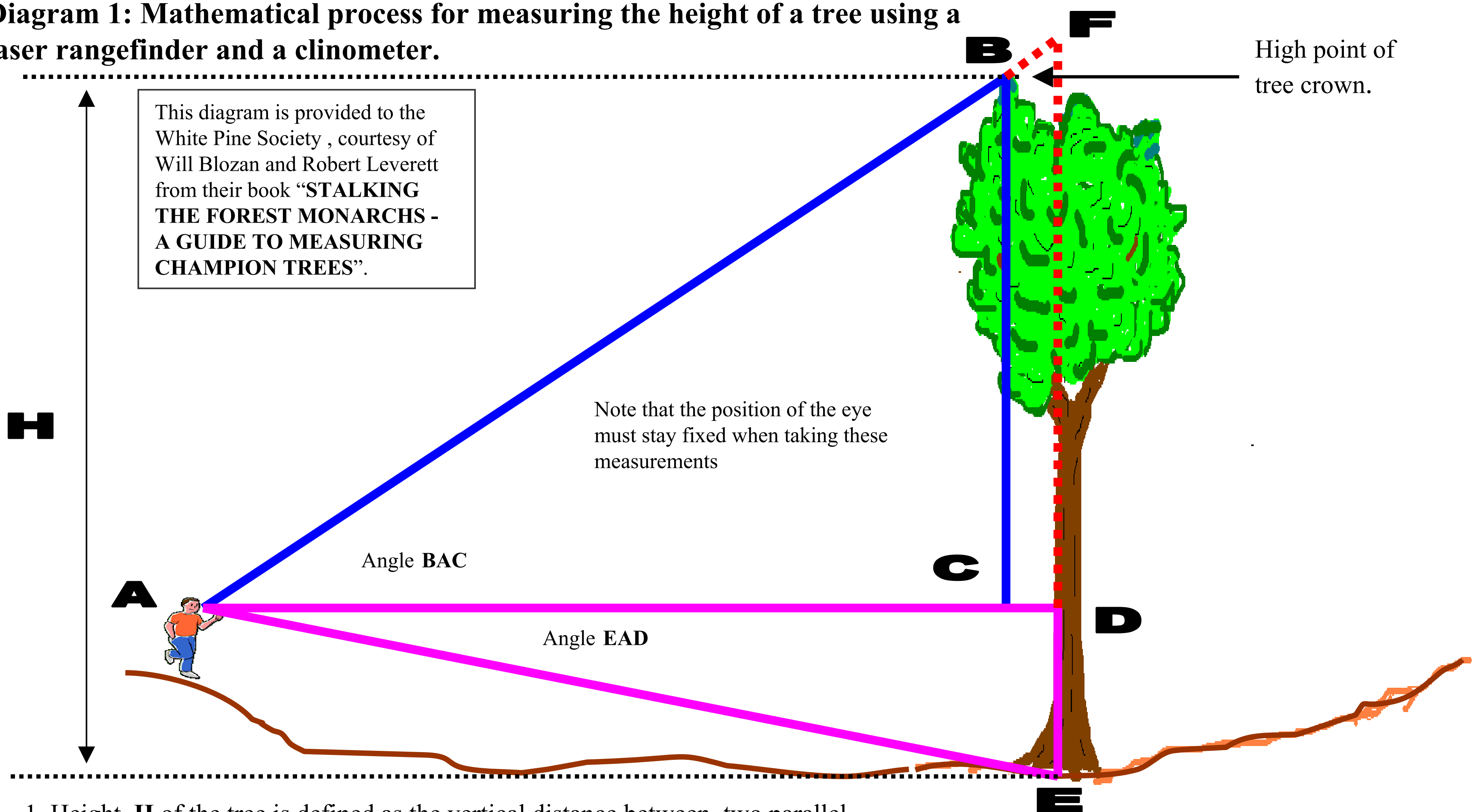
Diagram 1: Mathematical process for measuring the height of a tree using a laser rangefinder and a clinometer.



