PC-Mapper 5.x and CMT Survey 6.x Reference Guide

A Supplement to the PC-GPS Reference Guide

Printed in the United States of America

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Section 10 - COGO Functions

This section covers some of the commonly used Cogo menu functions. If you need information on any COGO function that is not discussed in this section, please refer to the OnLine Manual (Help/OnLine Manual). This chapter applies to PC Mapper 5.x and CMT-SURVEY 6.x only.

10.1 Summary of COGO Functions

The coordinate geometry (Cogo menu) operations let you define new points by various mathematical techniques. The Cogo functions are outlined briefly in the table below.

Function Name & Purpose:	**Function Name & Purpose:**
Traverse (See Section 10.4) Traverse (create points) by direction and distance, or by Scale factor. • **Solve** to calculate coordinates of new Point • **Store** to save coordinates of new Point	**Inverse** (See OnLine Manual) Determine direction and distance between Points. • **Solution automatically** calculated • **Solve** to store coordinates of inverse on a line
Cogo T/R/S - Scale (See Section 10.5) Scale a Feature to a fixed Point. • **Solve** to move Feature • **Store** to save Feature coordinates	**2 Point Resection** (See OnLine Manual) Use angle and distance data to two known Points to calculate coordinates of a new Point. • **Solve** to calculate coordinates • **Store** to save coordinates
Cogo T/R/S - Rotate (See Section 10.6) Rotate a Feature around a fixed Point. • **Solve** to rotate Feature • **Store** to save Feature coordinates	**3 Point Resection** (See OnLine Manual) Use angle data to 3 known Points to calculate coordinates of a new Point. • **Solve** to calculate coordinates • **Store** to save coordinates
Cogo T/R/S - Translate (See Section 10.7) Move a Feature to new coordinates. • **Solve** to move Feature • **Store** to save Feature coordinates	**Horizontal Curve** (See OnLine Manual) Define and place a Horizontal Curve. • **Solve** to generate curve and calculate defining points • **Store** to save curve and defining points
Corner Angle (See Section 10.8) Find the corner angle defined by 3 Points. • **Solution automatically** calculated	**3 Point Curve** (See OnLine Manual) Define a Horizontal Curve using 3 known Points. • **Solve** to generate curve, calculate segment and sector area • **Store** to store curve and PI, RP coordinates

Multiple Points (See Section 10.9)

Define new Points at equal intervals between two known Points.

- **Solve** to calculate coordinates
- **Store** to save coordinates

Curve between Tangents (See OnLine Manual)

Determine the Curve between two Tangent lines.

- **Solve** to generate curve and defining points
- **Store** to store curve and PI, PC, PT RP coordinates

Direction Cut (See Section 10.10)

Determine the cut Points for a specific area by direction.

- **Solve** to calculate coordinates
- **Store** to save coordinates

Radius Point (See OnLine Manual)

Determine the Radius Point from a known PC, PT and radius.

- **Solve** to calculate Radius Point
- **Store** to store Radius Point

Hinge Cut (See Section 10.11)

Determine the cut Point for a specific area by a hinge Point.

- **Solve** to calculate coordinates
- **Store** to save coordinates

Vertical Curve (See OnLine Manual)

Define and place a Vertical Curve.

- **Solve** to calculate Vertical Curve solution
- **Print** to print the curve solution

Station Offset (See OnLine Manual)

Create Stakeout Points from a Line or Area Feature.

- **Solve** to calculate coordinates
- **Store** to save coordinates

Spiral Curve (See OnLine Manual)

Define and place a Spiral Curve.

- **Store** to calculate Spiral Curve solution
- **Print** to print the curve solution

Intersection (See OnLine Manual)

Create new Points based on Line intersections.

- **Solve** to calculate coordinates
- **Store** to save coordinates

Curve by Radius (See OnLine Manual)

Create curve based on known PI, direction of tangent lines and curve radius.

- **Solve** to calculate solution points
- **Store** to save coordinates

TRS Least Square Fit (See OnLine Manual)

"Fit" Features in one NEZ plane (Plane 1) to another NEZ Plane (Plane 2). One or more points in both Planes must be in the same location. These points are the "Control Points".

Earth Work (Version 6.x only. See OnLine Manual)

Define area sections and compute volumes based on cross-sections or borrow-pit areas.

10.2 Working with Cogo Functions

This sub-section covers the use of the Cogo View and the Cogo mouse. The COGO functions can be applied to the Feature data in your Job file or Map file. The functions are useful for making design drawings and creating stake Points that can be downloaded to the GPS data collector for use in stakeout work.

To define meaningful Point, Line and Area Features, please use the **Map/Coordinate System** function to verify or set the proper datum, coordinate system and units before starting COGO work. Also, check the settings under the **View/Configure** menu and the **Angle and COGO** option and make sure they are consistent with your units of measurement. The View/Configure page will also be used to set units for your angle measurements (see Section 10.3). It is advisable not to change the datum and coordinate system unnecessarily.

It is also advisable to set the proper map scale before starting a COGO design job. To do so, edit or type over the data in the "1 inch:" or "1 cm:" field in the Tool Bar. The currently active unit of length is displayed to the right of this field.

When using the COGO functions to create a curve based on given Point Feature(s), please keep in mind that the new curve (a Line Feature) is a separate entity from the Point Feature(s). Similarly, the Station Offset Points created on or alongside a Line Feature do not become part of the Line Feature. If you wish to treat the original and new Features as a group, such as for the COGO Scale, Rotate and Translate operations, you could store the newly created Feature under the same Topic name as the original Feature. You may then easily select all the Features under the same Topic for COGO Scale, Rotate or Translate by double-clicking the Topic name in the Topic View.

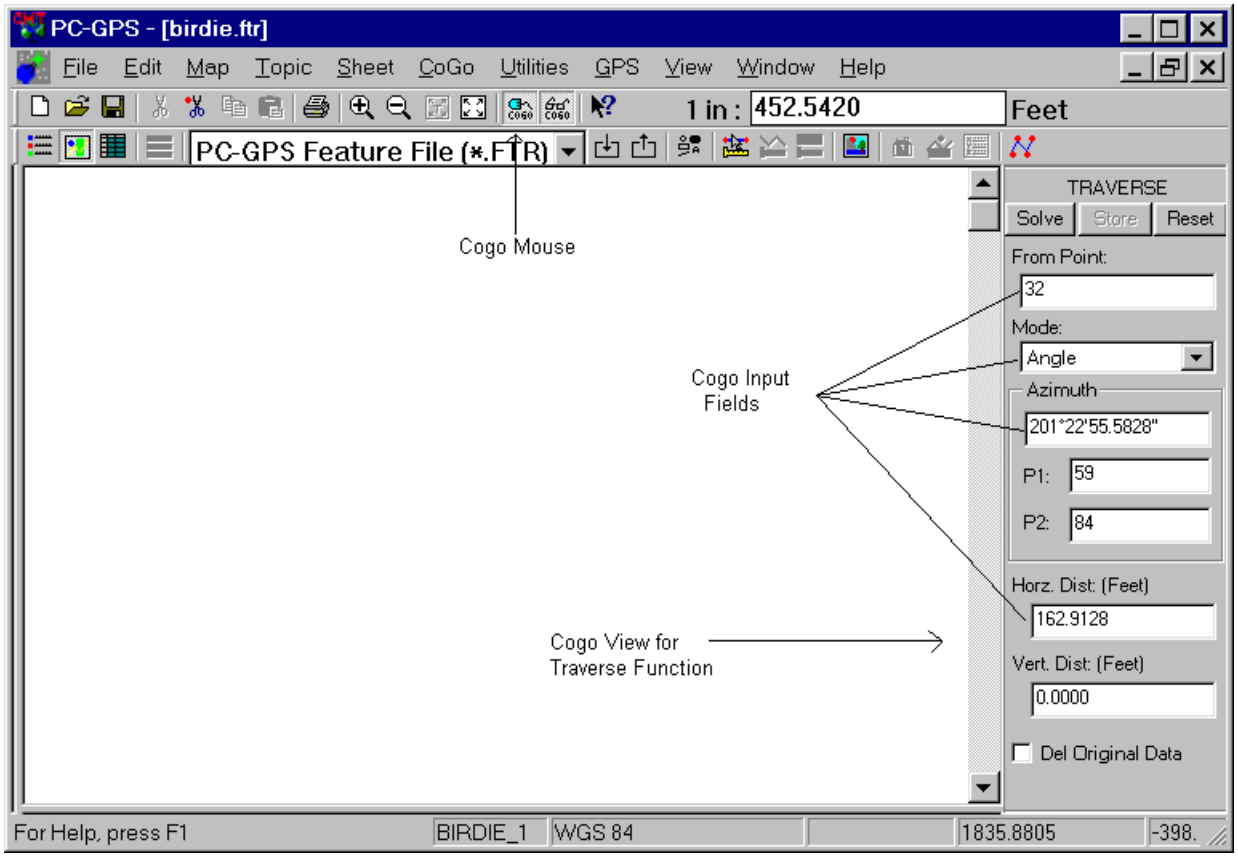
The new Features created by most of the COGO functions will be stored in a horizontal plane at 0 elevation. For example, when you select three Point Features to solve for a 3-Point Curve, only the (X,Y) coordinates of the three Points will be used in generating the curve and calculating the radius point and the point of intersection of the tangents. You may change the elevation of any Feature by editing the coordinates in the Feature Properties dialog.

However, a number of the COGO functions do make use of the elevation information. For example, the Traverse function lets you traverse in three dimensions. Also, you may translate or scale Features in three dimensions by using COGO Translate or COGO Scale, respectively. In addition, when you create a number of points at fixed intervals, the COGO Multiple Points function will store the new Points with the proper elevation values. And, of course, the COGO Vertical Curve function will create Points in a vertical plane at the specified interval.

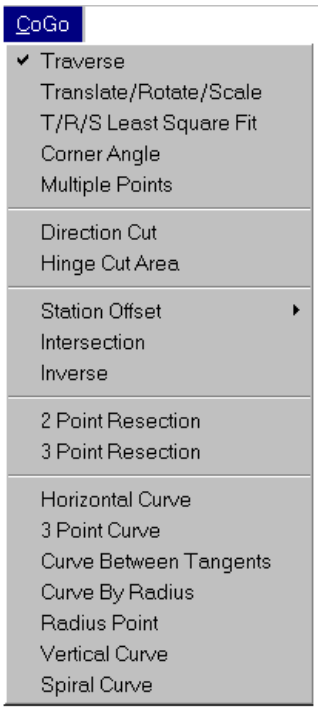
10.2.1 Cogo View

When you first select an option from the Cogo menu, the Cogo View will be displayed on the right-hand side of the screen. The active Cogo function will be listed at the top of the Cogo View.

The input and output fields displayed in the Cogo View vary according to the function selected. For example, when you select the **Cogo/Traverse** function, the "Cogo View" on the following page is displayed:



When the Cogo View is active for a function, a check mark will be displayed next to the associated Cogo menu option:



In this example, the Traverse function is selected. The Traverse option is marked with a check.

You can toggle OFF the Cogo View by un-marking the **View/Cogo View** menu option or clicking the Toggle Cogo View icon .

