

Surveying FE 208

Lecture 1

Learning Objectives for this Lecture

- 1. Write a precise definition for “Surveying”**
- 2. List some examples of specialized surveying**
- 3. Understand the historical context for surveying**
- 4. Describe some of the duties of a surveyor**
- 5. Understand what surveyor is responsible for**
- 6. Understand what a surveyor is not**

What is Surveying

Surveying has been an essential element in the development of the human environment since the beginning of recorded history (about 6,000 years ago). It is required in the planning and execution of nearly every form of construction. Surveying is defined as the science, art, and technology by which lines, distances, angles, and elevations are established and measured on or beneath the Earth’s surface.

The purpose of surveying in general is to locate the positions of points on or near the surface of the Earth. This can involve the measurement of distances and angles in order to

- a. Determine horizontal positions of points
- b. To determine elevation (or vertical distances) of points above or below a predetermined reference point, sea level for example
- c. To determine the configuration (topography) of the ground
- d. To determine the direction of lines
- e. To determine the length of lines
- f. To determine the positions of boundary lines
- g. To determine the areas of portions of land bounded by given lines

Specialized surveys can also be employed to:

- a. Layout construction lines for exact locations for buildings, bridges, roads or other engineering projects requiring accurate location (Construction Staking Surveys)
- b. Establish horizontal and/or vertical points of reference (Control Surveys)
- c. Establish new or existing property boundary lines (Cadastral Survey)
- d. Create ground contours (Topographic Survey)
- e. Create underwater contours or ground configuration (Hydrographic Survey)
- f. Create maps or collect data from aerial photography (Photogrammetric Survey)

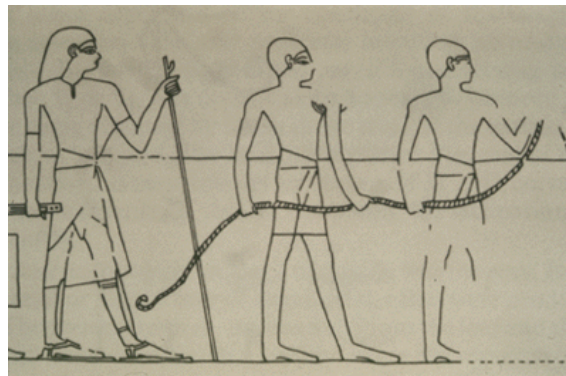
A. History of Surveying

Early Egypt circa 2700 B.C.

Surveying has been referred to as the world's second oldest profession

The beginnings of surveying trace back to early Babylonia and Egypt as a means of identifying land "ownership". The Egyptians first used it to accurately divide land into plots for the purpose of taxation. In particular, resurveys became necessary with the annual flooding of the Nile and the need to reestablish previously set boundaries.

The earliest surveyors were called "**Rope-Stretchers**". In fact, a calibrated rope was one of the tools used in surveying. Several tombs from the New Kingdom era, about 1100 BCE show the tomb owner overseeing men using calibrated ropes, with carefully measured knots, to measure fields, presumably to calculate the taxes for yield of these fields. The Egyptians developed a system of measurements based on a natural device, i.e. the human arm. They used cubits, traditionally the length from the bent elbow to the tips of the fingers; palms, the width of the palm of the hand; and digits, the width of the human fingers. So four digits equals one palm and seven palms equals one cubit. For additional information on early Egyptian surveyors, refer to the article by [Joel Paulson, Surveying in Ancient Egypt](#).



Rope-stretchers – Early surveyors along the Nile

Length			
1 thumb			
4 thumbs	=1 palm		
24 thumbs	=6 palms	=1 cubit	
28 thumbs	=7 palms	=1 royal cubit	approx. 52.4 cm
100 royal cubits	=1 khet		
20 000 cubits	=1 iteru	approx. 10.5 km	
Area			
1 khet x 1 khet	=1 aroua	=1 setjat	approx. 0.25 ha

Summary of ancient Egyptian length measures

Importance of boundaries

Earliest recordings show the importance placed on the boundary markers

In the Anglican Communion or Book of Common Prayer (1549)

“Cursed is he that removeth his neighbor’s land-mark. Amen”

On the Kudurru at the time of the pharaoh Marduk-Nadin-Akhe (ca 1100 BC)

The title is given that the stone is “The Establisher of the Boundary Forever”

The inscribed penalty is as follows:

Whensoever in later days an agent, or a governor, or a prefect, or a superintendent, or an inspector, or any official whatsoever, who shall rise up and be set over Bit-Khanbi, shall direct his mind, to take away those lands, or shall lay claim to them, or cause a claim to be made, or shall take them away or cause them to be taken away, or shall side with evil and shall return those lands to their province, or shall present them to a god, or to the king, or to the representative of the king, or to the representative of the governor, or to the representative of his council or to any other man, or shall cause curtailment or diminution, or shall say, "The lands were not the gift of the king" or because of the curse shall cause another to take them, or shall send a fool, or a man who is deaf, or one who is feeble-minded, or a vagabond or one who is without intelligence and he shall cause him to remove this memorial-stone, or shall cast it into a river, or put it in a well or destroy it with a stone, or burn it in the fire, or hide it in the earth, or hide it in a place where it cannot be seen, upon that man may Anu Enlil, Ea and Ninmakh, the great gods look with anger, and may they curse him with an evil curse that cannot be loosened.

