness; the price of steel nail plate probably fell below that of wrought-iron plate soon after the price of steel rails passed that of iron rails" (Temin 1964:227).*
- The 2002 paper also argued for further regional analysis of the lag times in accessibility of mass-produced nails (of various types) based on transportation difficulty and costs varying significantly in

certain places depending on access to navigable rivers and railroads or relative isolation.

- Most of the rest of the paper puts to the test the various claims about dating building sites based on types of nails found at the site by looking at a number of specific archaeological sites and comparing nails to other sources of information. The author also strongly contends throughout that nails are a better source of dating the construction of a site than other types of artifacts found within a site such as chinaware and glassware because these often seem to have been made and owned for several years or even a decade and a half prior to the construction based on the date of nails. People usually weren't, it would seem, buying a whole new set of china and glasses to go with their brand new home.
- [Rachel] "The Wire Nails Revolution: The History 1898-2000" by Jørgen Burchardt at Museum Vestfyn, Denmark
[http://131.111.147.69/CHS-Conf/Papers/12.%20pp.143-156Burchardt%20formatted%20by%20Yang\(PYT%20revised\)%20reformatted%20by%20Yang.pdf](http://131.111.147.69/CHS-Conf/Papers/12.%20pp.143-156Burchardt%20formatted%20by%20Yang(PYT%20revised)%20reformatted%20by%20Yang.pdf)
 - *The first machine for wire nails in the United States was built in 1851, and wire nail machines mainly made the smaller sizes of nails up to the 1870s [6]. Steel came to the production of cut nails. In 1884, they formed 5% of the cut nail production, but the share increased to 69% in 1889. The first steel wire nails were produced in 1875 [7], but cut nails still dominated over wire nails, and in 1886, they had their production peak [8]. First, in 1892, the production of wire nails exceeded the production of cut nails [9], but by 1920, cut nails still had 8% of the market. The dominating nail types have given archaeologists a tool to date old buildings [11], although the reuse of old nails and periods with several different types make the method unreliable.*
 - *The wire nails had several advantages. The nails consisted of less metal, so customers got many more when they bought a kg of nails. A cautious estimate tells that on average, a kg of nails provided around 190 two-inch cut nails but 300 wire nails [12]*
 - *The thinner wire nails were easier to use and did not splinter wood so easy [13]. At the same time, the price of steel declined. A study from the US shows a fall in the relative price of nails by a factor of about 15 times from the mid-1700s to about 1950 [14]. The declines were large enough to enable the development of other products.*
 - *Apparently, the cheap nails gave low-income people in the US a possibility to build their own homes in the 1870s by using a form of construction called balloon framing instead of employing expensive professional builders and carpenters [15].*
 - *A general nail machine, as one from the German Company Wafios, originally had an operating rate of 700 revolutions (nails) per minute. Rebuilt machines could reach operating speeds of 900 revolutions when small nails were produced [16].*
 - *More than a thousand different types of nails and sizes are standard on the market now. More nails have been developed for special purposes made to customers' specifications. When new building materials become available, the manufacturers develop new types, for instance, hooks and roller-shade wood-roller pins. The fastening of gutters needs*

special-design nails. Other heads are used for decorative effects. Many nails have a smooth shank, making them easiest to drive and offer the least pull-out resistance. Two-pronged shanks make nails or fencing staples useful for attaching mesh fences to wooden posts and frames. Most nails have a diamond point, which is a four-sided pyramid. Some have a blunter point to prevent splitting certain woods.

- *In Germany, companies in the nail business occasionally made cartel agreements. For some years, the companies had agreement regarding the sale, and customers could only buy nails through the cartel's central office.*
- *Similar national cartel agreements gave the inspiration for international cartels. Most of the important nail producers in Europe met in 1930 and came to an agreement. The negotiations ended with an agreement regarding the distribution of the sale of the total European market. This strong agreement pressed the American and British companies to join the cartel organized by the international export federation International Wire Export Company (IWECO) since 1932.*
- [Bill] Historic article clippings from the late 19th century on nail production: <http://www.charleswbullock.com/Guide/IndustryHistroy/AmerSteelWire/AmerSteelWire.html> From an account around 1891, when wire nails were about to overtake the cut nail in the market, in a book titled "THE MANUFACTURE OF IRON IN ALL AGES" by James A Swank of the American Wire Nail Company: *Very great difficulty was experienced in inducing the hardware trade to recognize the wire brad and wire nail as a salable commodity. From 1878 to 1880 the growth of the wire nail was very slow and was attended with many difficulties. Deep-rooted prejudices of all kinds had to be overcome. It was not until the year 1883 or 1884 that the wire nail came into the market prominently as a competitor of the cut nail, and it was at this time that the standard wire nail was instituted. Each successive year after this the demand for wire nails increased phenomenally, and, in fact, passed beyond the wildest hopes of the most sanguine. Down to 1883 all the cut nails manufactured in this country in commercial quantities were made of iron, but in that year cut nails made of Bessemer steel and others made of combined iron and steel were sold in American markets.* By the end of the 1890s, after a round of corporate consolidations and cartelizations that followed the Panic of 1893 and a glut of over-production, plus what the New York Times in 1895 called "unnatural" over-pricing, almost all wire nail production in the United States fell under the monopoly control of American Steel and Wire Company, which was shortly thereafter rolled into the US Steel mega-merger.
 - Some old photos: <https://www.rosenberg-library-museum.org/treasures/texas-nail-and-wire-company> An advanced nail factory in the United States, in the era before production offshoring due to containerization, could produce several tons of nails per week on machines that each manufactured nails at a rate of several nails per second on average – and so many nails would be produced that one factory might dominate the market for hundreds of miles, such as the Texas Nail & Wire Company in Galveston Texas, where the closest competition was about 700 miles away in Birmingham Alabama!
- Nail guns:
 - [Bill] Another intersection between civilian industry inventions and defense contracts: the nail gun was invented to help build the Spruce Goose prototype for