10.2.2 Cogo Mouse

When you select a function from the Cogo Menu, the Cogo Mouse is immediately made active. The Cogo Mouse icon, displayed on the tool bar, is displayed in light blue when the Cogo Mouse is active (or toggled ON). You can toggle the Cogo Mouse ON or OFF by clicking on the Cogo Mouse icon: 

The Cogo Mouse is used to select Features for Cogo functions. The Cogo Mouse is also used to indicate distance or direction for certain Cogo functions. To indicate distance, the Cogo Mouse activates the "Cogo Distance Circle". To indicate direction, the Cogo Mouse activates the "Cogo Direction Line". In this manual, the term **Cogo Mouse Field** is used to describe fields that accept input based upon the Cogo Mouse. When you place your mouse in a Cogo Mouse Field, the field will be highlighted in red.

The Cogo Mouse must be toggled ON in order for Cogo Mouse fields to accept mouse input. If the Cogo Mouse field will not accept mouse input, the Cogo Mouse probably is not toggled ON. Click on the Cogo Mouse icon on the tool bar to toggle it back ON.

When the Cogo Mouse is toggled ON, some of the standard PC-GPS mouse functions will not be accessible. You may notice that you cannot access the Feature Properties screen by double-clicking on a Feature if the Cogo Mouse is active.

Please note: Your mouse cursor will look the same regardless of whether the Cogo Mouse is toggled ON or toggled OFF. However, if the Cogo Mouse is active, your Cogo Mouse icon will be displayed in light blue. If the Cogo Mouse icon is not active, then the Cogo Mouse icon will be displayed in gray.

10.2.3 Selecting Data for Cogo Functions

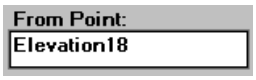
The input fields in the Cogo View vary according to the selected Cogo function. Data can be entered in the Cogo input fields using several methods: by Cogo Mouse, by Keyboard, or by Pull-Down Menu.

Selecting Features using the Cogo Mouse:

All the Cogo functions have input fields for specific Feature numbers or Feature names. (Example: From Point field in Traverse function.) These fields are **Cogo Mouse Fields**.

To select a Feature for one of these fields, first click your mouse cursor in the input field

(e.g. From Point field in Traverse function). The input field will be highlighted in red. Next, click your mouse on the Feature you wish to select. The Feature name will then be displayed in the input field.



If you would like to change the selection, you can either click on another Feature or simply type the Feature name in the input field.

Un-Selecting Features:

Selected Target Features may be “un-selected” by clicking the right-mouse button on the highlighted Feature in the Map View. Alternatively, you may right double-click on the Topic name in the Topic View. All of the Features in the Topic will be un-selected.

Multiple Feature Selection

For the **COGO Scale**, **Rotate** and **Translate** functions, you may select more than one Feature as the “Target”. This is particularly useful when you need to translate the entire Job to a correct reference point. It is also useful when you wish to move or scale a Line or Area Feature along with the Point Features from which it was created.

When you select a Target Feature for the COGO Scale, Rotate or Translate functions, it is added the “Target Features list”. When the Target Features field is highlighted, you may click on another Feature to add it to the list. Or, you may add all Features in a Topic to the list by double-clicking the corresponding Topic name in the Topic View. To work on all Features in the Job at the same time, simply click on **Edit/Select All**.

Please note: The Cogo Mouse must be active in order to select Features for Cogo functions by using the mouse.

An **Add** button is provided by the COGO Scale, Rotate and Translate functions to let you add a Feature to the Features list by entering its Feature ID into the Target Features field. To add a Feature, enter the Feature ID in the field above the Target Features list and then click on the Add button.

Selecting Angle Reference Points

Angle data for Cogo operations can be entered into the input fields using three different methods: **by reference points**, **by Cogo Direction Line** or **by keyboard**. For the reference point method, you select two reference points, called P1 and P2, from the Map. The azimuth between the P1 and P2 is the angle that will be automatically entered in the corresponding Azimuth or Angle field.

The **by Cogo Direction Line** and **by keyboard** methods are described in the next two sub-sections.

Using the Cogo Direction Line and Cogo Distance Circle

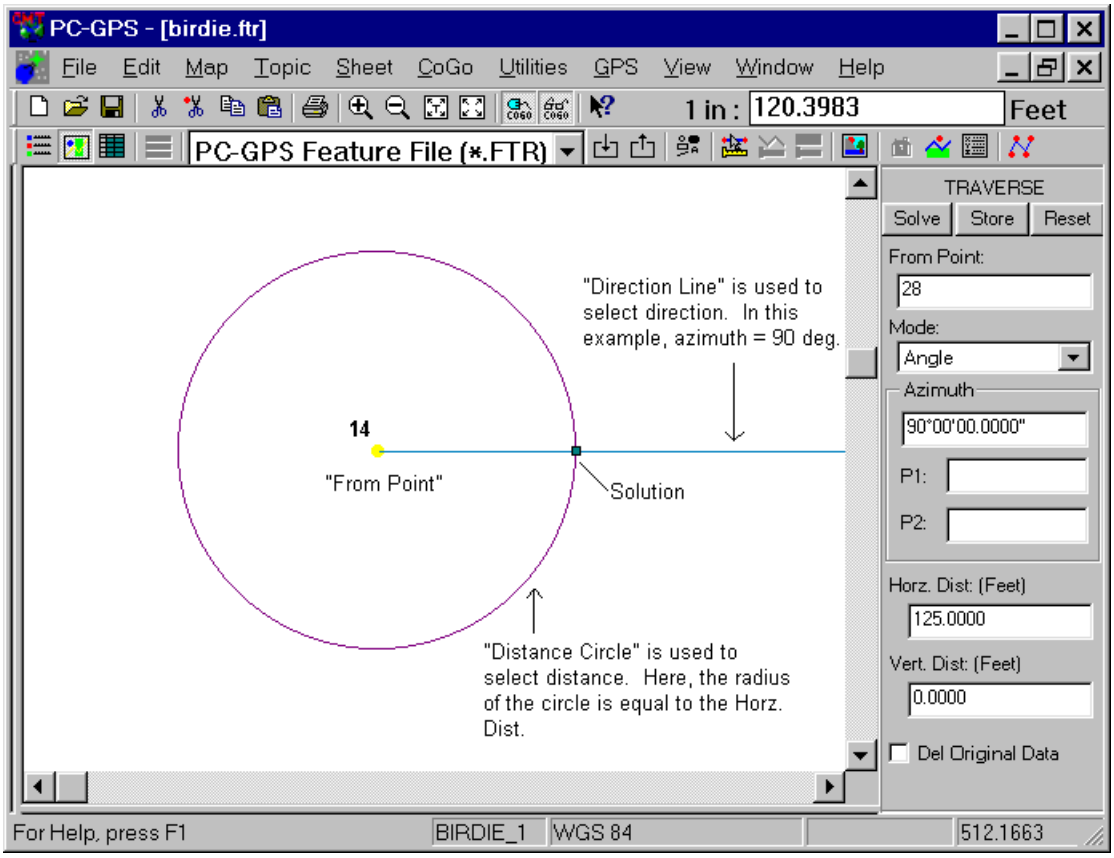
Many of the Cogo distance and direction fields accept input from the Cogo Mouse. When the Cogo Mouse is toggled ON, distance and azimuth can be quickly entered into these fields using the Cogo Direction Line and Cogo Distance Circle.

The Direction Line and Distance Circle are immediately displayed on the Map View when your cursor is placed in a Cogo Mouse direction or distance field. The direction or distance field will also be highlighted in red. (Not all distance and direction fields accept mouse input, so if the field is not highlighted in red, then you will need to enter the values via the keyboard.)

Please note: The Cogo Mouse must be toggled ON in order for the Distance Circle or Direction Line to become active.

Example using the Cogo/Traverse function

When you select the **Cogo/Traverse** function, the Direction Line is used to indicate the Azimuth and the Distance Circle is used to indicate the Horizontal Distance.



When you place the Cogo Mouse cursor in a direction field, like the Azimuth field shown above, the direction line will be displayed in the Map View. The value in the direction field corresponds to the current position of the direction line. When you move the direction line by dragging your mouse cursor across the Map View, you will notice that the direction value changes accordingly. When the value is correct, click your left-mouse button to "save" that direction value.

Please note: If you wish to enter a direction value using the keyboard, place your cursor in the field, double-click to highlight the field, then type-over the current value and immediately press the TAB key to save the new value.

When you place the Cogo Mouse cursor in a distance field, like Horizontal Distance field shown above, the distance circle will be displayed in the Map View. The value in the distance field corresponds with the radius of the distance circle. When you increase or decrease the size of the direction circle by moving your mouse, you will notice the distance value changes accordingly. When the value is correct, click your left-mouse button to "save" that direction value.

Please note: If you wish to enter a distance value using the keyboard, place your cursor in the field, double-click to highlight the field, then type-over the current value and immediately press the TAB key to save the new value.

Entering Data via the Keyboard

Some of the Cogo functions have input fields which require keyboard input.

(Example: Vertical Distance field in Traverse function)

To enter values into these fields, simply place your cursor in the associated field and then enter the appropriate number. To type over existing data, first double-click on the data field to highlight it, then key in the new value. Note: Keyboard-only input fields, like Vertical Distance, will not be highlighted in red when you place the mouse cursor in the field.

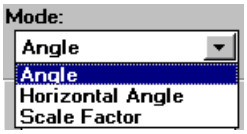
Entering Angle Data by Keyboard

Some COGO data input fields are for entering angle data. If the Angle Unit is set to D.M.S. in the View/Configure/Cogo dialog (Section 8.3), the angle data will be displayed with the degrees, minutes and seconds symbols such as in 90°15'25.2230". To change the displayed angle value, first double-click the data field to highlight it, then type over the existing data in the **dd-mm-ss.ssss** format. For example, to enter an azimuth of 90°15'25.2230" for the Traverse function, you would key in **90-15-25.2230**. To enter a bearing of N35°15'25.2230W", key in **N35-15-25.2230W**. Press the TAB key to save the data you just entered.

If you just wish to change a couple digits in the displayed data, you may place the mouse cursor next to those digits, use the Delete or Backspace key to clear them, then type in the new digits .

Using Cogo pull-down fields

Some of the Cogo functions have pull-down selection fields. (Example: Mode field in the Traverse function)



To enter data in the pull-down field, click the mouse on the down-arrow and then click on one of the options displayed. The selected option will be displayed in blue until you release the mouse cursor.

Moving between Cogo Input fields

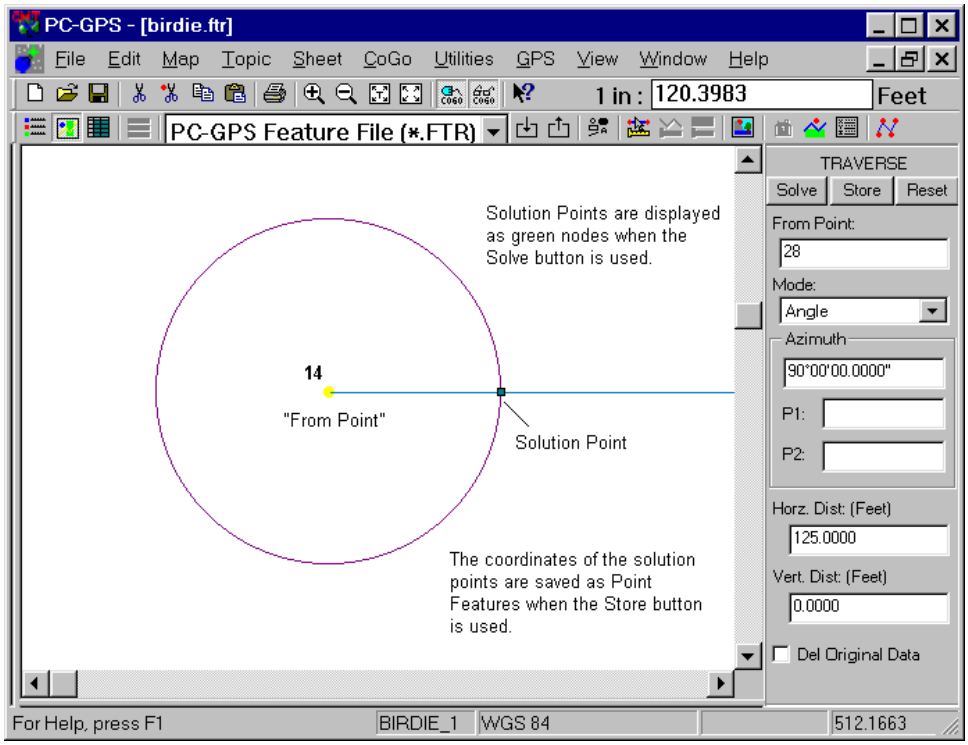
You can use either the TAB key or mouse cursor to move between fields.

