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Course: Survey of Ag/ Surveying I

Unit Title: Introduction to Surveying

Materials: Surveying tools

I. Lesson Title

- a. Surveying!

II. Situation

- a. This is an Agricultural Mechanics class that just finished up learning the basic theory of surveying. Students may have some knowledge in this area, others won't. Students should be in grades 10th-12th.

III. Teachers Objectives

- a. Explain the various surveyor methods used to measure distance through class participation with 90% accuracy.
- b. Summarize the process of correctly setting up, leveling, and measuring with a dumpy level and auto level through class participation with 90% accuracy.
- c. Perform distance measurements (pacing & metal tape) and the use of either a dumpy or auto level through given activity with 90% accuracy.

IV. Teaching Procedures

a. Interest approach

- i. Lay surveying tools out on the table for students to identify. Have each tool numbered that way students will be able to correctly label and identify each. Once your students are done identifying the tools, start the lesson. As the instructor, you will identify each tool for the student as you go throughout the lesson. Have students hang on to their answers to see how many they got correct.

b. Reasons to learn

- i. Why is it important to correctly identify tools before surveying?
- ii. Why is it important to understand the correct way to set up and use the levels for surveying?

c. Questions to answer

- i. What is the correct way to set up and use the dumpy level?
- ii. What are the different ways to measure distance?

d. Answers to questions

- i. What is surveying? *(Review this with students if necessary)*
 - 1. Surveying is the practice of taking essential measurements to determine accurate points or places on land.
- ii. Basic Surveying Principles
 - 1. Land surveys are used to establish exact locations, boundaries, or subdivisions of land.

2. Land surveys are performed for the following reasons:
 - a. Establish markers or monuments to define or preserve boundaries
 - b. Legally relocate markers or monuments
 - c. Determine lengths and direction of old land survey lines
 - d. Subdivide large parcels of land
 - e. Calculate areas, distances, and directions for survey data
 - f. Provide a technical and written descriptions of land and its boundaries
3. Surveyors must use different instruments to calculate the pieces of data that are needed as part of the land survey.
4. Distance Measurement
 - a. Measuring distance is one of the tasks most commonly done by the surveyor
 - b. The distance between two points on a 2D map is a horizontal distance
 - c. Land is measured on a flat plane due to this fact, and the measurement is not based on elevation changes
 - i. Even on sloping ground there are methods you can use to measure horizontal distance
 - d. Most common measurements are read in feet and tenths of a foot to simplify calculations.
 - e. There are many ways to measure distance in surveying:
 - i. Pacing
 1. A practice that involves a person walking out the distance and calculating the distance based on his or her pace factor.
 2. After determining your pace factor by walking a known distance several times and dividing that distance by your average number of steps
 3. *Odometer wheels* that roll on the land and measure the distance based on wheel revolutions can also be used.
 4. *These methods aren't always as accurate*
 - ii. Taping
 1. An *electronic distance measuring (EDM)* device is a piece of equipment that has circuit boards that calculate distance between two points through algorithms based on the speed of light (186,000 miles per second)
 - a. These are easy to use especially in long distances, but are expensive

2. Metal tape has been used for many years. This method is durable and accurate.

iii. Electronic equipment

1. Global positioning system/ geographic information system (GPS/GIS) is a software and equipment that use advanced technology and linked satellites to measure distance.

a. GPS uses satellites in orbit around the earth to determine where a point is located.

b. GIS is the software that computes use to translate information from GPS data

i. This method is gaining popularity due to its pinpoint accuracy but are also expensive.

5. Taping measurements

a. Taping is a process used in land surveying where a metal tape marked with length measurements is used to determine the distance between two points,

i. The main disadvantage when taping is that all the variables associated with physically measuring distance could cause an error in the final measurement.

ii. Temperature can also cause the metal tape to expand or contract.

iii. *There are 6 steps when using the taping process:*

1. First, "line in" the points to be measured by determining the shortest distance between the two points

2. Apply tension to remove sag to the tape. Be cautious to not apply too much tension and break the tape

3. Connect a plumb bob to one or both ends of the tape so it remains horizontal. This is mainly needed when obstructions or land features exist along the measurement line, requiring the tape to be elevated.

4. When measuring longer than 100', mark the distance with chaining pins. *Chaining pins* are metal stakes used during surveying to incrementally mark taping measurements on the ground. Chaining pins come in sets of 11 so

you can measure up to 1000' per set in 100' increments.

5. Once the distance is measured, read the tape to the nearest 1/10
 6. After an accurate measurement is read, record the distance in your field notes. Field notes allow you to continue your measurements and later describe what you measured and the recorded length.
6. Electronic measurements
 - a. This method is becoming more available and economical.
 - b. This equipment calculates distance between two points based on the speed of light (186,000 miles per second) and the time needed for the light to travel from one point to another.
 - c. The calculations are recorded on electronic data loggers for retrieval either on site or away.
 - d. Despite terrain conditions and, to some extent, weather conditions, distances can be measured easily, quickly and very accurately with EDM devices and electronic systems.
 7. Surveying Equipment and Use
 - a. The most common instruments used are the dumpy level and auto level.
 - b. The dumpy level
 - i. Also called builder's level, is one of the most commonly used surveying instruments.
 - ii. It's an optical tool that is used along with a target rod to measure the elevation rise and fall of a piece of land.
 - iii. Also used to sight and determine locations along a horizontal line.
 - iv. You don't have to be a professional surveyor to understand how to use the level.
 1. Before survey work can begin, the dumpy level must be mounted securely on a tripod stand.
 - a. All three legs of the tripod must be locked in a sturdy position on a firm footing. A plumb bob may be hung directly under the center of the tripod to assist in placing the instrument precisely over a given location.
 2. The dumpy level normally has four screws used in opposite pairs to adjust the position to level.

