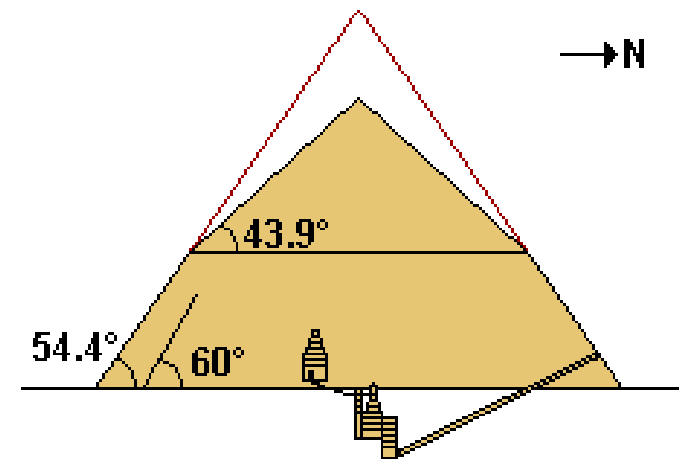


# SURVEYING

Surveying is thought to have originated in ancient Egypt as early as 2700 B.C., with the construction of the Great Pyramid of Khufu at Giza, though the first recorded evidence of boundary surveying dates from 1400 B.C. in the Nile River valley.



Front Cordsmen in a Scene of Stretching the Cord from the Tomb of Menna (Photo by David Goodman)



# EGYPTIAN SURVEYING TOOLS

The ancient Egyptian measuring rope (the old term for "surveyors" was "harpedonaptae" or rope-stretchers) was treated to hold its length. It was stretched taut between stakes and then rubbed with a mixture of beeswax and resin. Some of the ropes depicted in hieroglyph were graduated by knots tied at intervals. Accuracy was creditable, according to a 1909 triangulation survey that tied some original boundary stones. The Egyptian crews set the stones to divide the fertile Nile delta, and the "rope" was indispensable for measuring the distances.

**Plumb** bobs were appreciated for their ability to furnish a true vertical line. The Egyptians employed plumb tools in their sighting and leveling instruments, and as a way to continue distances vertically. They exploited all the possibilities of the bob, using it for astronomy, navigation, surveying, and building. It was their "workhorse" tool.

The sighting instruments were the "merchet" and the "groma". The merchet was a staff with a wide notched top. The notch was a long slit through which the instrument operator aligned a fixed plumb-line and the "rope-men". This enabled them to measure long lines effectively. The groma was a right-angle device designed for laying out fields, much like the surveyor's cross of more recent times. Of the two, the merchet was more accurate, and it was probably used to survey the pyramids.

Though nothing is known of the long-distance leveling devices, two different short-distance types were used to build the pyramids. The first was a water level. The bedrock was networked with narrow trenches, then filled with water. The waterline was marked on all the trench walls, the protrusions cut down, and the trenches re-filled with stone to create a level base. The second type of level was an A-frame with a plumb bob suspended from the apex. Since the Egyptians understood the isosceles triangle, stones could be cut and chiseled square, and mortared into place using this instrument.

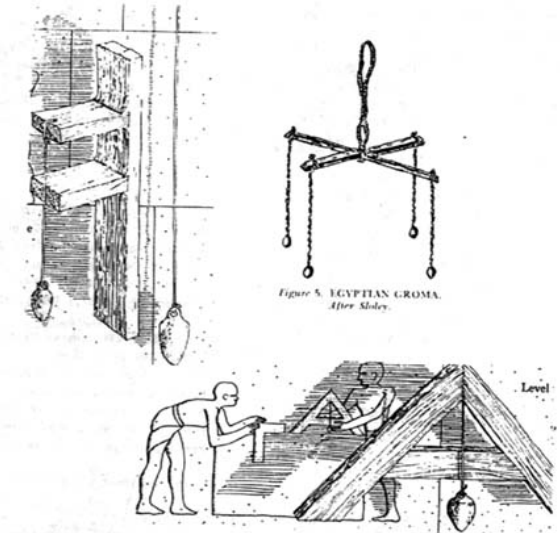
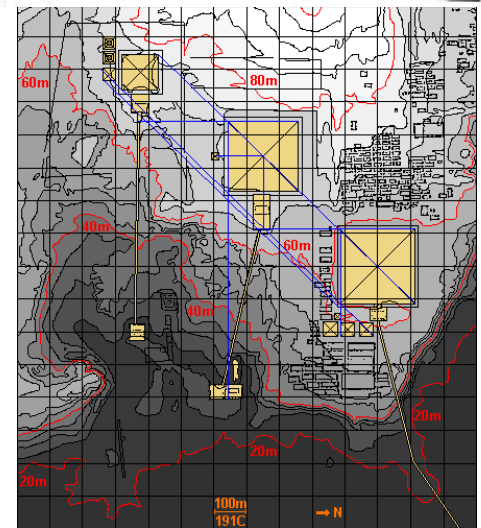


Figure 5. EGYPTIAN GROMA  
After Slides.