Deleting Data in Cogo Input fields

To delete data in a Cogo Input field, place your cursor in the field, double-click to highlight the field and then use the delete key to erase the contents of the field.

10.2.4 Displaying the Solution

After you have entered all the required values for the Cogo Function you are using, click the "Solve" button in the Cogo View to calculate the solution.



If the solution involves the creation of Points, then a green node will be displayed at the coordinate location of the new Point. The example above shows the Traverse function.

If the solution involves moving existing Points, the selected Points will be moved to the new location when you use the Solve button. (Example: Scale, Translate, and Rotate functions.)

The new locations will not be saved unless you click the “Store” button.

10.2.5 Storing new Coordinates

The “Store” button is used to save the coordinates of Points created by the Cogo functions. When you click the “Store” button, the Feature Setting dialog box will be displayed:

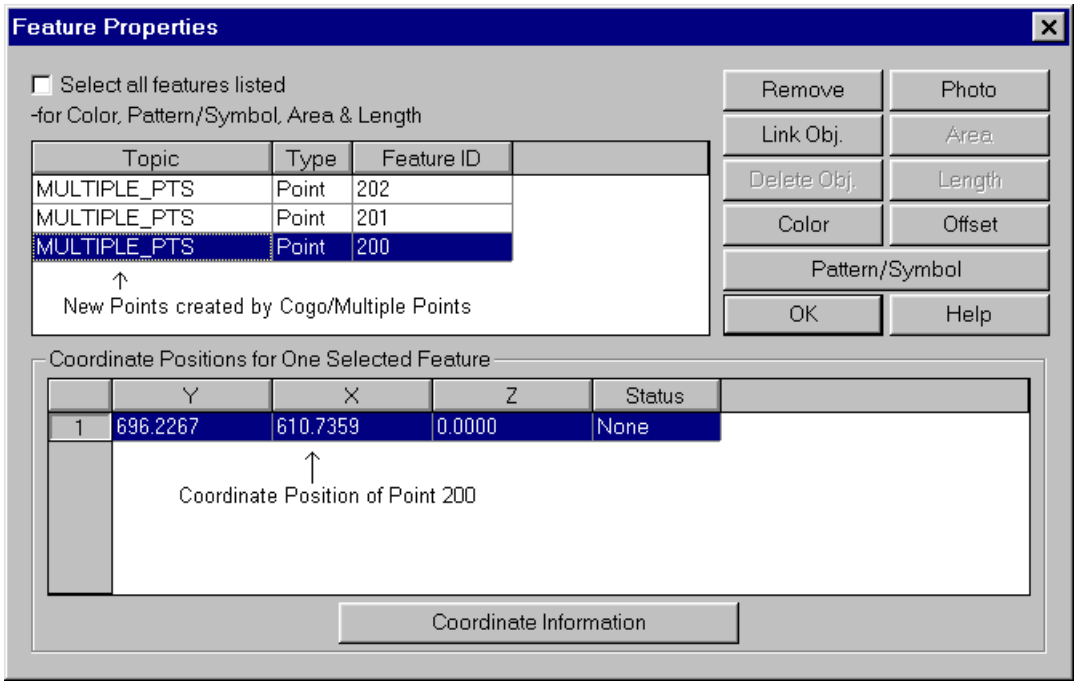
This dialog box is used to specify the **Start ID number** and **Topic** for the new Point.

The default **Topic** name corresponds to the Cogo function which was used to create the new Point. In the example shown above, the new Point was created by the TRAVERSE function, and therefore the default Topic name is TRAVERSE. If you wish to rename the Topic, you can type in another Topic name in the Topic Name field.

The **Start ID** number indicates the ID number or "Topic order number" for the Point. In the example above, the Point is the first point in the TRAVERSE Topic and therefore the default Start ID is 1. If you want to use another ID number, you can enter another number in the Start ID field. Note that the ID number must be unique.

After you have verified the Start ID and Topic name for the new Point(s), click on the OK button in the Feature Settings dialog box. The Point(s) will be stored and displayed on the Map View. In addition, the new Topic will be appended to the Topic View.

If the Cogo function has created more than one Point, the Feature Properties screen will be displayed immediately after you click on the Confirm button in the Feature Settings box.



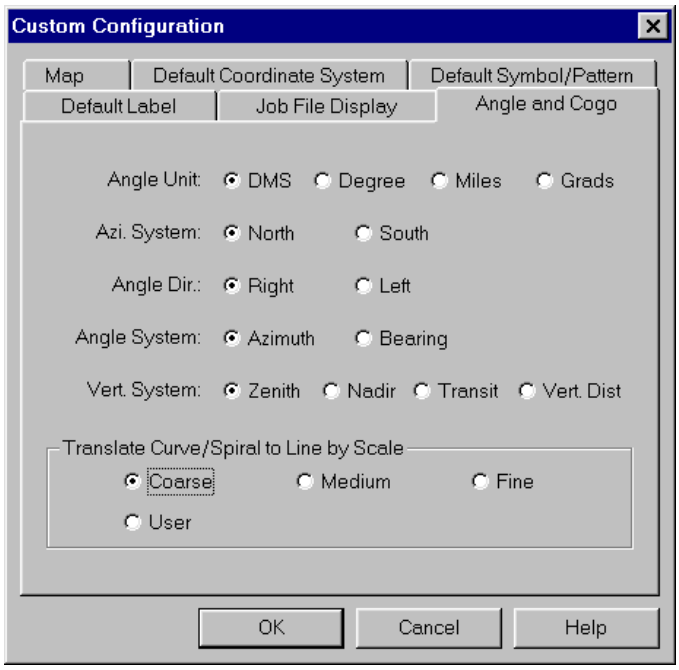
Each new Point created is listed in the Feature Properties dialog. The Topic name is shown under the "Selected Shape" column. In this example, the Points were created by the **Cogo/Multiple Points** function and the Topic name is "Multiple Points". The first Feature ID number corresponds to the Start ID number listed in the Feature Settings box.

When the Feature Properties dialog box is first displayed, the first Point listed will be highlighted in the Selected Shape/Type/Feature ID columns. The coordinates for the highlighted Point Feature are shown under the Latitude, Longitude and Elevation fields. To view the coordinates of another Point, simply click on the ID number listed in the Feature ID column.

To return to the Main PC-GPS screen, click on the **OK** button.

10.3 Cogo Configuration (View/Configure)

The parameters for your Cogo functions can be set using the "Angle and Cogo" page of the **View/Configure** menu. When you select **View/Configure** and click on the Angle and Cogo tab, the following dialog box is displayed:



The default settings are shown in this example screen. To change any of these settings, click on the selection circle that corresponds to one of the other options and then click on the OK button. For example, to change the Angle Units from D.M.S. to Degrees (decimal degrees), click on the selection circle for Degree and then click on the OK button.

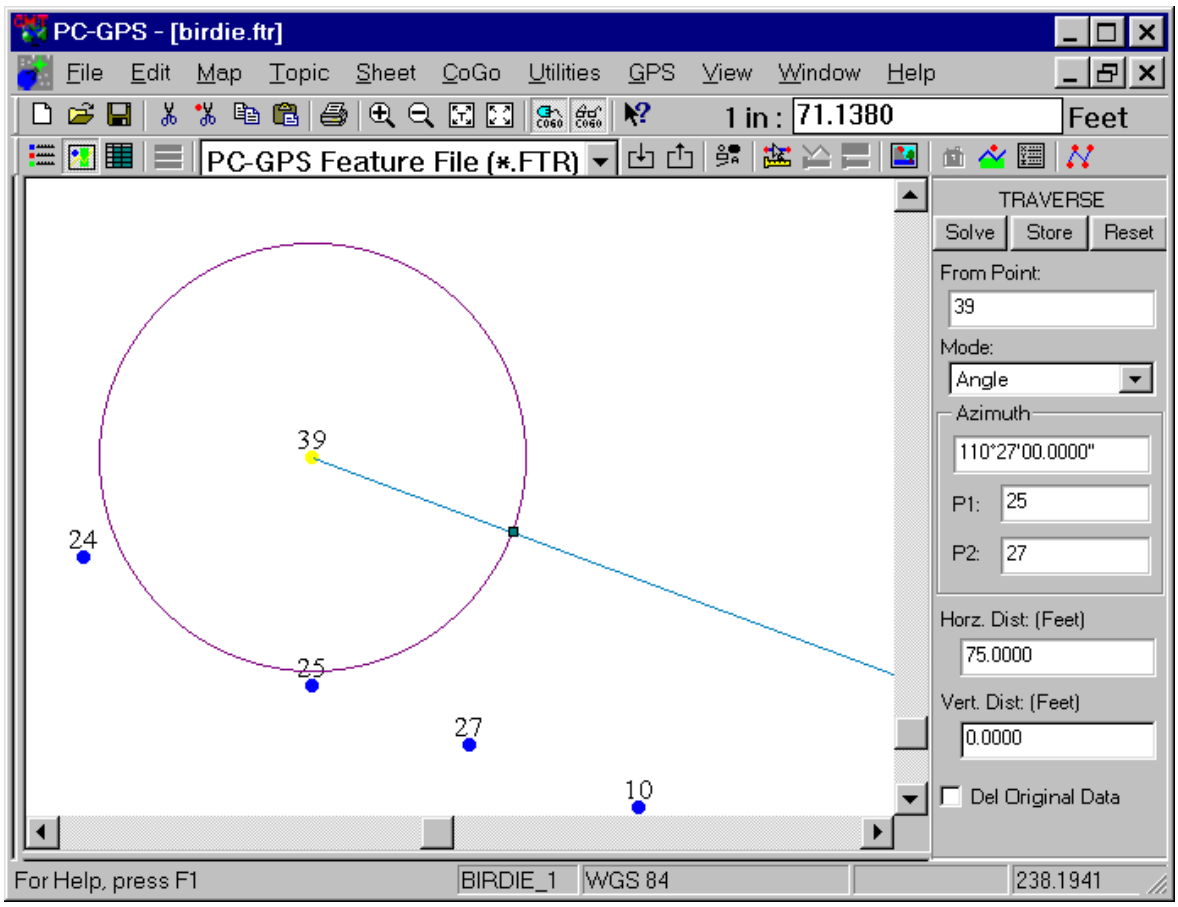
The options under **Translate Curve/Spiral to Line by Scale** are used to specify how your Curves and Spirals will be defined in PC-GPS. In PC-GPS, Curves and Spirals are stored as Line Features. The **Coarse**, **Medium**, **Fine** and **User** selections refer to the number of nodes which will be used in the Line Feature. The *Coarse* setting corresponds to the fewest number of nodes needed to represent the curve, while the *Fine* setting corresponds to a much larger number of nodes. **For example**, in a given curve, the Coarse setting may result in 40 nodes in the Line and the Fine setting might result in more than 1000 nodes in the Line. The *User* setting allows you to specify the interval between nodes. If your Map distance units are feet, an *User* interval of 1 would be equivalent to 1 node every foot along the Line.