1. Height **H** of the tree is defined as the vertical distance between two parallel horizontal planes, one passing through the highest point of the tree and the other passing through the base of the tree. This height can be divided into two segments **BC**, the component above eye level, and **DE**, the component below. Note that height is not synonymous with tree length.

BC=AB[SIN(BAC)]

DE=AE[SIN(EAD)]

H=BC +DE

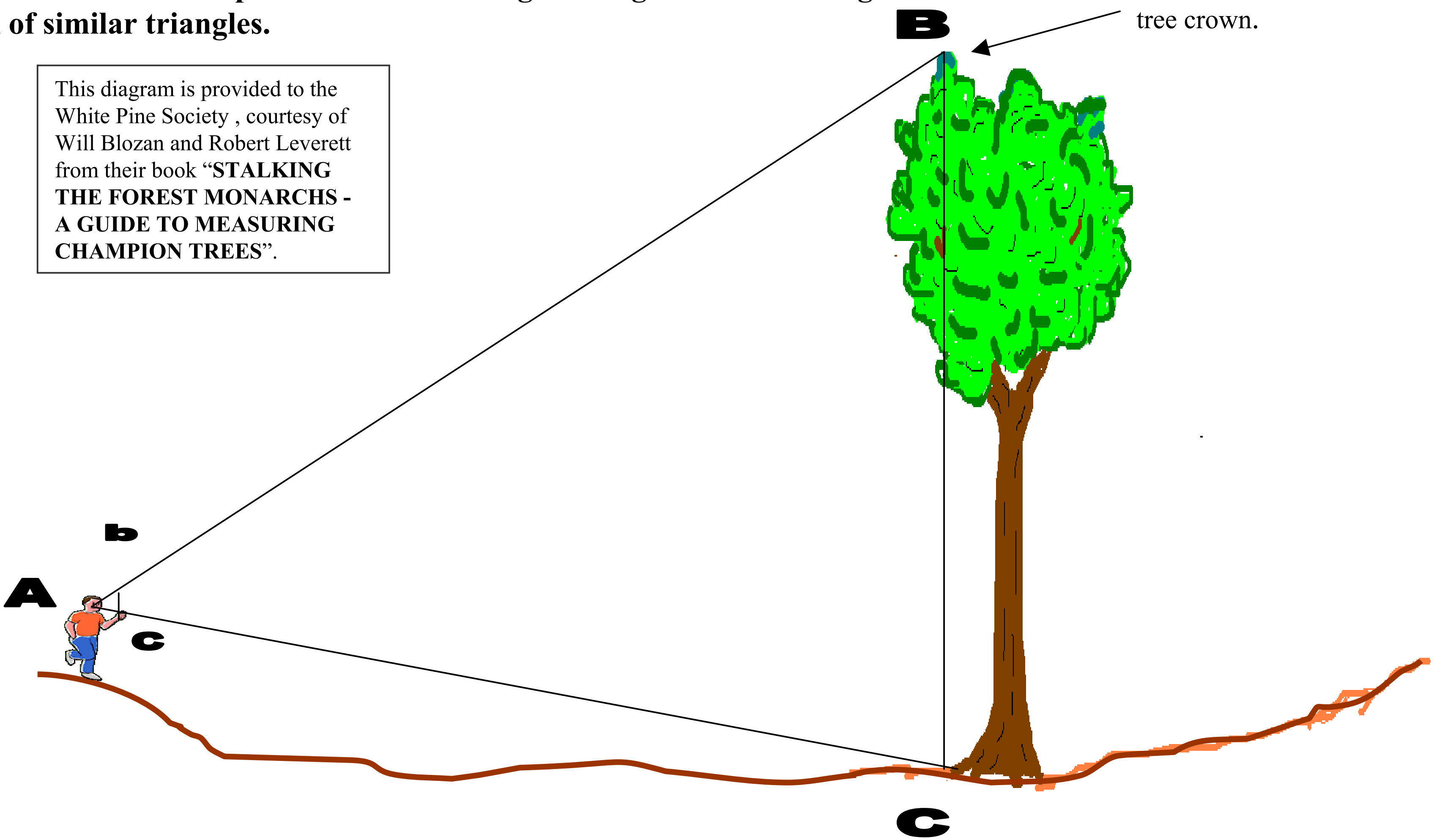
2. Distances **AB** and **AE** are measured with a laser rangefinder. Angles **BAC** and **EAD** are measured with a clinometer.

