INSTRUMENTATION

Geodesy relies heavily on the science of measurement. In the past, measurement of distance, angles, and time (gravity) were predominant but, more recently, they have yielded to electronic signal processing which provides the ability to measure phase shifts of offset waves and to split time intervals into very small pieces. Physical quantities are measured indirectly, but can be determined quite precisely. The following list is incomplete, but consider:

Eratosthenes measured the length of a shadow and compared it to the length of a vertical staff to measure the angular distance of the sun from the zenith. He estimated 1/50 of a circle - 1 significant digit. He also, purportedly, estimated the distance from Syene to Alexandria by the rate of camel caravans to be 5000 stadia - also 1 significant digit.

Poseidonius measured the distance between Rhodes and Alexandria based upon the sail time of a ship. The angles he measured were from the horizon to the maximum elevation of the star Canopus as it crossed his meridian. The difference in vertical angles measured at the two locations was taken to be the angle subtended at the center of the earth.

Snellius was the first to use a telescope to measure triangles (cross hairs were invented later). He used an odometer to measure the baseline distances and computed his triangles correctly trigonometrically. The Gunter's chain was invented in England in 1620.

Picard was the first to use a telescope containing crosshairs for measuring triangles. He measured his baselines using "well seasoned varnished rods."

Reliable Time: Christian Huygens invented the pendulum clock in 1657 (variations in the period of a pendulum are related to gravity). 100 years later John "Longitude" Harrison built the first marine chronometer capable of keeping time accurate enough for longitude navigation.

The French Academy of Science: The equipment (including the latest quadrants for measuring horizontal and vertical angles and wooden bars for measuring baselines), procedures, logistics, and results of performing the Lapland and Peru surveys are documented by Smith (1986).

Delambre & Mechain: Since the purpose of their project was to determine a standard of length, much effort was devoted to establishing and maintaining very tight control on the standard length bars used in the survey. Upon completion of the survey, length standards (distance between marks etched on platinum iridium bars) were issued and sent throughout the world.

Modern measuring instruments include digital theodolites, EDM, GPS and atomic clocks capable of splitting time into nanoseconds.