Please set the desired scale before creating Cogo Line Features.

Please note: The Map distance units may be set using the Unit option under the **Map/Coordinate System** menu option.

10.4 Traverse Function

When you select the **Cogo/Traverse** function, a Cogo View similar to the example shown below is displayed:



Example of Traverse function using Angle mode

(Topic View & Sheet View are OFF and Points have been labeled using Topic/Autolabel.)

Summary The Traverse function is used to create a new Point based on direction and distance from a known point.

- **Solve** to calculate coordinates of new Point.
- **Store** to save coordinates of new Point.
- **Reset** to clear data fields.

Options: Under the "Mode" field there are three options: **Angle**, **Scale Factor**, and **Horizontal Angle**. It is a good idea to first select the mode you want to use before specifying values for the Cogo Input fields.

Angle mode is used to create a Point based on azimuth and distance from a Point. The Point is identified as the "From Point". The azimuth between two reference points ("P1" and "P2") is used for the azimuth of the traverse. The user needs to identify the From Point, P1, P2 and horizontal distance. (Note: If you do not want to use reference points to select azimuth, you may skip the P1, P2 fields. Instead, place your cursor in the Azimuth field and type-in the azimuth.)

Scale Factor mode is used to create a Point based on a scale factor between the "From Point" and to "To Point". The user needs to specify the From Point, To Point,

and Scale Factor. Scale with elevation selection is optional. The new Point will be created between the "From Point" and to "To Point" with the distance based upon the scale factor. For example, if the scale factor input is .5, then the new Point will be placed half way between the From Point and the To Point. **Note**: If you do not use the "scale with elevation" option, the solution point will maintain the elevation of the From Point.

Horizontal Angle is used to create a Point based on a distance and a horizontal angle. The horizontal angle is the angle formed by the line between the From Point and a Back Point AND the line between the From Point and the new traverse point. The user needs to specify From Point, Back Point, Horizontal Distance, and Horizontal Angle. Vertical Distance is optional.

Cogo Mouse Fields

From Point: Click Cogo Mouse on the Point Feature which is your From Point

P1 and P2: Click Cogo Mouse on the azimuth reference points.

Horizontal Distance or Scale: Use Cogo Distance Circle to specify distance or scale.

To Point or Back Point: Click Cogo Mouse on the Point Feature to be To Point or Back Point.

Horizontal Angle: Use Cogo Direction Line to indicate angle.

Please note: For any of the Cogo Mouse fields, you may also enter the appropriate value by keyboard. After you enter the value, press the TAB key to move to the next field.

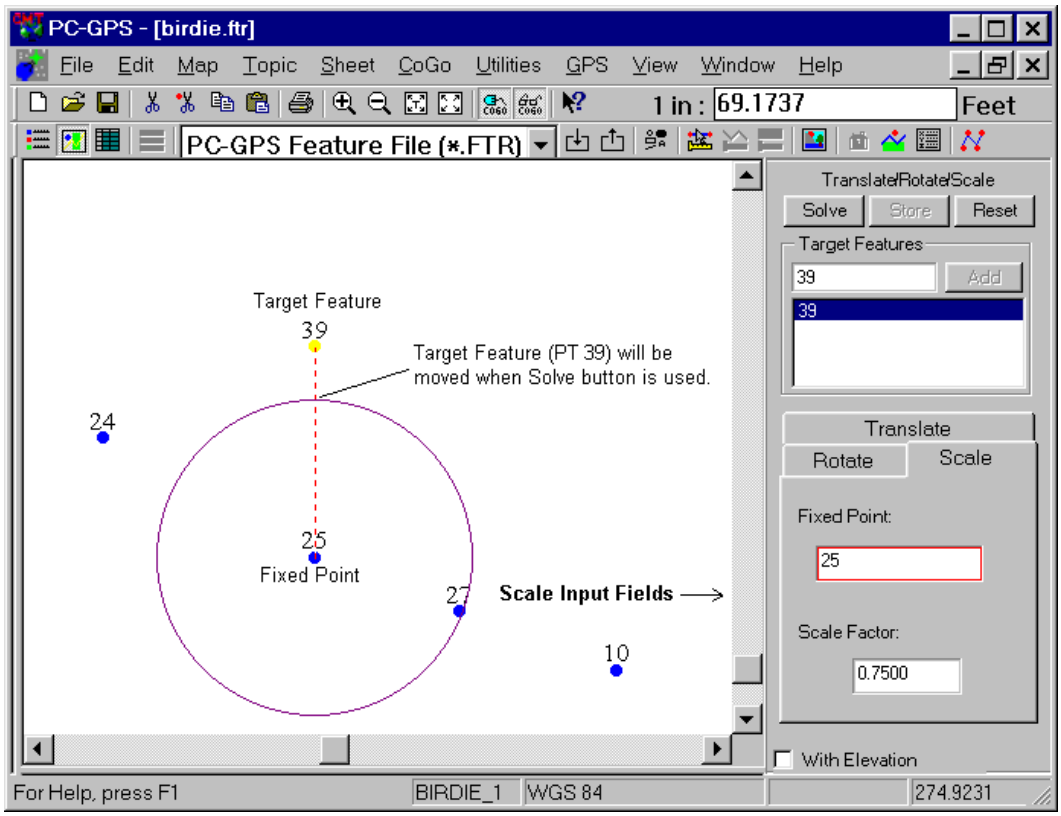
Steps for Traverse function using the Angle mode:

1. Select "Angle" in the Mode field.
2. Click your Cogo Mouse on the Point Feature which is your From Point.
3. Click the Cogo Mouse on the Point Feature which is the P1 reference point.
4. Click the Cogo Mouse on the Point Feature which is the P2 reference point. Remember that the azimuth between "P1" & "P2" will be used as the traverse azimuth from the "From Point".
5. Use the Distance Circle to select Horizontal Distance. Click the mouse to save the value.
6. (Optional) Enter a value for Vertical Distance.
7. Click on the **Solve** button. A green node will be placed at the solution location.
8. Click on the **Store** button to save a new Point at the solution location.
9. Verify the Start ID and the Topic name in the Feature Settings dialog and click on Confirm.

Results: A new Point will be placed at the solution location. This new Point will be assigned to the TRAVERSE topic.

10.5 Scale Function

When you use the **Cogo/Translate/Rotate/Scale** option, the Cogo View is displayed as follows. Note that separate input fields are provided for Translate, Rotate and Scale.



Example of Scale function

(Topic View & Sheet View are OFF and Points have been labeled using Topic/Autolabel.)

Summary The Scale function is used to move a Feature based on scale distance from a fixed Point.

- **Solve** to move selected Feature.
- **Store** to save the new coordinates of the Feature.
- **Reset** to clear the data fields.

Options: There is a mark-box option for **With Elevation**. Mark this option if you would like the scale to also apply to the elevation of the selected Feature.

Cogo Mouse Fields

Target Features: Click the Cogo Mouse on the Point, Line or Area to be scaled. You may select multiple target Features for this function. (Section 8.2.3)

Fixed Point: Click the Cogo Mouse on the fixed reference Point Feature. The Fixed Point may not be the same as the first Point of the Feature in the Target Feature field.

Scale Factor: Use the Cogo Distance Circle to select the scale distance from the fixed Point. A scale greater than 1 will expand the scale Feature away from the fixed Point. A scale less than 1 will contract the scale Feature toward the fixed Point.

Steps for Scale function:

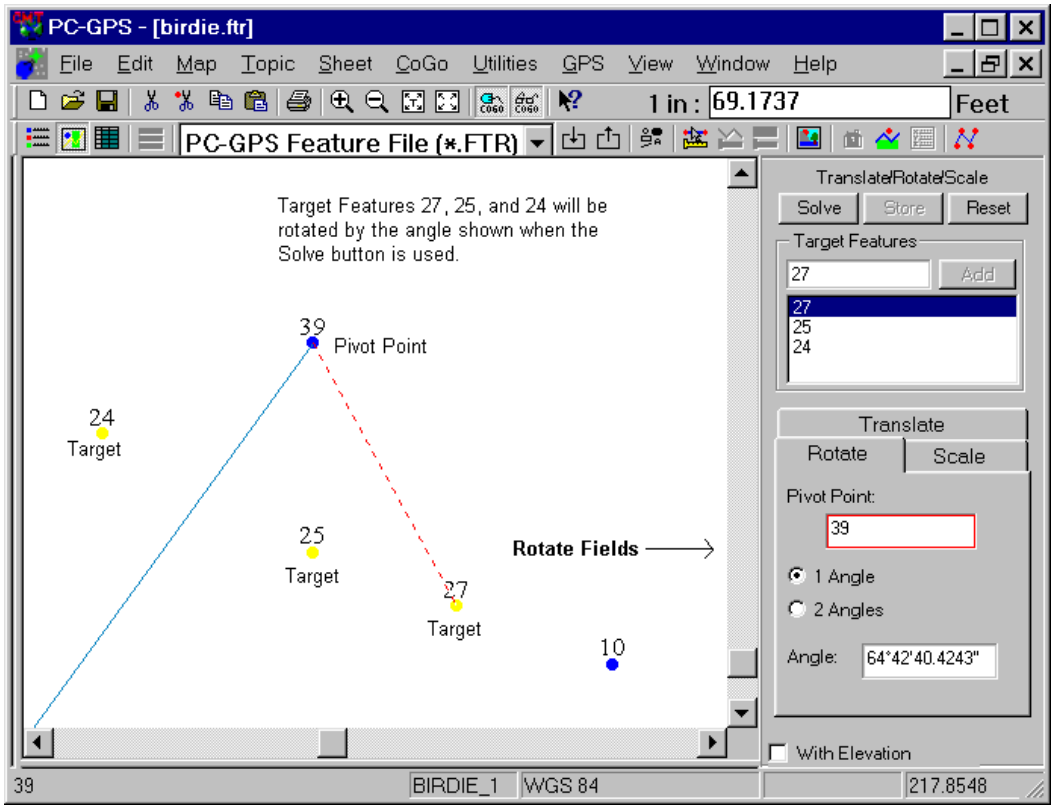
1. Click your Cogo Mouse on the Feature to be scaled (moved).
2. Place your cursor in the Scale Fixed Point field and then click your Cogo Mouse on the Point Feature which is the fixed reference Point.
3. Use the Cogo Distance Circle to indicate scale. Click the mouse button to save the value.
4. Click on the **Solve** button to display the new size of the scaled Feature.
5. Click on the **Store** button to save the new coordinates.

Please note: If you enter a Feature ID into the Target Features field via the keyboard, you must click on **Add** to append it to the list of selected Features.

If the new size/position of the scaled Feature(s) is not what you expect, you may click on the **Target Features** field to restore the display of the original data. If you wish to clear all data fields, simply click on **Reset**.

10.6 Rotate Function

When you use the **Cogo/Translate/Rotate/Scale** option, the Cogo View is displayed as follows. Note that separate input fields are provided for Translate, Rotate and Scale.