3. From the diagram, it is apparent that for this process to work, it is not necessary for the high point to be directly over the base of the tree.

4. A common mistake of measurers is to perform the calculation **AD[TAN(BAD)]** to calculate the component of height above eye level. The distance actually being calculated is **DF** instead of **BC**. Some clinometers are set to perform this calculation. Height becomes a percentage of the base line **AD**.

Diagram 2: Mathematical process for measuring the height of a tree using the principal of similar triangles.

This diagram is provided to the White Pine Society , courtesy of Will Blozan and Robert Leverett from their book "**STALKING THE FOREST MONARCHS - A GUIDE TO MEASURING CHAMPION TREES**".



The principal of similar triangles can sometimes be used to measure a tree's height. In the above diagram, triangle **Abc** is similar in shape to triangle **ABC** so that corresponding sides are proportional in length. The measurer obtains the lengths **Ac**, **AC**, and **bc** (bc is a device such as a standard 12 inch ruler. The measurer must determine the point **C** on the ground directly beneath the high point of the tree's crown. The ratio and proportion **BC/bc = AC/Ac** holds if the triangles are truly similar. Rearranging the formula gives **BC = (AC/Ac) bc.** This method assumes triangle **Abc** is truly similar to triangle **ABC.** In actual practice the triangles are seldom formed in such a way as to be similar.

Diagram3: Mathematical process for measuring the height of a tree using a tape measure and a clinometer.

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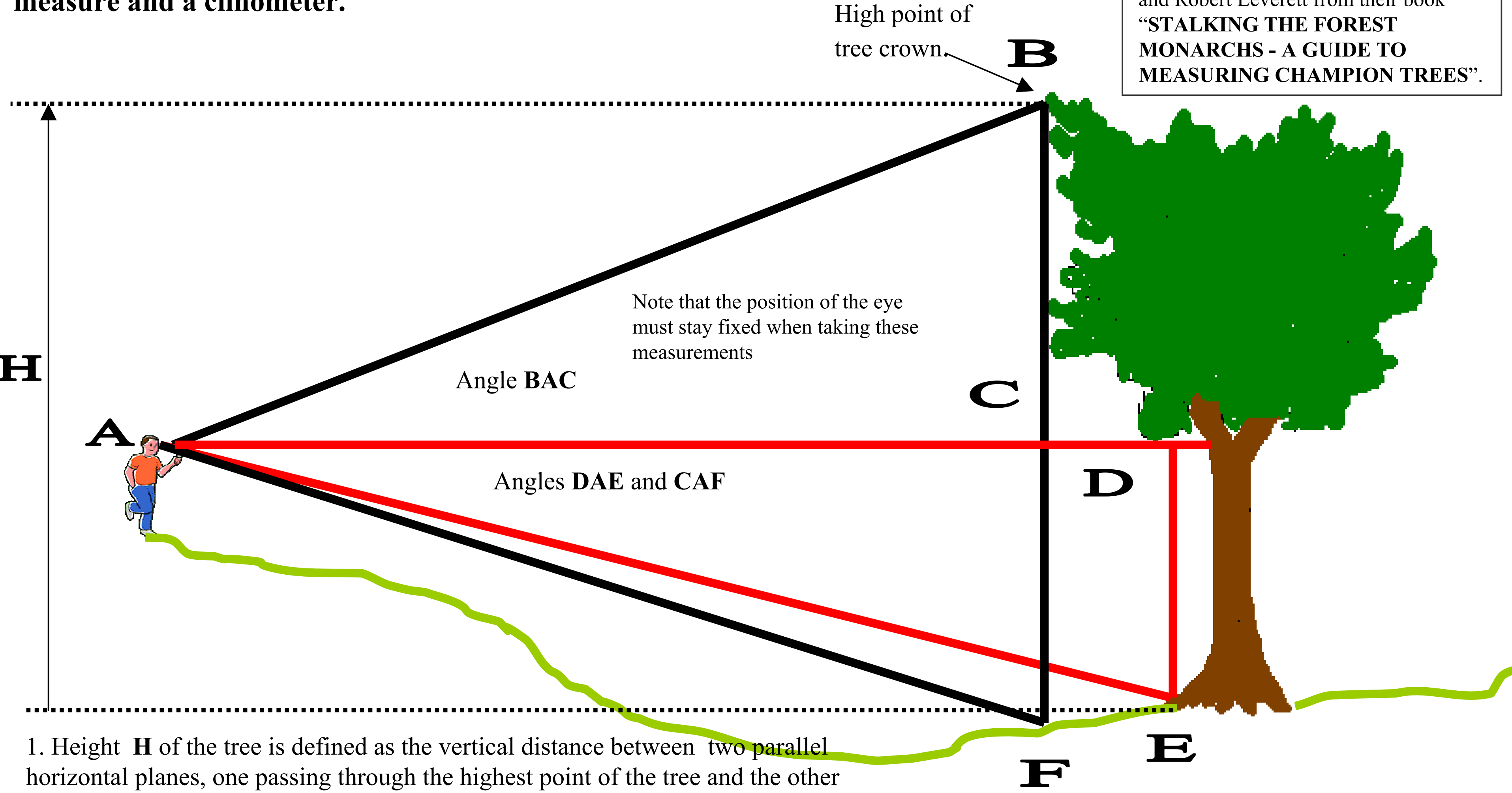

