

Interchangeable parts

Interchangeable parts are parts that are for practical purposes identical. They are made to specifications by processes that ensure that they are so nearly identical that they will fit into any device of the same type. One such part can freely replace another, without any custom fitting (such as filing). This interchangeability allows easy assembly of new devices, and easier repair of existing devices, while minimizing both the time and skill required of the person doing the assembly or repair.

Before the 18th century, devices such as guns were made one at a time by gunsmiths, and each gun was unique. If one single component of a weapon needed a replacement, the entire weapon either had to be sent back to an expert gunsmith to make custom repairs or discarded and replaced by another weapon. During the 18th and early 19th centuries, the idea of replacing these methods with a system of interchangeable manufacture was gradually developed.^{[1] [2]} The development took decades and involved many people.^{[1] [2]} Some of the prominent leaders of this cultural change are discussed below.

Historical development

Around 1778, Honoré Blanc began producing some of the first firearms with interchangeable parts. Blanc demonstrated in front of a committee of scientists that his muskets could be assembled from a pile of parts selected at random. Other inventors who began to implement the principle included Henry Maudslay, John Hall, and Simeon North.

In the U.S., Eli Whitney saw the potential benefit of developing "interchangeable parts" for the firearms of the United States military, and thus, around 1798, he built ten guns, all containing the same exact parts and mechanisms, and disassembled them before the United States Congress. He placed the parts in a large mixed pile and, with help, reassembled all of the weapons right in front of Congress, much like Blanc had done some years before.^[3]

The Congress was immensely impressed and ordered a standard for all United States equipment. With interchangeable parts, the problems that had plagued the era of unique weapons and equipment passed, and if one mechanism in a weapon failed, a new piece could be ordered and the weapon would not have to be discarded. The hitch was that the guns Whitney showed Congress were made by hand at great cost by extremely skilled workmen. Whitney, however, was never able to design a manufacturing process capable of producing guns with interchangeable parts. Fitch (1882:4)^[1] credited Whitney with successfully executing a firearms contract with interchangeable parts using the American System, but historians Merritt Roe Smith and Robert B. Gordon have since determined that Whitney never achieved interchangeable parts manufacturing. His family's arms company, however, did so after his death.

Mass production using interchangeable parts was first achieved in 1803 by Marc Isambard Brunel in cooperation with Henry Maudslay, and Simon Goodrich, under the management of (with contributions by) Brigadier-General Sir Samuel Bentham the Inspector General of Naval Works at Portsmouth Block Mills at Portsmouth Dockyard for the British Royal Navy during the Napoleonic War. By 1808 annual production had reached 130,000 sailing blocks.^{[4] [5]}
[6] [7] [8] [9] [10] [11] [12] [13]

The first mass production using interchangeable parts in America was, according to Diana Muir in *Reflections in Bullough's Pond*,^[14] "The world's first complex machine mass-produced from interchangeable parts", which was Eli Terry's pillar-and-scroll clock, which rolled off the production line in 1814 at Plymouth, Connecticut. Terry's clocks, however, were made of wooden parts. Making a machine with moving parts mass-produced from metal would be much more difficult.

The crucial step in that direction was taken by Simeon North, working only a few miles from Eli Terry. North created one of the world's first true milling machines to do metal shaping that previously had to be done by hand with a file. Diana Muir believes that North's milling machine was online around 1816.^[14] Muir, Merritt Roe Smith,

and Robert B. Gordon all agree that before 1832 both Simeon North and John Hall were able to mass-produce complex machines with moving parts (guns) using a system that entailed the use of rough-forged parts, with a milling machine that milled the parts to near-correct size, and that were then "filed to gage by hand with the aid of filing jigs."^[15]

Historians differ over the question of whether Hall or North made the crucial improvement. Merrit Roe Smith believes that it was done by Hall.^[16]^[17] Muir demonstrates the close personal ties and professional alliances between Simeon North and neighboring mechanics mass-producing wooden clocks to argue that the process for manufacturing guns with interchangeable parts was most probably devised by North in emulation of the successful methods used in mass-producing clocks.^[14] It may not be possible to resolve the question with absolute certainty unless documents now unknown should surface in the future.

Socioeconomic context

The principle of interchangeable parts flourished and developed throughout the 19th century, and led to mass production in many industries. It was based on the use of templates and other jigs and fixtures, applied by semi-skilled labor using machine tools instead of the traditional hand tools. Throughout this century there was a lot of development work to be done in creating gauges, measuring tools (such as calipers and micrometers), standards (such as those for screw threads), and processes (such as scientific management), but the principle of interchangeability remained constant. With the introduction of the assembly line at the beginning of the 20th century, interchangeable parts became ubiquitous elements of manufacturing.