Example of Rotate function

(Topic View & Sheet View are OFF and Points have been labeled using Topic/Autolabel.)

Summary The Rotate function is used to rotate a Point, Line or Area Feature around a fixed Point

- **Solve** to rotate selected Feature.
- **Store** to save the new coordinates of the Feature.
- **Reset** to clear the data fields.

Options: There are two methods for the Rotate function - by **1 Angle** or by **2 Angles**.

1 Angle method is used to rotate a Point, Line or Area Feature by a given angle. The Rotate Feature is moved in relationship to a Pivot Point. The distance between the Rotate Point and the Pivot Point remains constant. The user needs to specify the Rotate Feature, Pivot Point and Rotate Angle.

2 Angles method is used to rotate a Point Feature using two reference Angles. The distance between the Rotate Point and the Pivot Point remains constant. The fields "Old" and "New " are displayed. The user needs to specify Rotate Feature, Pivot Feature, Old Angle and New Angle. The Feature will be rotated by an angle equal to the difference between the Old Angle and the New Angle. If the New Angle is greater than the Old Angle, then the Feature will be rotated clockwise.

Cogo Mouse Fields

Target Features: Click the Cogo Mouse on the Feature to be rotated. You may select multiple target Features for this function. (Section 8.2.3)

Pivot Point: Click the Cogo Mouse on the Pivot Point. The Pivot Point must be a Point Feature. It cannot be a Node. The Pivot Point may not be the same as the first Point of the Feature in the Target Feature field.

Rotate Angle: Use the Cogo Direction Line to choose the rotation angle.

Old Angle: (Two Angles option) Use the Direction Line to choose the base angle.

New Angle: (Two Angles option) Use the Direction Line to choose a reference angle.

Please note: Suppose you are rotating an Area Feature along with the Point Features at the nodes of the Area Feature, and you wish to use the Point Feature at the first Node of the Area Feature as the Pivot Point. After selecting all Features to be rotated, place the Point Feature at the second Node of the Area Feature into the Target Features field, then select the Point Feature at the first Node of the Area Feature as the Pivot Point.

Steps for Rotate function using the Rotate Angle option:

1. Click your Cogo Mouse on the Feature(s) to be rotated. The Feature ID(s) will be shown in the Target Feature column.
2. Place your cursor in the Rotate Pivot Point field and then click your Cogo Mouse on the Point Feature which is the pivot point.
3. Use Cogo Direction Line to select the rotate angle. Click the mouse to save the angle.
4. Click on the **Solve** button to rotate the Feature.
5. Click on the **Store** button to save the new coordinates of the Feature.

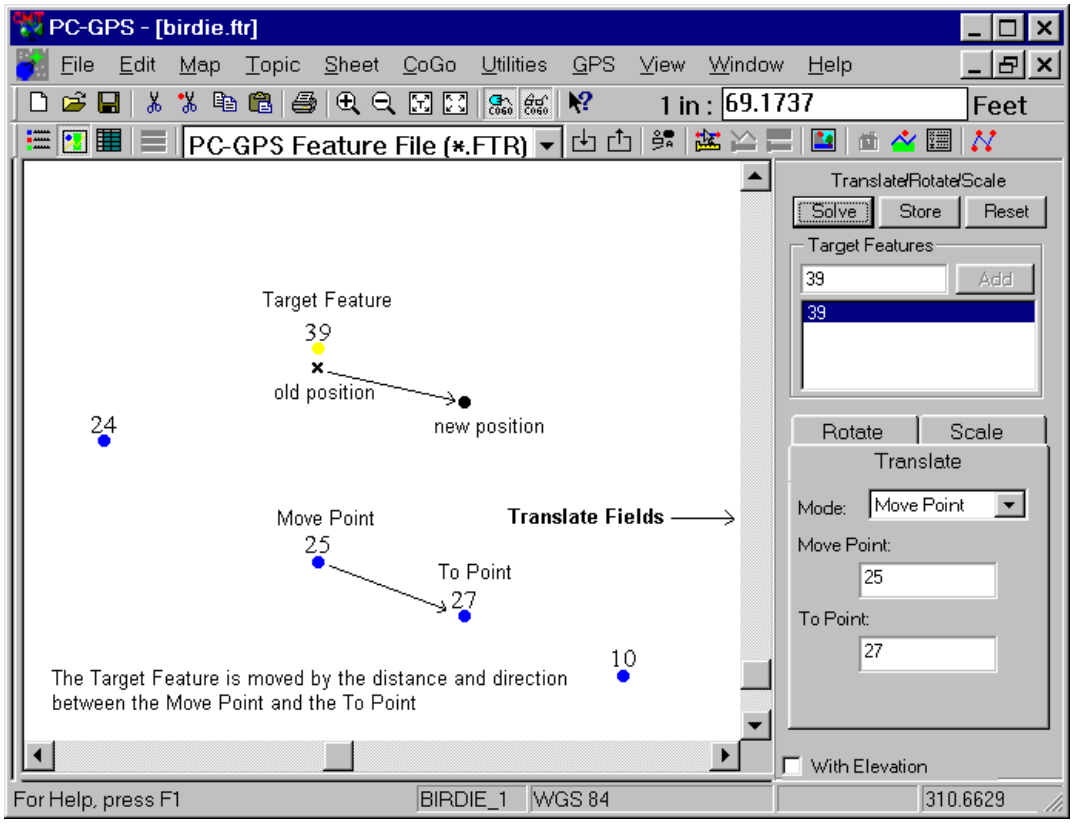
Result: The Rotate Point is rotated by the angle specified. The distance between the Rotate Point and Pivot point remains fixed.

Please note: If you enter a Feature ID into the Target Features field via the keyboard, you must click on **Add** to append it to the list of selected Features.

If the new position of the rotated Feature(s) is not what you expect, you may click on the **Target Features** field to restore the display of the original data. If you wish to clear all data fields, simply click on **Reset**.

10.7 Translate Function

When you use the **Cogo/Translate/Rotate/Scale** option, the Cogo View is displayed as follows. Note that separate input fields are provided for Translate, Rotate and Scale.



Example of Translate function using the Move Point option

(Topic View & Sheet View are OFF and Points have been labeled using Topic/Autolabel.)

Summary

The Translate function is used to move a Feature (Target Feature) a fixed distance in the X, Y, and Z direction. The user may specify the distance using relative or absolute values.

Note: The Target Feature may be a Point, Line or Area.

- **Solve** to move the Target Feature.
- **Store** to save the coordinates of the Feature.
- **Reset** to clear the data fields.

Options: There are three modes for this function - **Move Point**, **Adjust Point**, and **Coordinates**.

Move Point mode is used to move the Target Feature by relative distance and direction. The user needs to specify a Move Point and a To Point as well as a Target Feature. The distance and direction between the Move Point and the To Point determines the distance and direction the Target Feature will be moved. In the example above, Point 39 (Target Feature) is moved by the distance and direction between Point 25 (Move Point) and Point 27 (To Point).

Please note: The Move Point and the To Point must be Point Features. They cannot be nodes.

Adjust Point mode is used to move the Target Feature a fixed distance in the X, Y, and Z directions. Easting, Northing and Elevation fields are displayed when this mode is selected. For these fields, the user needs to input the shift in each direction. For example, to move the Target Feature directly south by 200 feet, you would enter: Northing of -200, Easting of 0.000, and Elevation of 0.000.

Coordinates mode is used to move the Move Feature to an exact coordinate location. The fields of Northing, Easting, and Elevation will be displayed when the coordinates option is selected. The user needs to enter an exact coordinate location for the Target Feature in these fields.

Cogo Mouse Fields

Target Features: Click the Cogo Mouse on the Feature to be moved. You may select multiple target Features for this function. (Section 8.2.3)

Move Point: Click the Cogo Mouse on the first point for the relative distance/direction indication. With the Move Point option, the Target Feature will be moved the distance and direction between Move Point and To Point. With the Coordinate Option, the Move Point is moved to the coordinate location entered in the East, North & Elev fields.

To Point: Click the Cogo Mouse on the second point for the relative distance/direction indication. Target Feature will be moved the distance and direction between the Move Point and the To Point. (Move Point option)

Steps for the Translate function using the Move Point mode:

1.Click on the Target Feature(s). The Feature ID(s) will be shown in the Target Feature field.

2. Select “Move Point” from the mode pull-down field.

3. Place your cursor in the Move Point field and then click the Cogo Mouse on the point which represents the Move Point. The Feature ID will be displayed in the Move Point field.

4. Click the Cogo Mouse on the point which represents the To Point. The Feature ID will be displayed in the To Point field. Remember, the Target Feature(s) will be moved by the distance and direction between the From Point and the To Point.

5. Click on the **Solve** button to view the solution location.

6. Click the **Store** button to move the Target Feature(s) to the new coordinate location.

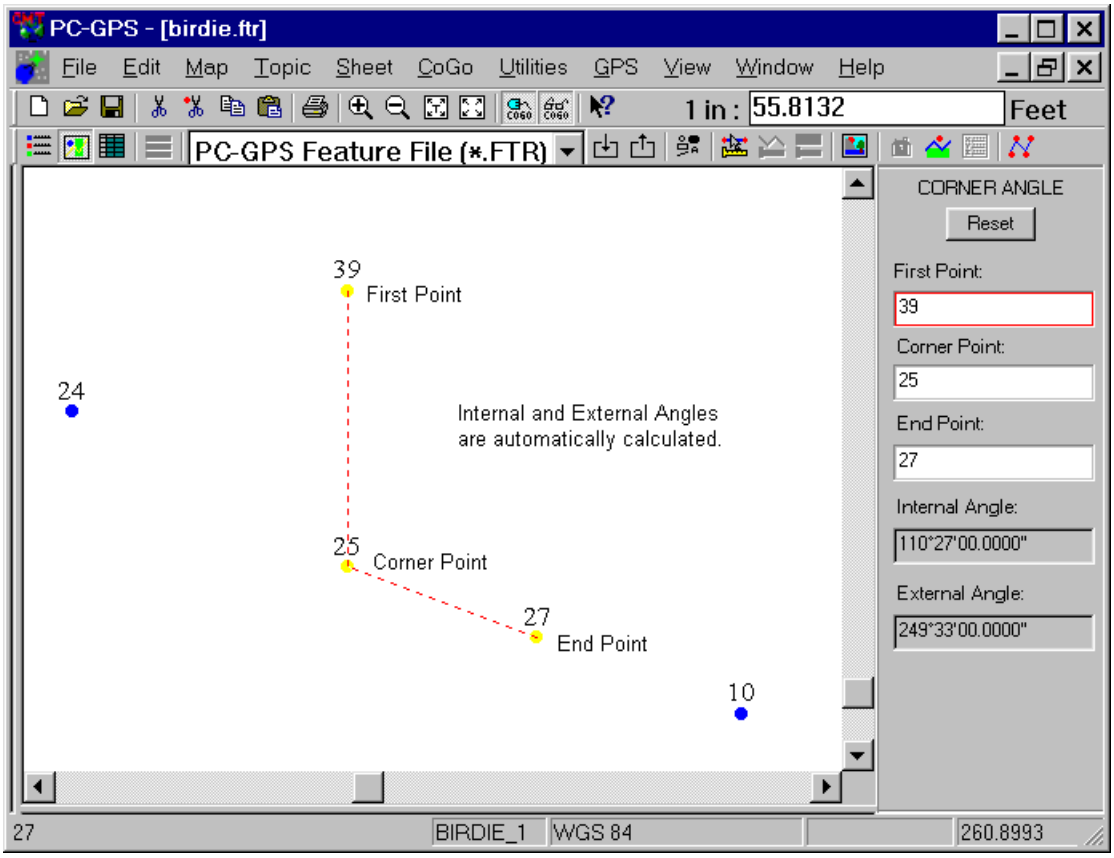
Please note: If you enter a Feature ID into the Target Features field via the keyboard, you must click on **Add** to append it to the list of selected Features.