- a. A spirit (bubble) level on the tool functions as the leveling guide.
 - b. A good rule of thumb is to turn opposing screws towards each other or away from each other to level the instrument across one axis.
3. The instrument scope is an optical device (telescope) through which the user looks to sight a level horizontal line.
4. Once the instrument has been leveled on one axis, the instrument scope should be turned 90° and aligned with the other axis/screws to level the tool along that axis.
 - a. After the instrument is leveled, it can be rotated 360° on the tripod and used to sight horizontally in any direction.
5. A helper needs to hold the target rod at the desired locations on the property or build site for the measurement process. A *target rod* is a stick or pole marked with measurements and used with a leveling instrument to determine elevation.
 - a. The surveyor looks through the leveling instrument scope and aligns the scope crosshairs on the target rod to determine the point's elevation. Measurements are logged in field notes.
 - b. The target rod is graduated in feet and tenths and hundredths of a foot or in metric measurements. The large red numbers indicate feet and the smaller black numbers located between the feet graduations signify $1/10^{\text{th}}$ of a foot. Between each $1/100^{\text{th}}$ of a foot or $1/10^{\text{th}}$ of an inch. The distance between these marks and from the top to the bottom of the mark it is equal to $1/100^{\text{th}}$ of a foot.

8. Auto level

- a. Auto levels are similar to dumpy levels, but they normally have only three screws for adjustment. The instrument should be

leveled using all three screws once the level is placed at the desired location on the tripod stand.

- b. The main difference between the dumpy level and the auto level is that the auto level has a compensator built into the instrument. Refractors that are part of the compensator help ensure that the tool is leveled by automatically eliminating slight movements from level.
- c. The dumpy level is also more expensive than an auto level, but it is also more accurate.

9. Laser level

- a. Laser levels are becoming more popular in the surveying industry.
- b. These are set up and stationed the same as the auto and dumpy level.
- c. However, for the laser level, the surveyor does not have to sight a target rod through a scope. Instead, the tool projects a laser beam that is captured by the laser receiver unit. The laser beam is directed either in a straight line or in a level plane completely around the tool.
- d. For this instrument, the surveyor does not need assistance when taking measurements.

Levels and instruments:



Image found at:

https://www.sccssurvey.co.uk/media/catalog/product/cache/1/image/800x/040ec09b1e35df139433887a97daa66f/l/e/leica-na324-tripod-right-front_1_1.jpg



Image found at:

https://images.homedepot-static.com/productImages/644a5b88-33d5-4afc-b756-8845e2a9d153/svn/dewalt-laser-level-dw0822-64_1000.jpg



Image found at:

<http://www.johnsonlevel.com/Content/files/BuildersLaserLevel.png>

Rods:

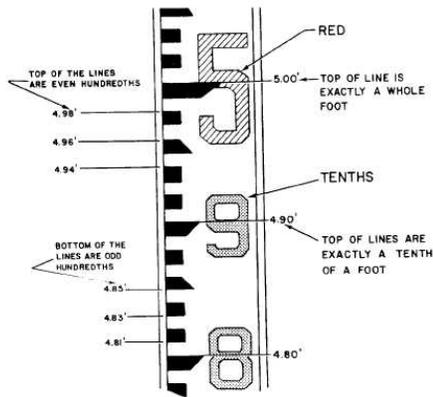
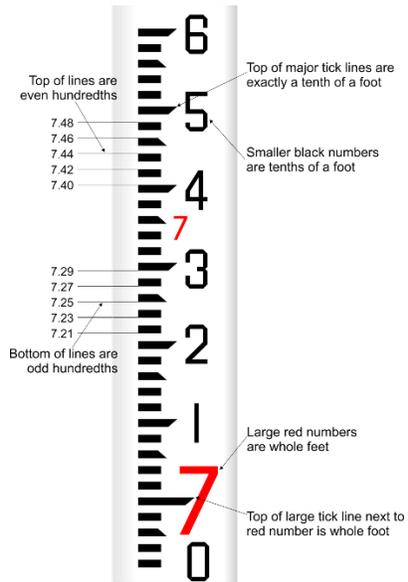


Image found at:

https://upload.wikimedia.org/wikipedia/commons/thumb/7/7b/Reading_Leveling_Rod_jpeg.png/1200px-Reading_Leveling_Rod_jpeg.png

Image found at:

http://constructionmanuals.tpub.com/14043/img/14043_141_1.jpg

Tapes/chains:



Image found at:

<https://3.imimg.com/data3/JQ/MO/GLADMIN-158576/construction-survey-tools-250x250.jpg>

Image found at:

https://www.engineersupply.com/Seco-Marking-Pins-2183-00.aspx?VariantId=50dc38e5-b7b9-4ea9-a26b-46fb11939299&utm_source=google&utm_medium=cse&utm_term=ES4653&gclid=EAlalQobChMI0sKQreL41wIVCQRpCh0deAhHEAQYA_iABEgKVqfD_BwE

Tripod:



Image found at:

<http://surveyequipment.com/media/catalog/category/leica-gst05-tripod-399244.jpg?1406115584>

V. Testing Solution Through Application

- a. Students will measure distance through pacing and metal tape. They will need to correctly perform the activity. If the GPS/GIS instrument is available, students can also practice this as well.
- b. Students will also perform the set up and use the dumpy or auto level the correct way. Students should narrate their actions to make sure all steps are taking.

VI. Closure

- a. Review these questions with the students:
 - i. What is the correct way to set up and use the dumpy level?
 - 1. See above
 - ii. What are the different ways to measure distance? Explain each.
 - 1. Taping and electronic measuring (allow time for description)

Allow time for discussion for each question.