See also

- Allowance (engineering)
- Engineering fit
- Engineering tolerance
- Louis de Tousard
- Preferred numbers

Bibliography

- Cantrell, J.; Cookson, G. (eds) (2002), *Henry Maudslay and the Pioneers of the Machine Age*, Stroud.
- Coad, Jonathan (1989), *The Royal Dockyards, 1690-1850*, Aldershot.
- Coad, Jonathan (2005), *The Portsmouth Block Mills: Bentham, Brunel and the start of the Royal Navy's Industrial Revolution*, ISBN 1-873592-87-6.
- Cooper, C. C. (1982), "The production line at Portsmouth block mill", *Industrial Archaeology Review* **VI**: 28–44.
- Cooper, C. C. (1984), "The Portsmouth system of manufacture"^[18], *Technology and Culture* **25** (2): 182–225, doi:10.2307/3104712.
- Fitch, Charles H. (1882), *Extra Census Bulletin. Report on the manufacture of fire-arms and ammunition.*^[19], Washington, DC, USA: United States Government Printing Office.
- Gilbert, K. R. (1965), *The Portsmouth block-making machinery*, London, UK.
- Gordon, Robert B. (1989), "Simeon North, John Hall, and mechanized manufacturing"^[20], *Technology and Culture* **30** (1): 179–188, doi:10.2307/3105469.
- Hounshell, David A. (1984), *From the American system to mass production, 1800-1932: The development of manufacturing technology in the United States*, Baltimore, Maryland, USA: Johns Hopkins University Press, LCCN 83-016269, ISBN 978-0-8018-2975-8. *Traces in detail the ideal of interchangeable parts, from its origins in 18th-century France, through the gradual development of its practical application via the armory practice ("American system") of the 19th century, to its apex in true mass production beginning in the early 20th century.*

- Muir, Diana (2000), *Reflections in Bullough's Pond: Economy and Ecosystem in New England*, University Press of New England, ISBN 978-0874519099.
- Smith, Merritt Roe (October 1973), "John Hall, Simeon North and the Milling Machine"^[21], *Technology and Culture* **14** (4): 573–591, doi:10.2307/3102444.
- Smith, Merritt Roe (1977), *Harper's Ferry Armory and the New Technology*, Cornell University Press.
- Van Dusen, Albert E. (2003). "Eli Whitney"^[22]. *Laptop Encyclopedia of Connecticut History*. CTHeritage.org. Retrieved 2009-02-18..
- Wilkin, Susan (1999), *The application of emerging new technologies by Portsmouth Dockyard, 1790-1815 [PhD Thesis]*, The Open University. (Copies available from the British Thesis service of the British Library).

Further reading

- North, Simon Newton Dexter; North, Ralph H. (1913), *Simeon North: First Official Pistol Maker of the United States: A Memoir*^[23], Concord, NH, USA: Rumford Press.

External links

- Origins of interchangeable parts^[24]
- Animation of a 50-part handgun assembly^[25]

References

- [1] Fitch 1882, p. 4 (<http://books.google.com/books?id=gtZy4zvRRi0C&pg=PA4#v=onepage&q&f=false>).
- [2] Hounshell 1984, pp. 25–46.
- [3] Van Dusen 2003.
- [4] http://www.makingthemodernworld.org.uk/stories/enlightenment_and_measurement/05.ST.02/?scene=3&tv=true
- [5] <http://www.portsmouthdockyard.org.uk/Page%206.htm>
- [6] <http://www.sciencemuseum.org.uk/collections/exhiblets/block/start.asp>
- [7] Gilbert 1965.
- [8] Cooper 1982.
- [9] Cooper 1984.
- [10] Coad 1989.
- [11] Coad 2005.
- [12] Wilkin 1999.
- [13] Cantrell & Cookson 2002.
- [14] Muir 2000.
- [15] Gordon 1989.
- [16] Smith 1973.
- [17] Smith 1977.
- [18] <http://jstor.org/stable/3104712>
- [19] <http://books.google.com/?id=gtZy4zvRRi0C&pg=PP10#v=onepage&q>
- [20] <http://jstor.org/stable/3105469>
- [21] <http://jstor.org/stable/3102444>
- [22] http://www.ctheritage.org/encyclopedia/ct1763_1818/whitney.htm
- [23] <http://books.google.com/?id=QjMxAAAAMAAJ&pg=PR1#v=onepage&q>
- [24] <http://www.uh.edu/engines/epi1252.htm>
- [25] <http://video.google.com/videoplay?docid=-5053379821405436208>

Article Sources and Contributors

Interchangeable parts *Source:* <http://en.wikipedia.org/w/index.php?oldid=382393727> *Contributors:* 388775, 4twenty42o, Addshore, Aitias, AlainV, Alansohn, AngelOfSadness, Antandrus, Anwar saadat, Blueraspberry, Brian the Editor, Bushcarrot, Canrocks, Christopher Parham, ConCompS, Dabomb87, Darth Panda, Dominus, Dsfs14, E. Ripley, Elipongo, Femto, Frehley, Gargoyle888, Gene Nygaard, Gparker546, Gzkn, Hilltoppers, Iseaturtles, Iridescent, Ixfd64, J.delanoy, JForget, Jfortun89, JustAGal, Kansan, Karma Thief, Kle2, Levineps, Mental Floss Scholar, Mikeblas, Mr. Lefty, Mumblingmynah, Neckelmann, Noctibus, OberstRölf, Peter, Peter Horn, Piano non troppo, Pie4all88, Pilotguy, Pingveno, Qxz, Razorflame, Riddley, Rumping, Ryz05, Sceptre, Seidenstud, Sennen goroshi, Shanes, Simon12, Sljaxon, Soccereagle, Spangineer, Thatguyflint, Three-quarter-ten, Tide rolls, Tom, Tommy2010, Tommyyoungblood, Tresiden, Uncle Milty, Versus22, West.andrew.g, 203 anonymous edits

License

Creative Commons Attribution-Share Alike 3.0 Unported
<http://creativecommons.org/licenses/by-sa/3.0/>