

Friday Guest lecture.

Mon: HW 7 Mondsch 163-165
Barnett. Ch 14

Timekeeping devices and watches

During the 19th century timekeeping increasingly permeated ordinary life in Europe and North America. There was an associated increase in demand for timekeeping devices. Major factors in this were:

- 1) increasing use of standardized precision time in
 - * workplaces
 - * transportation (railroads)
 - * communication (e.g. telegraphs)
- 2) war efforts, e.g. U.S. Civil War in which large numbers of people had to be moved at co-ordinated times.
- 3) increasing wealth resulted in demand for clocks + watches

Demo: Smithsonian Natl Museum America History Revolution!

There are two ~~types~~ types of timekeeping device to consider: clocks (not portable) and watches (portable). The latter is what would lead to an explosion in timekeeping abilities and time-consciousness amongst ordinary people.

Who produced these watches? How were they manufactured? We consider these questions in the case of the United States.

We first consider the general process of making a watch.

1 Manufacturing portable mechanical watches

The basic design for mechanical watches was finalized in the late 18th century and demand for portable watches emerged during the 19th century. A portable watch would have a diameter of about 3 inches and the machinery of the watch would have to be made at a suitable size.

- a) Find the Wikipedia page "Mechanical Watch." This should show images of the internal mechanism of various portable watches. The "Mechanism" section shows a cutaway drawing of a pocketwatch. Identify at least three types of components inside this watch that are crucial to its functioning.

Gears, axles, bearings, springs (very fine)

- b) These components obviously need to be produced with very precise dimensions in order for the watch to tell time accurately. How precise? A rough way to estimate this is via the sizes of a gear in the mechanism. Here

$$\frac{\text{seconds lost in one hour}}{1 \text{ hour in seconds}} = \frac{\text{deviation from correct diameter of a gear}}{\text{correct diameter of a gear}}$$

Suppose that one wanted to lose at most 5.0 s every hour (roughly two minutes per day). Estimate the diameter in inches of any gear in the illustrated watch mechanism. Use your estimate to determine the deviation from the correct diameter that will give this time keeping error.

Consider a $\frac{1}{4}$ inch = 0.25 inch wheel

$$\frac{5 \text{ s}}{3600 \text{ s}} = \frac{\text{deviation}}{0.25 \text{ inch}} \Rightarrow \text{deviation} = 0.25 \text{ in} \frac{5}{3600}$$

$$= 0.00035 \text{ in}$$

very small fraction of an inch

- c) Do you think that, in the early 19th century, it would have been more feasible to produce an accurate clock by making the mechanical pieces by hand or by a machine available at that time? Explain your answer.

It is doubtful that such machinery existed. It would have been more feasible to produce these by hand.

- d) Looking at a watch, roughly how long might it take for a skilled person to make the entire mechanism of a watch by hand? Roughly how many watches could be made by hand by a single skilled watchmaker in one year?

Perhaps 1 or 2 per week \Rightarrow 50 to 100 per year

- e) The population of the United States in 1850 was about 23 million. Roughly how many watch makers, working by hand, would it require to equip everyone with a watch within two years? Does this seem feasible? As a basis for comparison, Switzerland, the major center for watch production in the world at the time, produced about 2.2 million watches in 1850.

$$50 \text{ per year} \quad \frac{23\,000\,000}{100} = 230\,000 \text{ people} \Rightarrow 1\% \text{ US pop}$$

$$100 \text{ per year} \quad \frac{23\,000\,000}{200} = 115\,000 \text{ people} \Rightarrow 0.5\% \text{ US pop.}$$

- f) In order to satisfy worldwide demand for watches by the mid 19th century, production would have to be increased to at least ten times of what it had been previously. This would require mass production by machines. What difficulties would have hindered this at that point?

* The ability of existing machines to produce the parts accurately enough.