May Sin the light of the bright heavens, with leprosy that never departs clothe his whole body, so that he may not be clean till the day of his death, but must lie down like wild ass at the outer wall of his city.

May Shamash, the judge of heaven and earth, smite his countenance, so that his bright day may turn to darkness for him.

May Ishtar, the lady, the princess among the gods, send a curse (?) upon him, and in misery (?), her message of anger, may he multiply his words day and night, and like dog may he pass the night in the open place of his city.

May Marduk, the king of heaven and earth with dropsy, the bond of which cannot be loosened, fill his body.

May Ninib, the lord of the boundary and the boundary stone, tear out his boundary-stone, tread down his boundary, and change his holding.

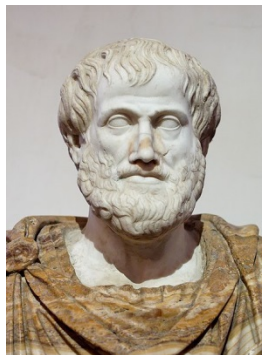
May Gula, the mighty physician, the great lady, put a grievous sickness in his body, so that he may pass light and dark blood like water.

May Adad, the ruler of heaven arid earth, overwhelm his fields, so that there may spring up abundantly weeds in place of green herbs and thorns In place of grain.

May Nabu, the exalted minister, appoint him days of scarcity and drought, as his destiny.

May all the great gods, whose names are mentioned on this memorial-stone, drive him into evil and unhappiness. His name, his seed, his offspring, (and) his posterity may they destroy in the mouth of widespread peoples.

Early Greek Surveying circa 550 B.C.



The Greek mathematician traveled to Egypt sometime around 550 BC to study from the Egyptians. While there he developed a number of mathematical principles related to surveying, in particular, height measurements from shadow ratios. Shortly after, Pythagoras also traveled to Egypt to study and eventually founded a school in what is now southern Italy, devoted in part to mathematics learned while in Egypt. Eventually both made it back to Greece and spread the knowledge gained. Here, legendary figures, including Aristotle, Plato, and Archimedes made the city of Alexandria a great center of science, surveying, and related endeavors.

Although no records exist, it is clear from the layout of cities in Egypt, Greece, and later Rome, that the same geometry of planning and construction was used, suggesting a transfer of knowledge from each civilization to the next. For additional information on early Greek surveyors, refer to the article by [John Brock, Pyramids to Pythagoras: Surveying from Egypt to Greece – 3000 B.C. to 100 A.D.](#)

Early Roman Surveying circa 100 A.D.

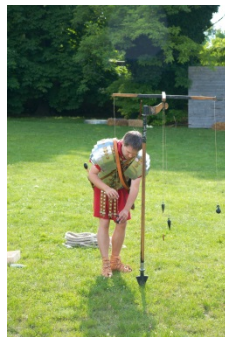
The Roman Empire is another civilization noted for its land surveying prowess. The Romans established land surveying as an official profession; land surveyors in this time were known as agrimensores. From the first century AD, agrimensores in Rome were known for creating perfect straight lines and right angles. These lines would be used to dig shallow trenches, some of which are still in existence to this day. Many Roman surveying methods were based on those used in ancient Egypt and Greece.

Europe circa 1700's

By the 1680's, questions about the true size and shape of the Earth were pushing on Isaac Newton and later Tycho Brahe and Johannes Kepler to develop their physical laws related to planetary motion and gravity. At this same period, a family of astronomers and surveyors, the Cassini family, began an ambitious project of surveying all of France. When they started, determining longitude was still an inaccurate science. However, Jean-Dominique Cassini worked out a new way of calculating longitude that was much more precise than any method used up until then. It involved calculations based on the movements and eclipses of Jupiter's four largest moons. Cassini used the moons to calculate the correct time in Paris, which the French often used as the prime meridian. Then he figured out the difference between the time in Paris and the local time where he was surveying land. Knowing the difference between the two times helped Cassini calculate the longitude of the site he was surveying. Surveyors who were trained in Cassini's method fanned out throughout France to take measurements and report back. In addition, people around the world used Cassini's technique to pinpoint locations, and then sent him the information. The Cassini family put all of the measurements on a huge world map. Gradually the map took on a shape that reflected, for the first time, the true proportions of land and seas. Scientific accuracy, rather than guesswork, became the new standard in mapmaking. The next 200 years would be the golden age of mapping throughout the world.

In America, The journals of explorers Meriwether Lewis and William Clark contained hundreds of maps as well as drawings and observations about this new area of the country. In 1814, Clark published a full map of the region. For the first time, the eastern and western parts of the country were connected through mapped details. Clark's map, connecting the known and unknown, prompted the beginning of western expansion in the United States. It stirred people's imaginations and offered them a route for following their dreams. Throughout the 1800s, this same exploration and mapping process was going on worldwide— both on land and at sea.

