Weds: Paper 1 due by 5pm

Fri: Read Barrett Ch 11 pg 114 – 118
Mondsch 137 — 140

Developing a Marine Chronometer

The Longitude Act of 1714 of Great Britain stipulated conditions required by the British government for accurate longitude finding. The highest reward would be given to a method that would be able to find the longitude accurately to 0.50° on a voyage to the West Indies and back. This would require an accuracy of 2min for the entire trip.

Both celestial and timekeeping approaches were pursued to solve this problem. The timekeeping approach required a clock that would be much more accurate than those devised and improved by Huygens and Hooke.

The person who most successfully pursued this project was John Harrison (English, 1693-1776) who learned clock making. None of his clocks involved any fundamentally different approaches.

* they either used pendulums or balance springs as regulators
* they used mainsprings to drive the clocks.

A long series of crucial innovations gradually reduced timekeeping errors in these clocks.

These innovations included:

1) temperature compensated pendulums
2) friction reducing bearings
3) advances in escapement design.
4) advances in mounting to reduce rocking.

Harrison produced a series of clocks:

1) H.1 (1735) - large
   - pendulum regulator
   - tested on a trip to Lisbon and showed promise

show Greenwich Museum page

2) H.2. (1737-1739) - not tested., also large

3) H.3 (1759) - used circular balances
   - also large
   - not satisfactory

4) H.4 (1759) - watch size
   - balance
   - tested on a voyage to Jamaica 1761 returned to Portsmouth 1762
   - retested on a voyage to Barbados 1764
   - lost 15s on the entire five month voyage

   = 0.1s per day.

The Harrison H.4 clock was the clock that finally succeeded.

Copies of the H4 clock were soon afterward made by Larcum Kendall and tested on Captain Cooks Second Voyage

Demo: Wikipedia Page Second Voyage of Captain Cook

Howse pg 75 In this case the watch performed well enough that it became the most trustworthy navigation tool for locating longitude

Q What is likely to have been the next fundamental issue in developing marine chronometers?

The next task would be to make the manufacture of these much cheaper so that most ships could use them. These were first developed by John Arnold and Thomas Earnshaw. They reduced the cost from about £500 (Kendall) to about £60 each. In particular the Earnshaw clocks

Demo : Earnshaw Watch , British Museum

Such watches were required by the British East India Company (early 1800s) on all its ships.

Q What is the overall pattern in the developement

	Harrison	Kendall	Arnold Earnshaw
produced	prototype	working copy	mass produced, cheaper
sponsor/ incentive	government	government	businesses, government.

Q What were the broader consequences for the world of this navigation? How did clocks assist?

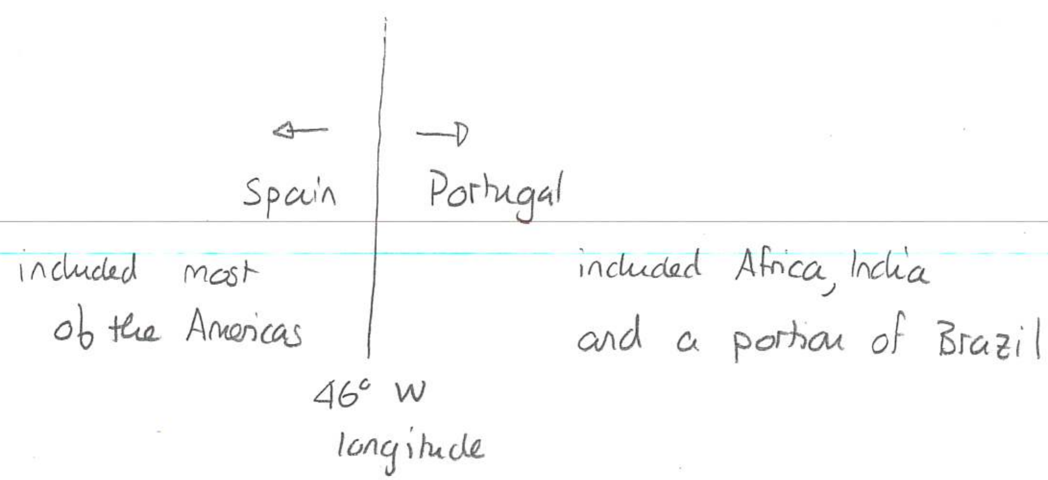
Longitude finding for mapping

Aside from finding longitude at sea in order to aid navigation there were other avenas where it was important. On land finding longitude helped improve the precision of mapping efforts.

Demo: Cassini Map of France

Such longitude finding could better map important regions but it could also settle disputes.

One such dispute concerned a treaty that divided the world into two regions of influence, one dominated by Portugal and the other by Spain. The Treaty of Tordesillas (1494) divided Earth (outside of Europe



Demo: Search Britannica Map Treaty of Tordesillas.

Q What issue might this pose elsewhere on the globe?

When these powers explored the Pacific Ocean, it was unclear where the anti-meridian (134° E) passed. This became contested after Portuguese and Spanish explored Indonesia and the Phillipines. This was resolved via the Treaty of Zaragoza (1529) which designated a boundary at particular islands rather than longitude, because the longitude was not known. The line is roughly at 146° E giving Portugal a larger share of the globe

Demo: Wikipedia page Treaty of Tordesillas