Howard Hughes, more properly known as the Hughes H-4 Hercules cargo plane prototype. Its development at Hughes Aircraft during and after WWII was funded by tens of millions of dollars in federal defense contract money. In addition to experimenting around with new plywood products for the implementation of the design, the company's civil engineer Morris Pynoos designed a nail gun to fire temporary nails into the delicate plywood while glue was curing, without pushing the wood pieces out of place through repeated manual hammering.

https://en.wikipedia.org/wiki/Nail_gun

- [Bill] Even if you're thinking about them in terms of their intended construction use ([as opposed to recent vigilante action against the FBI](#)), nail guns cause tens of thousands of ER level accidents in the US annually, costing hundreds of millions of dollars, bringing the war home. https://en.wikipedia.org/wiki/Nail_gun
- [Rachel] https://www.jlconline.com/tools/fastening-tools/a-brief-history-of-portable-nail-guns_o
 - After the invention of the Spruce Goose prototype nail gun in 1944, various manufacturers scrambled to get a viable commercial nail gun to market. The technology already existed for air staplers, which also used serially-arranged "clips" of fasteners, so the main challenge was reducing recoil while also producing enough power to drive the nail. The first success was the Nu Matic Nailer, invented in the early 50s by Bill Burnison. Other big names in the 1950s-70s were Powerline, Fas-Nail and Spotnails. Spotnails successfully solved the recoil problem by borrowing from the engineering principles used in ejection seats in fighter airplanes. The seats had to generate enough power to clear the plane, but also had to insure the survival of the pilot.
- [Rachel] <https://www.stapleheadquarters.com/the-history-and-invention-of-nail-guns>
 - *The first commercial pneumatic nail guns became available in the 1950s. The earliest stand-up versions fired 40–60 nails per minute into subflooring. The first handheld nail gun versions appeared in the 1960s. Designs steadily improved to fire more and different gauges of nails. Eventually, cordless versions appeared. Nail guns have been powered by electricity, compressed air, and even explosive gases. In 2019, a New Zealand-based company called Airbow introduced a portable, rechargeable pneumatic nail gun that doesn't require a tether to an air hose. Using advanced valve technology, the Airbow nail gun employs just a gram of air to fire a nail with compressed air stored in the tool itself. It recharges on a compatible air compressor.*
- [Rachel] CDC mythbusting on the velocity of nail guns (often over-reported): <https://blogs.cdc.gov/niosh-science-blog/2013/07/16/nail-gun-comic/>
 - What it boils down to is there are 2 types of nail guns, Powder Actuated Tools (PATs), comparable to a gun blank charge; and Pneumatic Nail Guns (PNGs). PATs are capable of high-velocity charges, but they are mainly used for specialized tasks such as driving nails into concrete or metal. PNGs are much more common, and they're capable of propulsion of about a tenth of the velocity of PATs. Many papers on nail gun injuries didn't distinguish between PAT- and PNG-involved incidents, which led to a long lineage of citations that didn't take the type of nail gun into account when discussing nail gun velocity. All this to say, PNGs are still very much capable of causing serious injury or death.

- [Rachel] 1998 article mentions Tom Silva from This Old House not adopting nail guns for home framing until into the 1970s (also details various innovations in the 1980s and 1990s in the technology):
<https://www.tampabay.com/archive/1998/09/26/new-nail-guns-don-t-need-a-compressor/>
 - *Freedom came to nail guns in 1986, when the Paslode Corp. introduced a nail gun that functions without hose or compressor. The gun is powered by internal combustion, just like the granddaddy of all portable machinery, the gasoline engine.*
 - *Pulling the Paslode's trigger releases MAPP gas (methylacetylene propadiene) from a disposable fuel-cell cylinder and injects the gas into the combustion chamber. Simultaneously, a spark detonates the mix and plunges a piston against the nailhead, driving it home in a lightning-quick stroke.*
 - *Paslode makes its Impulse gas-powered guns in two versions: a framing nailer and a smaller model for finish work. The smaller gun gets about 2,500 shots per \$7 cylinder, the larger gun 1,200.*
 - *Last year, Porter-Cable began manufacturing gas nailers called Bammers: a framer, two finish guns and a crown stapler for assembling cabinets and holding insulation. All use MAPP gas in a cylinder similar to the Paslode's, but they operate without fans, motors or batteries.*
 - *A pressure-sensitive piezoelectric crystal, similar to that in a gas barbecue grill, generates the spark. The air and fuel are mixed and exhausted as the tool is plunged, so cocking the gun requires 23 pounds of push.*