Modern Surveying



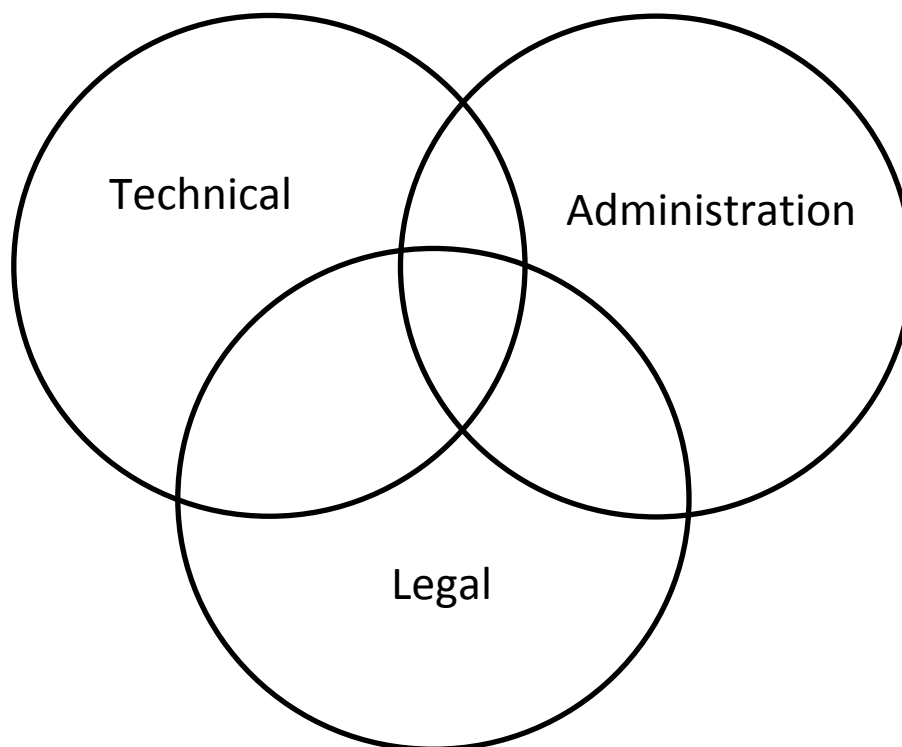
Surveying has come a long way from the ancient Roman Surveyor using the Groma to the modern day surveyor relying on satellite positioning for accurate location of points on the

Earth's surface. Precise location and measurement are more important now than ever. Today's surveyors have traded in their field books for electronic data collectors, compass and tape have been replaced by digital total stations, and accurate positioning utilizes the huge gains from the space program with satellite navigation and laser technologies.

However, the root of all surveying still requires the fundamental knowledge of geometric and trigonometric relationships of positions to each other. The purpose of this course is to strengthen those foundations.

What does a surveyor do

Land surveyors carry out a variety of measurements dealing with earth (ground), air and water surfaces. The purpose is to establish boundaries to satisfy ownership and provide concrete research for legal documents. A land surveyor will also perform research to discover any previously recorded boundaries and compare them with their own physical measurements. In effect, A land surveyor is a collector of data and information about the measurements that they make. The practice of surveying overlaps into three distinct areas:



The technical area deals with the functions and understandings of the equipment and survey techniques and practices employed. The administrative area includes the necessary filings of land plats and records to the local governing body administering the practice of surveying, generally the county-level surveyor's office. The legal area primarily deals with the research of land and survey records necessary prior to a survey commences. It includes the descriptions of any and all boundary markers set, accessory evidence to a survey, etc.

Each state has specific requirements about the profession of surveying. In California, for example, licensed professional land surveyors can provide the following services:

- prepare legal descriptions and maps for subdividing property
- perform boundary line adjustments
- replace lost or obliterated property corners
- set boundary markers or property corners, also known as monuments
- retrace boundaries for fences and other purposes
- locate, relocate, establish, reestablish, or retrace any property line or boundary of any parcel of land, right-of-way, easement, or alignment of those lines or boundaries
- prepare legal descriptions and information shown with the description of any deed or other
- title document
- prepare maps or plats for plot plans
- stake the location of fixed engineering works for construction purposes
- determine boundary discrepancies
- locate, relocate, establish, reestablish, or retrace the alignment or elevation for any of the
- fixed works embraced within the practice of civil engineering
- determine contours of the earth's surface for topographic maps
- photogrammetric surveying or aerial topographic mapping

A survey that does not determine property lines, but is made only for geological or landscaping purposes, does not require a licensed land surveyor.

What does a surveyor not do

Land surveyors are not in a position to make judgment decisions on legal issues. That is simply a matter that can be resolved only by a judge. The surveyor can make all of the surveying measurements, render testimony in what was or was not found in a survey, offer information gleaned from courthouse land deed records as testimony, but cannot make any type of judgment or decision regarding ownership or other legal matters related to a survey.

Simply put, A surveyor is a collector of information and data. A surveyor is not a judge

Reading for this Section

Paulson, Joel. Surveying in Ancient Egypt

Brock, John F. Pyramids to Pythagoras. Surveying from Egypt to Greece

Kiser, pages 1-2