Survey and Alignment  
of the Khufu pyramid

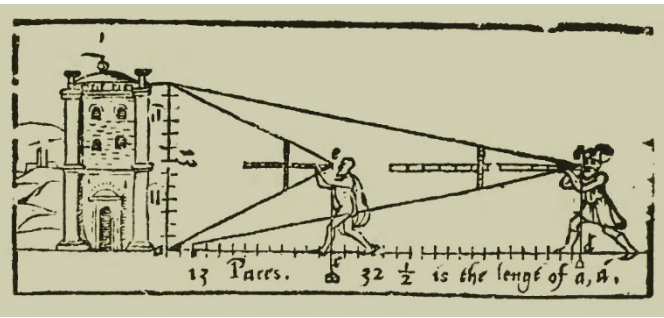
HYPATIA - world's leading astronomer and surveyor.

## Invention of the Astrolabe



The classic surveyors were the Romans. In order to forge an Empire that stretched from the Scottish border to the Persian Gulf, a large system of roads, **bridges**, aqueducts, and canals was built, binding the country economically and militarily. Surveying was a major part of Roman public works projects.

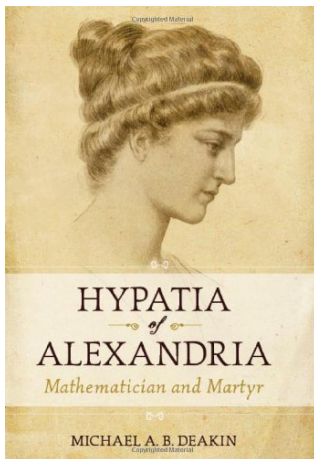




The theodolite was invented in the sixteenth century. Its precise origin is unclear, but one version was invented by English mathematician Leonard Digges in 1571, who gave it its name.



The practice of triangulation was introduced by Gemma Frisius in 1533. By measuring the **distance** of two sides of a triangle in a ground survey, the third side and the triangle's area can be calculated.



Triangulation was aided by the inventions of the prismatic **astrolabe** (invented by Hypatia) and the heliotrope. ***Why not call Hypatia the mother of geodesy?***

The latter was invented by German mathematician Johann Gauss, father of geodesy .

# Benjamin Banneker: Surveyor, Mathematician, Astronomer

**Benjamin Banneker (1731-1806)** was one of those rare humans who have exceptional talent in many fields. Banneker was born on a farm near Baltimore, Maryland, in 1731, the son of a free mother and a slave father. Banneker taught himself astronomy and surveying.

Thomas Jefferson recommended Banneker for a position on the commission to survey and plan the city of Washington, D.C.

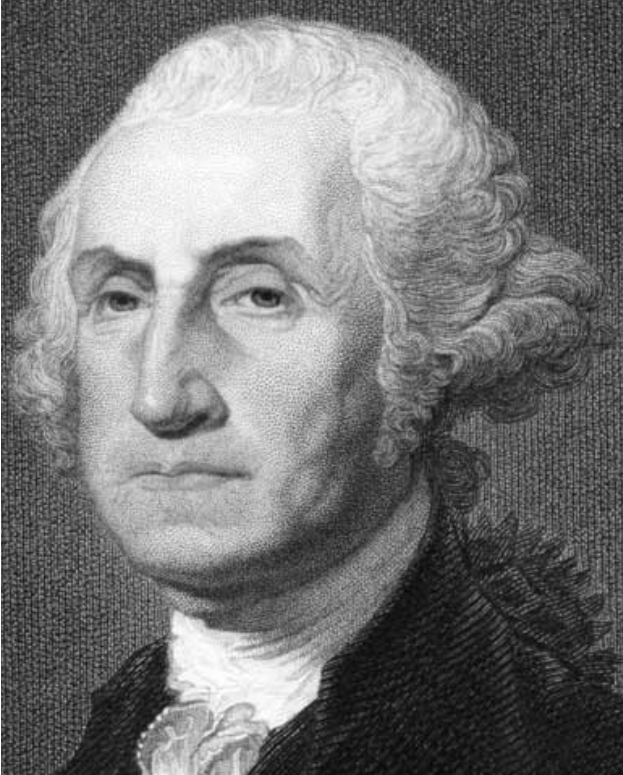


# THE SILK ROAD



The historic Silk Roads, which were a network of trade routes across land and sea that connected the lands from China across Asia to the Mediterranean, connected civilizations and peoples from different cultures, religions and languages with each other allowing the exchange of ideas, technical know-how and friendship, creating a legacy of connectedness and cultural appreciation.