If the new position of the moved Feature(s) is not what you expect, you may click on the **Target Features** field to restore the display of the original data. If you wish to clear all data fields, simply click on **Reset**.

After you have stored the new target location, you may return the Target Feature to the original location by reversing the From Point and the To Point.

10.8 Corner Angle Function

When you select the **Cogo/Corner Angle** function, a Cogo View similar to the example shown below is displayed:



Example of Corner Angle function

(Topic View & Sheet View are OFF and Points have been labeled using Topic/Autolabel.)

Summary

The Corner Angle function is used to calculate the angle defined by 3 points.

- Angle is **calculated** when First Point, Corner Point and End Point are identified.
- **Reset** to clear the data fields.

Cogo Mouse Fields

First Point: Click your Cogo Mouse on the Point which represents the first point.

Corner Point: Click your Cogo Mouse on the Point which represents the corner point.

End Point: Click your Cogo Mouse on the Point which represents the end point.

Steps for Corner Angle function

1. Identify the First Point by clicking on the Point with your mouse cursor.

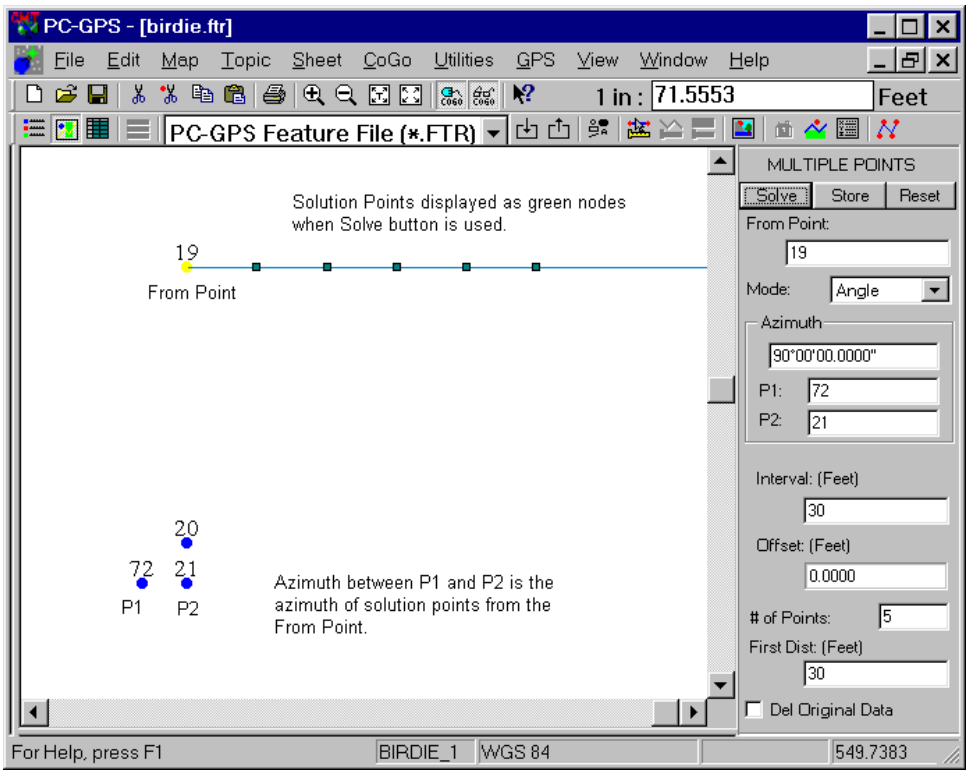
2. Identify the Corner Point by clicking on the Point with the mouse cursor.

3. Identify the End Point by clicking on the Point with the mouse cursor.

Result: The angle formed by the three Points will be automatically calculated and displayed in the Corner Angle field.

10.9 Multiple Points Function

The data input panel for **Cogo/Multiple Points** looks like the following:



Example of Multiple Points function

(Topic View & Sheet View are OFF and Points have been labeled using Topic/Autolabel.)

Summary

The Multiple Points function is used determine the coordinates of a number of Points which lie on a line extending from an existing point. The **Number of Points** and/or the **Spacing** can be set by the user.

- **Solve** to calculate coordinates of multiple points.
- **Store** to save coordinates of the new Points.

- **Reset** to clear the data fields.

Options: There are two modes for the Multiple Point function - **To Point** mode and **Angle** mode. There are also options for Number of Points, Interval, Spacing, Offset, First Distance and Vertical Distance Spacing. Options vary by the mode selected.

To Point mode is used to determine the coordinates of points which lie between two existing points. The user must specify the "From Point" and the "To Point". Points can be created using either the Number Points option or the Interval option. If the number of Points is set by the user, PC-GPS will calculate the corresponding distance interval. If the distance interval is set by the user, PC-GPS will calculate the corresponding number of Points.

Angle mode is used to determine the coordinates of points which lie on a line extending from one known point. The azimuth of the line is determined by the azimuth between two reference points - P1 and P2. (Note: If you do not want to use reference points to select azimuth, you may skip the P1, P2 fields. Instead, place your cursor in the Azimuth field and move the Cogo Direction line to find azimuth.)

Number of Points: Enter the number of Points to be created. (Note: If you are using the To Point mode and you specify a horizontal or vertical interval, then the Number of Points field will show the calculated number of Points.)

Horizontal Dist. Spacing or **Interval** : Enter the horizontal interval between Points.

(Note: If you are using the To Point mode and you specify a number of Points, then the Horizontal Dist. Spacing field will display spacing after you click on Solve.)

Vertical Dist. Spacing: Enter the vertical interval between the new Points.

(Note: If you are using the To Point mode and you specify a number of Points, then the Vertical Dist. Spacing field will display spacing after you click on Solve.)

Offset: Enter an offset distance if you would like the Points to be offset from the "From Point". (Note: When the cursor is in the Offset field, the azimuth line from the "From Point" can be moved up/down or right/left to select the offset.)

First Distance: Enter the distance between the From Point and the first new Point.

Cogo Mouse Fields

From Point: Click your Cogo Mouse on the Point which represents the From Point.

To Point: Click your Cogo Mouse on the Point which represents the To Point.

P1 and P2: Click Cogo Mouse on the azimuth reference points.

Steps for Multiple Points function using Angle mode: (P1 and P2 as reference points)

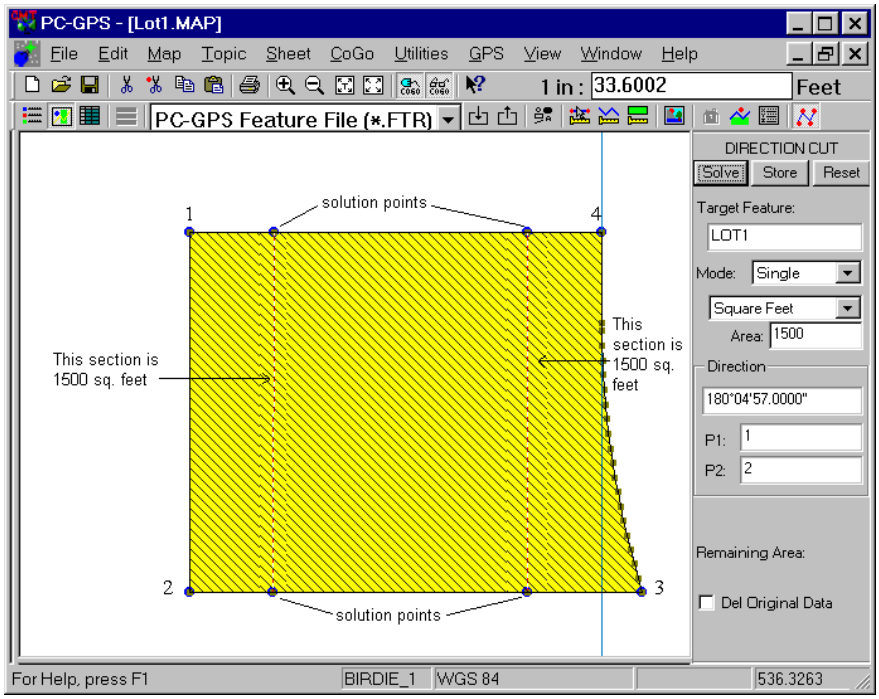
1. Select "Angle" from the Mode field.
2. Place the cursor in the From Point field and then click the Cogo Mouse on the From Point.
3. Click the Cogo Mouse on the Point that represents P1.
4. Click the Cogo Mouse on the Point that represents P2.
5. In the Interval field, enter the horizontal distance between the new points.

6. In the # of Points field, enter the number of new points to be created.
7. Enter the spacing between the first point and the From Point in the First Distance field.
8. Click on the **Solve** button. The solution Points will be displayed as green nodes.
9. Click on the **Store** button to save the new Points.
10. Verify the Start ID and the Topic Name in the Feature Settings dialog and click on Confirm.
11. The Feature Properties dialog box will show the coordinate locations of the new Points. Click on the OK button to return to the main PC-GPS screen.

Result: The new Points will be displayed on the Map View. The Points are assigned to the Multiple Points Topic.

10.10 Direction Cut Function

When you select **Cogo/Direction Cut**, the following Cogo View will be displayed:



Example of Direction Cut function (Single Mode)

(Topic View & Sheet View are OFF and Points have been labeled using Topic/Autolabel. LOT1 is the Area Feature)

Summary

The Direction Cut function is used to calculate solution Points which define lines to cut out a specified area from an Area Feature. The solution Points lie on the perimeter of the Area.

- **Solve** to calculate coordinates of solution Points.
- **Store** to save coordinates of the Points.

- **Reset** to clear the data fields.

Options: There are two **modes** for the Direction Cut function: **single** mode and **multiple** mode. Single mode is used to cut a section of a specified size from an Area Feature. Single mode yields two solutions. Multiple mode is used to evenly divide an Area Feature into two or more sections of a specified size. The remaining area is calculated and shown in the Cogo View. The user may specify remaining area to be on either Side 1 or Side 2.

Area: The pull-down field for Area lists Sq. Feet, Sq. Meters, Acres, and Hectares.

Direction: The direction of the cut is based on the azimuth between two reference points - P1 and P2. (Note: If you do not want to use reference points to select azimuth, you may skip the P1, P2 fields. Instead, place your cursor in the Azimuth field and enter the direction of the cut using the keyboard.)

Cogo

Mouse

Fields

Target Feature: Click on the Area Feature you want to Cut. The Feature ID will be displayed in the Target Feature field.

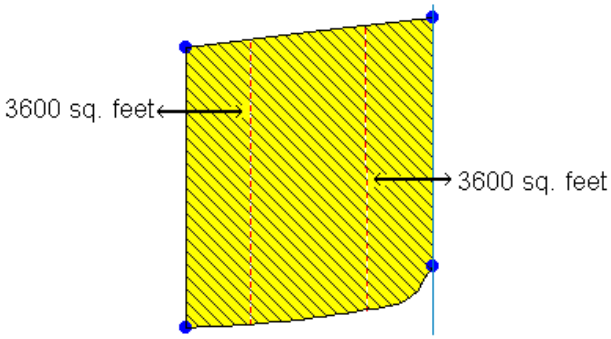
Steps for Direction Cut function (Single Mode): (P1 and P2 as azimuth reference points.)

