

7. Measuring Distances



To measure distances, land surveyors once used 100-foot long **metal tapes** that are graduated in hundredths of a foot. (This is the technique I learned as a student in a surveying class at the University of Wisconsin in the early 1980s. The picture shown below is slightly earlier.) Distances along slopes are measured in short horizontal segments. Skilled surveyors can achieve accuracies of up to one part in 10,000 (1 centimeter error for every 100 meters distance). Sources of error include flaws in the tape itself, such as kinks; variations in tape length due to extremes in temperature; and human errors such as inconsistent pull, allowing the tape to stray from the horizontal plane, and incorrect readings.



Figure 5.8.1 Surveying team measuring a baseline distance with a metal (Invar) tape.

Credit: Hodgson, 1916

Since the 1980s, **electronic distance measurement** (EDM) devices have allowed surveyors to measure distances more accurately and more efficiently than they can with tapes. To measure the horizontal distance between two points, one surveyor uses an EDM instrument to shoot an energy wave toward a reflector held by the second surveyor. The EDM records the elapsed time between the wave's emission and its return from the reflector. It then calculates distance as a function of the elapsed time. Typical short-range EDMs can be used to measure distances as great as 5 kilometers at accuracies up to one part in 20,000, twice as accurate as taping.

The Nature of Geographic Information

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Figure 5.8.2 Total station.

Instruments called **total stations** combine electronic distance measurement and the angle measuring capabilities of theodolites in one unit. Next, we consider how these instruments are used to measure horizontal positions in relation to established control networks.

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