1. Height **H** of the tree is defined as the vertical distance between two parallel horizontal planes, one passing through the highest point of the tree and the other passing through the base of the tree. This height can be divided into two segments **BC**, the component above eye level, and **CF**, the component below. Note that height is not synonymous with tree length.

2. Distances **AE** and **AF** are measured with a tape measurer. Angles **BAC**, **FAC**, and **EAD** are measured with a clinometer. The point F is directly beneath the high point of the crown; i.e. a plumb line from the high point to the ground would intersect the ground at point **F**. The following calculations are made to compute the tree height. Next diagram shows how to determine **F.**

AC=AF[COS(FAC)]

BC=AC[TAN(BAC)]

CF=AC[TAN(FAC)]

H=BC +CF

Diagram3a: Mathematical process for measuring the height of a tree using a tape measure and a clinometer. Determining point F.

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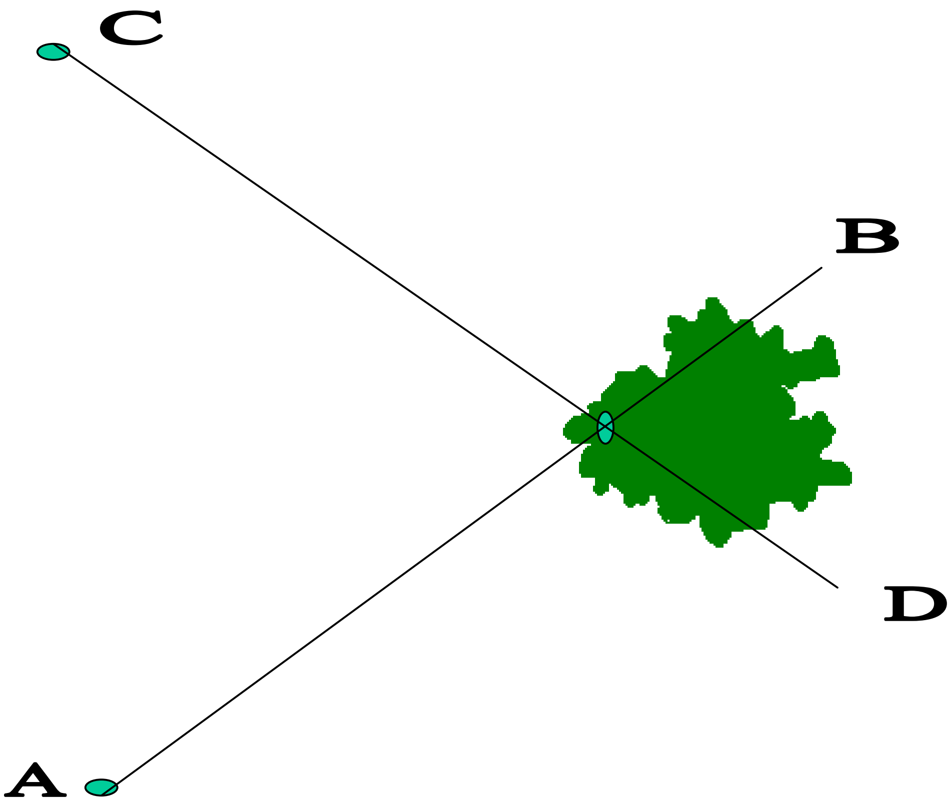