1. Choose the Cut units using the Area pull-down field.
2. Enter a Cut value in the Area field. (e.g. 1500)
3. Place your cursor in the Target Feature field and click on the Area Feature you want to Cut. The Feature ID will be displayed in the Target Feature field.
4. Click on the Point that represents P1.
5. Click on the Point that represents P2. (Remember, the azimuth between P1 and P2 is the direction of the cut.)
6. Click on the **Solve** button. Two dashed lines will be drawn over the Area Feature. The intersections between the dashed lines and the perimeter of the Area Feature represent the solution Points.
7. Click on the **Store** button to save the new Points.
8. Verify the Start ID and the Topic Name in the Feature Settings dialog and click on Confirm.
9. The Feature Properties dialog box will show the coordinate locations of the new Points. Click on the OK button to return to the main PC-GPS screen.

Result: The four solution points will be displayed on the Map View. The Points are assigned to the Direction Cut Topic. If you want to create an Area Feature using these solution points, you may use the **Utilities/Join/Join Lines/Points** option.

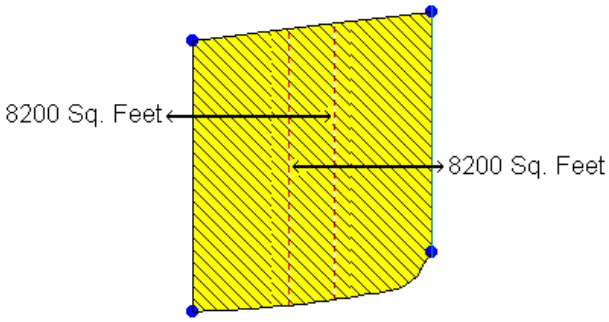
Please note: The following diagrams illustrate the case, in single mode, when the Cut value is less than half of the total area and the case when the Cut value is greater than half of the total area.

Cut value is less than half of total area:



Area Feature is 13800 square feet. Cut value is 3600 square feet.

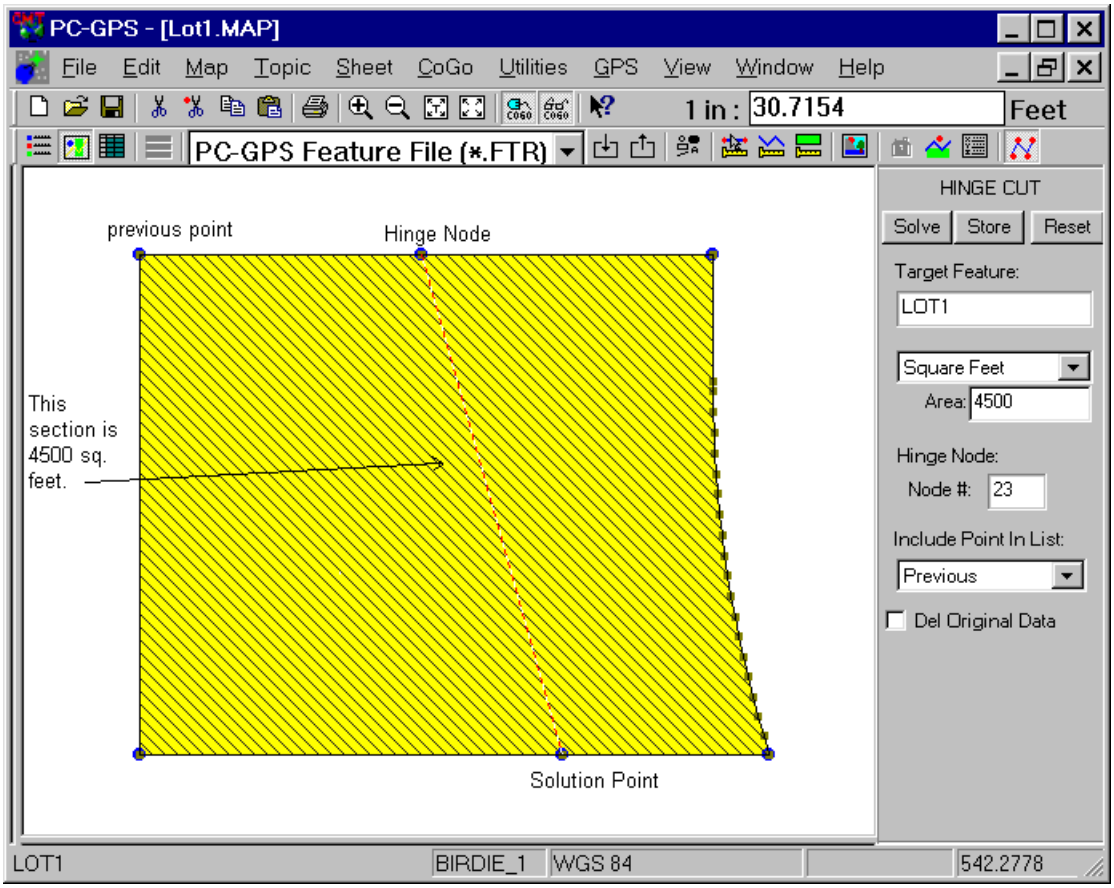
Cut value is more than half of total area:



Area Feature is 13800 square feet. Cut value is 8200 square feet.

10.11 Hinge Cut Area Function

When you select the **Cogo/Hinge Cut Area** function, the following Cogo View will be displayed:



Example of Hinge Cut Area function

(Topic View & Sheet View are OFF and Points have been labeled using Topic/Autolabel. LOT1 is the Area Feature)

Summary The Hinge Cut Area function is used to calculate a new Point that forms a line to cut out a specified area from an Area Feature. A hinge node is specified as the beginning point for the line. The hinge node is a node in the Area.

- **Solve** to calculate coordinates of solution Point.
- **Store** to save coordinates of the new Point.

Options: There are options for **Area** and **Include Point**.

Area: The pull-down field for Area lists Sq. Feet, Sq. Meters, Acres, and Hectares. Choose the unit you wish to use for the Hinge Cut measurement.

Include Point in List: Choose either Previous or Next. Previous means that the node preceding the "Hinge Node #" will be included in the solution area. Next means that the node following the "Hinge Node #" will be included in the solution area.

Cogo Mouse Fields

Target Feature: Click on the Area Feature you want to Cut. The Feature ID will be displayed in the Target Feature field.

Hinge Node: Click on the node (in the Area Feature) which represents the hinge point for your Cut. Note: You can also enter the node number via the keyboard.

Steps for Hinge Cut function:

1. Choose the Cut units using the Area pull-down field. (The options are Sq. Meters, Sq. Feet, Acres, Hectares)
2. Enter a Cut value in the Area field. (e.g. 4500)
3. Place your cursor in the Target Feature field and click on the Area Feature you want to Cut. The Feature ID will be displayed in the Target Feature field.
4. Click on a node which represents your Hinge point (beginning point of the cut line). The node number will be displayed in the Hinge node field. (You may also enter the node number via the keyboard.)
5. From the Include Point in List field, select either Previous or Next.
6. Click on the **Solve** button. A dashed line will be drawn across the Area from the Hinge Point to the solution point. (The intersection between the dashed line and the perimeter of the Area Feature is the solution Point.)
7. Click on the **Store** button to save the new Point.
8. Verify the Start ID and the Topic Name in the Feature Settings dialog and click on Confirm.
9. The Feature Properties dialog box will show the coordinate locations of the new Points. Click on the OK button to return to the main PC-GPS screen.

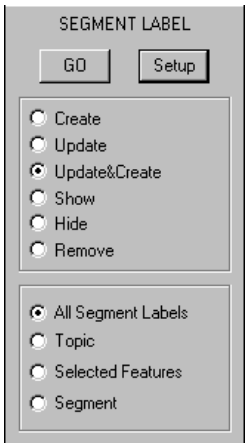
Result: The solution point will be displayed on the Map View. The Point will be assigned to the HINGE CUT Topic. If you want to create an Area Feature using this solution point, you may use the Join Lines/Points option under the Utilities/Join function.

Section 11 - Map Labels

The Map/Labels function is used to label and customize the appearance of Markers and other labels in your Job based on user-specified preferences

11.1 Segment Label

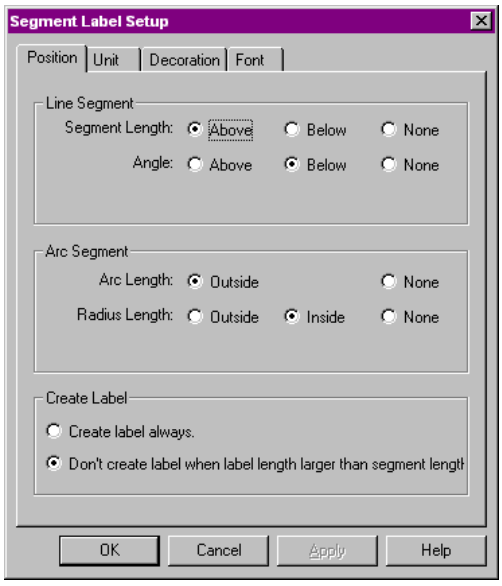
The Segment Label function is used to label any line segments in your map with length and directional information. These labels can be customized in a variety of ways. When you click on Map/Label/Segment Label, the following dialog is displayed to the right of the Map View. This is called the Label View :



Click on the **Setup** button to access the Setup menu. There are four options available in the Segment Label Setup dialog. Each option is discussed in the following sub-sections:

Position:

Click on the **Position** tab at the top of the screen to access the Position setup window. The Position dialog window will be used to define the location of the text label with respect to its corresponding line segment or arc segment. The Position setup dialog is displayed as follows:



Line Segment Length: Specify the position of the text label for segment length. Options are: Above (the segment), Below (the segment) or none (no label for segment length).

Line Segment Angle: Specify the position of the text label for the line segment angle.

Arc Segment, Arc Length: Choose to label arc lengths outside the arc or not at all.

Arc Segment, Radius Length: Choose to label arc segment radius lengths inside or outside the arc segment, or not at all.

If outside is specified for both arc length and radius length, a new option will appear asking you to pick which label will appear first: Arc Length or Radius Length.

Create Label: Choose to always create label or choose to only create the label when the label length does not exceed the length of the segment.

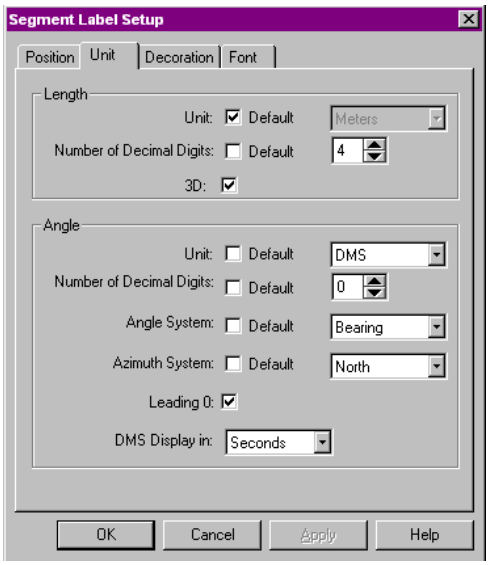
Choose **OK** to accept these settings and return to the Label View or **Cancel** to abort these changes and return to the Label View screen.