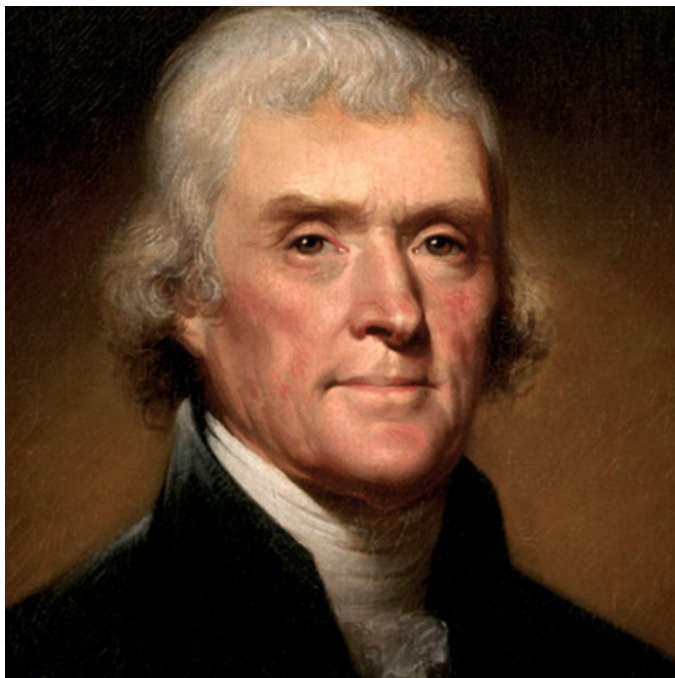
# GEORGE WASHINGTON



One of America's most famous (and earliest) land surveyors is [George Washington](#). The young future president got his bright start at the age of 17 in 1749. It was not long until he was appointed to be the Surveyor General for Virginia. Washington actually played an essential role at this time, because surveying the land promoted expansion westward.

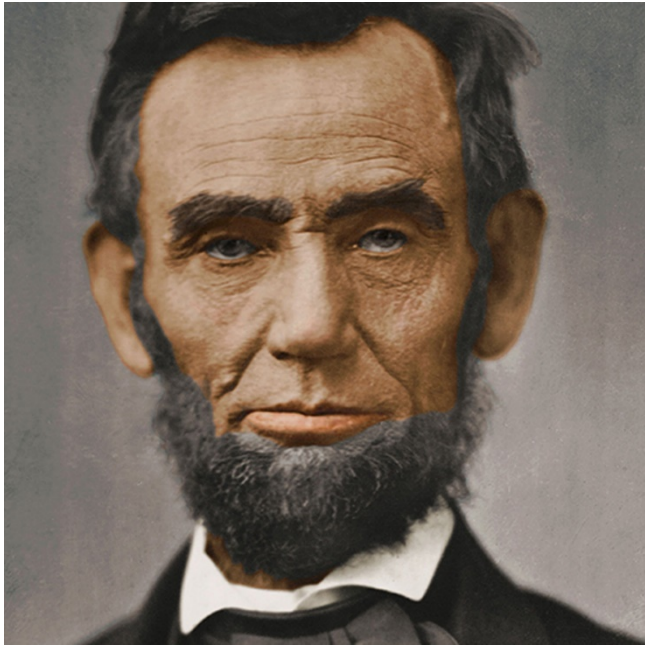
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# Thomas Jefferson

was appointed to work as the Albermarle County surveyor in Virginia in 1773. He also promoted surveying by sending Lewis & Clark on their expedition to explore the land gained through the Louisiana Purchase.



# ABRAHAM LINCOLN

Long before stepping into the role as the 16th President, Lincoln started out as a self-educated man.

Working at as a postmaster and a storekeeper as he studied law and, yes, surveyed land, he began to build the foundations for what would be a most consequential career.

# Lewis and Clark



Lewis and Clark were tasked with some of the most intensive land surveying in American history. While Lewis had a reputation as more of a planner, Clark was an expert surveyor and mapmaker. Together, the partners traveled across the land then known as the Louisiana Purchase, making their way to Oregon to scout it out.

President Thomas Jefferson sent the famous Lewis & Clark on their trek, the Corps of Discovery Expedition.