This view looks down from above the crown of the tree. It can be thought of as a vertical projection.

1. Measurer, standing at point **A** sights down a pendulum, held in the hand, from the apparent high point of the crown to the apparent intersection with the ground. The pendulum is held in line with the eye and the high point of the tree's crown. An assistant is directed to stretch a tape measure from point **A** along line **AB** on the ground. The assistant will go directly beneath the high point.

2. Measurer moves to point **C** and repeats the procedure. The assistant is directed to stretch a tape measure from point **C** along line **CD** on the ground. Again, the assistant will go directly beneath the high point. The point on the ground where the two tape measures cross should be directly beneath the high point of the crown. Finding points **A** and **B** where the high point of the crown is visible from both locations and there are clear paths from the points to beneath the high point may prove difficult to impossible. Use of a laser range finder eliminates this problem and is the preferred measurement technique.

Diagram 4: Measuring the circumference of a tree.

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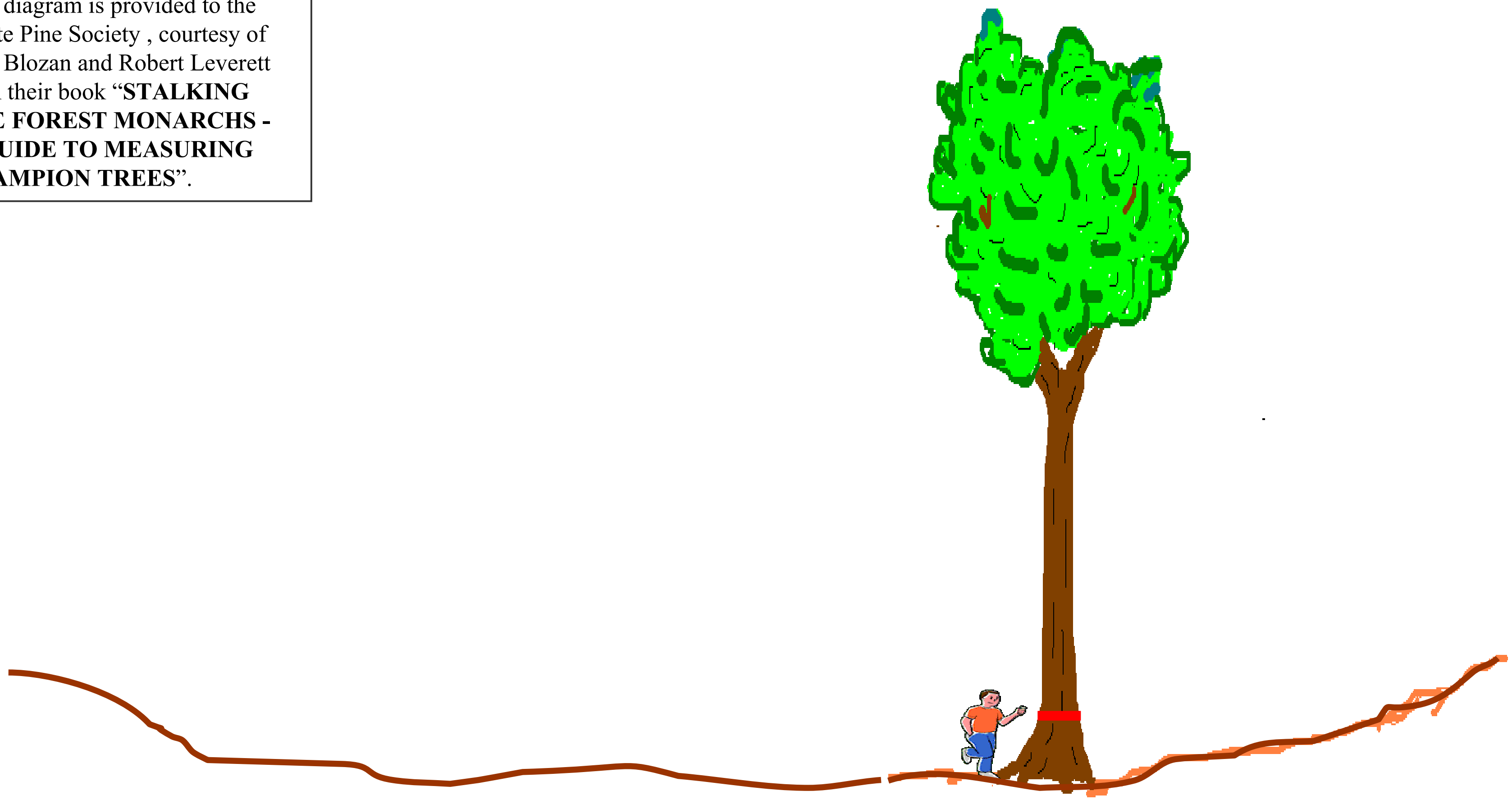