* The existence of skilled workers to use those machines

Clockmaking in the US

Clocks, being larger were easier to manufacture than watches. By the late 1700s there was already a clockmaking industry in the US that made clocks by hand. The process became mechanized

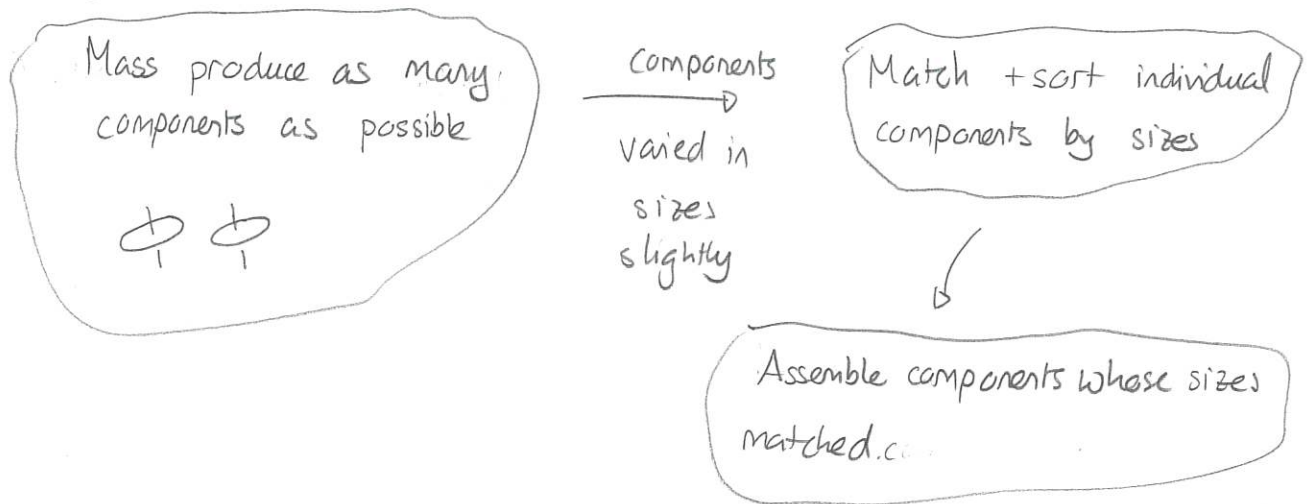
- Landes
pg 336-337
- 1) Eli Terry (1807-1808) developed a water-powered factory for producing wooden clocks - Terry clock at Smithsonian
~ 1000 per year
 - 2) Chauncy Jerome (late 1830s)
 - * mass produced brass clock
 - * first run 40 000 ~ \$1.40 each - Jerome clock at Smithsonian.
 - * exported to Great Britain!

Watchmaking in the US

In the early 1800s watchmaking was dominated by England but this passed to Switzerland. Most watches in the US were imported from these two countries. The modes of the industry were:

- Landes
BHR 53, p1
(1979)
- 1) England - watchmaking pre-eminent 1675-1725
 - innovations throughout the 18th century
 - watches handmade by specialized craftsmen.
 - system of division of labor
 - parts interchangeable in the rough
 - produced ~ 100 000 watches per year.
 - 2) Switzerland - various technical innovations in France reduced cost of watches
 - continental watches became cheaper than British watches.
 - division of labor system extended further in Switzerland.
(Jura region)
 - pool of cheap labor assisted by refugees from France.
 - subcontracting system (ébauche)

This was challenged in the 1850s by manufacturers in the United States who developed a way to mass manufacture watches. The first company to do this was established in 1850 and eventually came to be called the Waltham Watch Company. The strategy was:



1853 - first Waltham (American Watch Co) batch

1857 - only about 1000 pieces.

1864 ~ total produced 118 000

1865 - civil war inspires greater product Elery watch.

1877 ~ 1 million

1901 ~ 10 million

Other competitors emerged and they used the same strategies: Elgin watches.