1. To measure the circumference of a tree locate a point 4.5 feet up the trunk from the base. If the tree is on sloping ground go to the mid-point of the slope. Measure the circumference perpendicular to the axis of the trunk. If the tree is multiple-trunked and forks below 4.5 feet from the ground, measure the largest trunk. If there is a point below 4.5 feet where the trunk is smaller in circumference than at exactly 4.5 feet, measure the circumference at the smallest point. This measure is used in most champion tree formulas.

Diagram 5: Measuring the crown spread of a tree.

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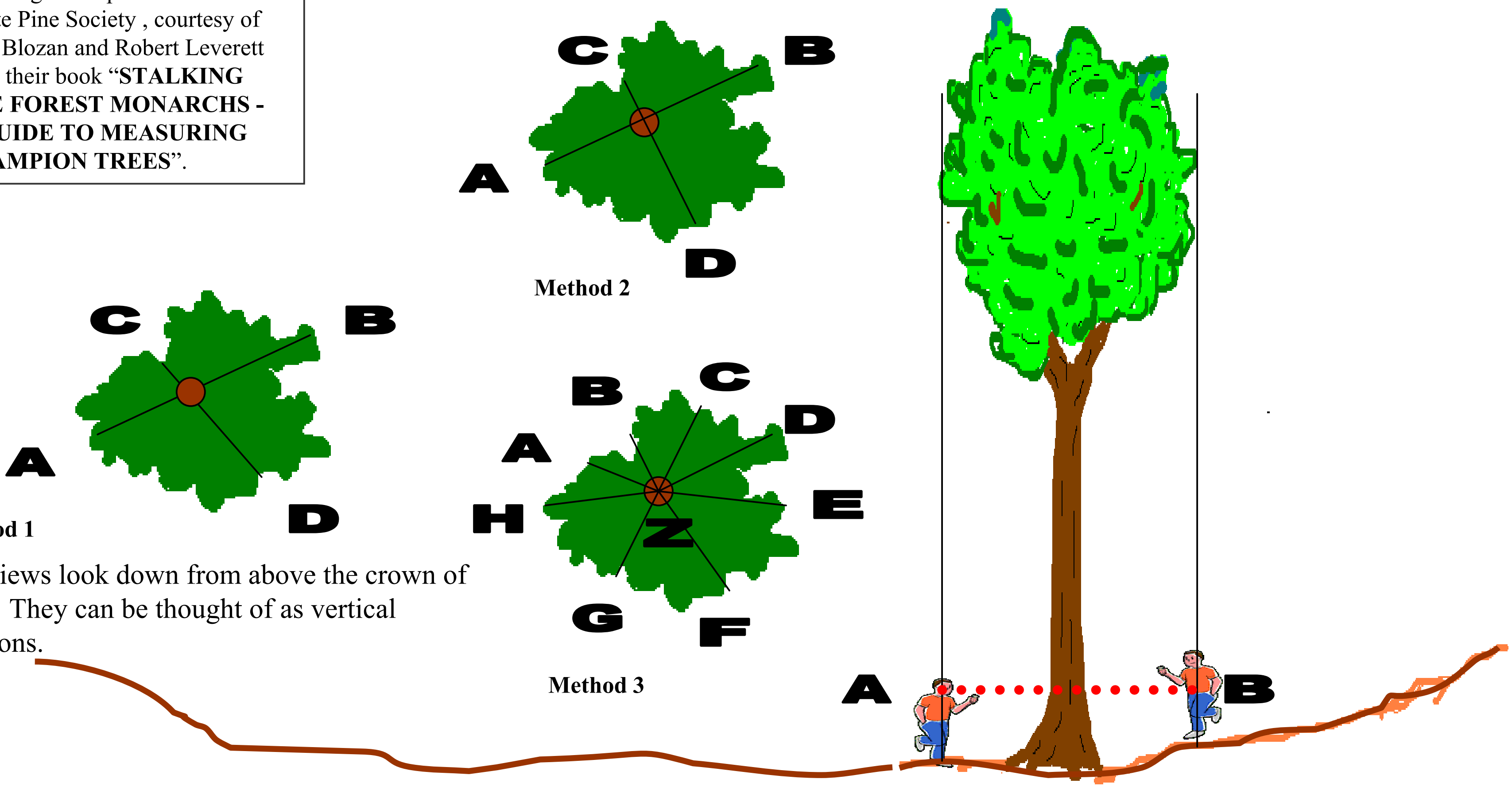

These views look down from above the crown of the tree. They can be thought of as vertical projections.

There are several way to approach measuring average crown spread. Method 1 seeks to find the longest and shortest spreads and average them. Method 2 is to find the longest spread and then take another measurement at right angles to the long spread and average them. In Method 3 the measurer moves around the tree taking periodic measures of the spread from the measurer to the tree. In the diagram the measurer would employ the simple formula:

AVERAGE CROWN SPREAD = 2[(AZ+BZ+CZ+DZ+EZ+FZ+GZ+HZ)/6]. Finding the end point of a branch requires nothing more than a clinometer that has a scale calibrated in degrees. Sighting upward from beneath a branch and moving until the tip is seen and the angle is 90 degrees insures that the measurer is directly under the branch.

To calculate champion tree points on the American Forests formula follow the steps below.

1. Measure the circumference, C, at breast height (4.5 feet above the base) of the tree, in inches. If the tree is on sloping ground, go to mid-slope.

2. Measure the height, H, of the tree in feet.

3. Measure the average crown spread, S, in feet.

4. Calculate the tree's points using the following formula.

$$H = C + H + S/4$$

This formula weights girth over height by a factor of 12 to 1 and favors trees grown in the open over forest-grown specimens. The formula is a tradeoff between accuracy and simplicity. It does not measure actual volume. The formula has the advantages of capturing important information about a tree and being simple to use. However, measuring girth at 4.5 feet above the ground is a forestry convention. A more useful process would be to take an average of girth measurements at 1 foot, 3 feet, 5 feet, and 7 feet to better capture the lower trunk volume. Other dimensions being equal, the tree with the larger basal swell would be the larger.