Please note: If the position of the label is the same for segment length and angle in line segments or arc length and radius length for arc segments (e.g. “above” and “above” for both segment length and angle), then a new option will appear underneath prompting you to specify which label will appear first.

Also note: If any changes are made, when both labels are in the same position, then you must choose the “Create” option to make the changes. The “Update & Create” or “Update” options will not work in this case.

Unit:

The Unit Setup dialog is used to define units of measurement, decimal precision and other display settings for length and angle labels. After clicking on the Unit tab, the following dialog is displayed:



Length, Unit: Mark the default check box if you want to use the global length measurement units specified in your Job. To use a different unit of measure, uncheck the Default box and choose from the available options: Meters, Feet (Int'l), KM, Miles and US Feet.

Length, Number of Decimal Digits: Specify the number of decimal digits to be used for length labels. To stay consistent with the global settings of your Job, check the Default box.

Length, 3D: Choose to label slope distance.

Angle, Unit: Mark the default check box if you want to use the global angle measurement units specified in your Job. To use a different unit of measure, uncheck the Default box and choose from the available options: DMS, Degree, Mils, or Grads.

Angle, Number of Decimal Digits: Specify the number of decimal digits to be used for angle labels. To stay consistent with the global settings of your Job, check the Default box.

Angle, Angle System: Specify the angle system to be used for angle labels.

Angle, Azimuth System: Choose between North and South for the azimuth system to be used for angle labels.

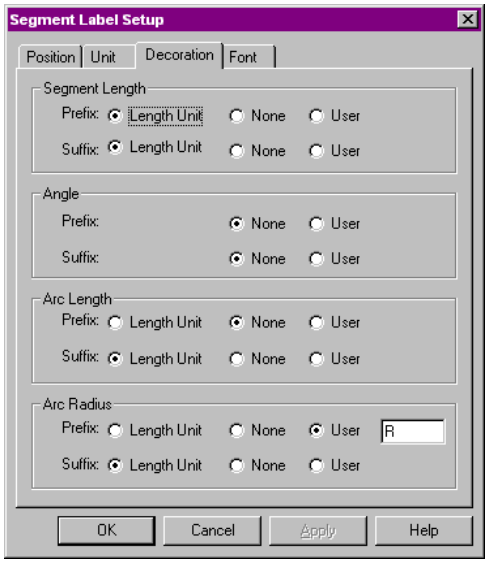
Angle, Leading 0: Choose to display angle measurements with a "0" in front of the measurement or not.

Angle, DMS Display in: Choose from available options to display DMS in: Degrees, Minutes or Seconds

Choose **OK** to save your settings and return to the Segment Label frame or choose **Cancel** to abort changes.

Decoration:

The Decoration Setup dialog is used to define all prefixes and suffixes for segments, angles and arcs (both radii and lengths). Choose from pre-defined prefixes and suffixes or enter your own. After clicking on the Decoration tab, the following dialog is displayed:



Segment Length, Prefix/Suffix: If a prefix or suffix is desired, choose to use the current unit of measurement or choose "User" to specify your own (limit of 5 characters). Choose "None" for no prefix or suffix.

Angle, Prefix/Suffix: If a prefix or suffix is desired, choose "User" to specify your own (limit of 5 characters). Choose "None" for no prefix or suffix.

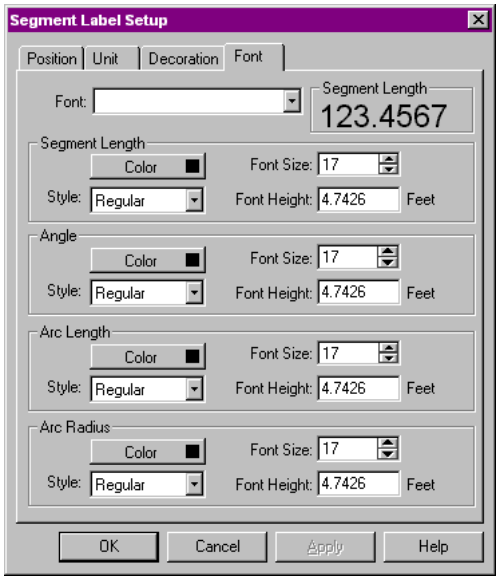
Arc Length, Prefix/Suffix: If a prefix or suffix is desired, choose to use the current unit of measurement or choose "User" to specify your own (limit of 5 characters). Choose "None" for no prefix or suffix.

Arc Radius, Prefix/Suffix: If a prefix or suffix is desired, choose to use the current unit of measurement or choose "User" to specify your own (limit of 5 characters). Choose "None" for no prefix or suffix.

Choose **OK** to save your settings and return to the Segment Label frame or choose **Cancel** to abort changes.

Font:

The Font Setup dialog is used to define all font types, sizes/heights, styles and colors for segments, angles and arcs (both radii and lengths). After clicking on the Font tab, the following dialog is displayed:



Font: Choose the desired font type from the pull-down menu.

Segment Length, Color: Click on the Color button to specify a color.

Segment Length, Style: Click on the pull-down menu to choose from one of the available font styles: Regular, *Italic,* **Bold,** or ***Bold Italic.***

Segment Length, Font Size/Height: Specify a font size or height.

Angle, Color: Click on the Color button to specify a color.

Angle, Style: Click on the pull-down menu to choose from one of the available font styles: Regular, *Italic,* **Bold,** or ***Bold Italic.***

Angle, Font Size/Height: Specify a font size or height.

Arc Length, Color: Click on the Color button to specify a color.

Arc Length, Style: Click on the pull-down menu to choose from one of the available font styles: Regular, *Italic,* **Bold,** or ***Bold Italic.***

Arc Length, Font Size/Height: Specify a font size or height.

Arc Radius, Color: Click on the Color button to specify a color.

Arc Radius, Style: Click on the pull-down menu to choose from one of the available font styles: Regular, *Italic,* **Bold,** or ***Bold Italic.***

Arc Radius, Font Size/Height: Specify a font size or height.

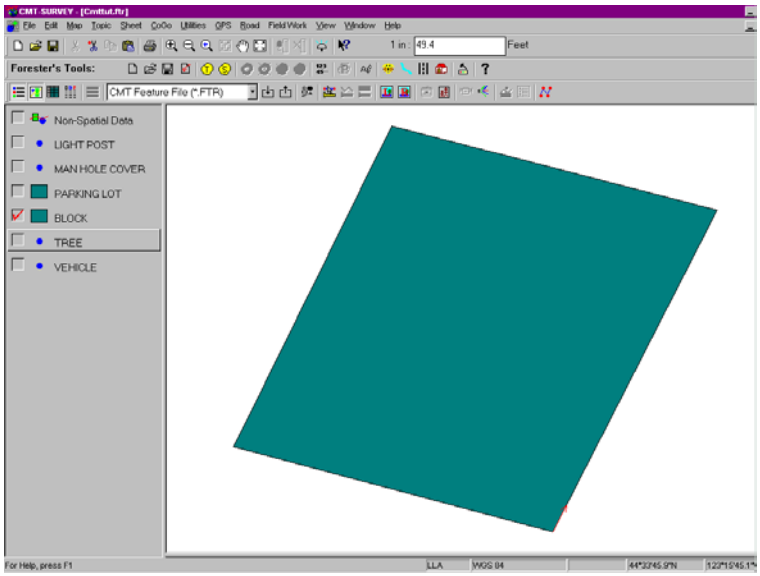
Choose **OK** to save your settings and return to the Segment Label frame or choose **Cancel** to abort changes.

Once you have defined all of the setup parameters for segment labeling, you are now ready to label your data.

Example:

For this example, we will use the CMTTUT.FTR file included with CMT-SURVEY. Open the file, CMTTUT.FTR in the Survey65 folder.

After the file has been opened, turn off all topics except for the “Block” topic. Your Map View will look similar to the following:



Now choose Map/Label/Segment Label to access the Segment Label frame on the right side of the Map View. Click on the **Setup** button and specify the following parameters:

Position:

Line Segment:	**Arc Segment:**	**Create Label:**
Segment length – Above	Arc length – None	Create label always
Angle – Below	Radius length – None	

Unit:

Length:	**Angle:**
Unit – US Feet	Unit - DMS
Number of Decimal Digits – 4	Number of Decimal Digits – 2
3D – (no check mark)	Angle System – Azimuth
	Azimuth System – North
	Leading 0 – (no check mark)
	DMS Display in – Seconds

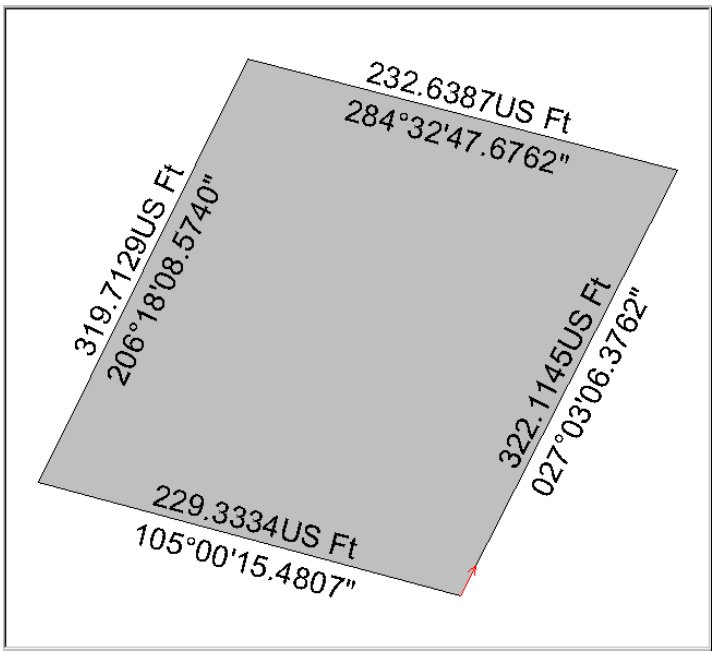
Decoration:

Segment Length:	**Angle:**	**Arc Length:**	**Arc Radius:**
Prefix – None	Prefix – None	Prefix – None	Prefix – None
Suffix – Length Unit	Suffix – None	Suffix – None	Suffix – None

Font:

Segment Length:	**Angle:**	**Arc Length:**	**Arc Radius:**
Color – Black	Color – Black	Color – Black	Color – Black
Style - Regular	Style – Regular	Style – Regular	Style – Regular
Size – 23	Size – 23	Size – 23	Size – 23

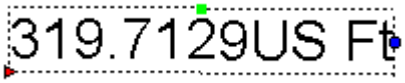
After the above settings have been entered, click **OK** to accept these settings and return to the Segment Label screen. You are now ready to insert the labels. In the SEGMENT LABEL frame, click on the “Create” option and then click on the **GO** button. You should see the following in the Map View:



Please note: The segment labels will be created in the active topic and not the "Non-Spatial Data" topic.

Now that you have labels in your Map View, you may want to make some changes to customize the labels to your needs.

First, click once on any label. You will see the label gets selected with a dashed line around it along with some symbols. This will look like the following:



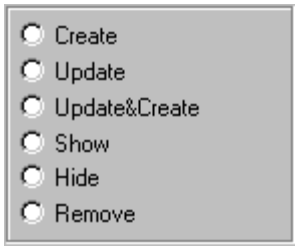
The different symbols allow for quick customization of the label:

: MOVE. Click and drag on this symbol to move the label to a new position.

: SIZE. Click and drag on this symbol to resize the text label.

: ROTATE. Click and drag on this symbol to rotate the label.

To make changes to all of the labels, you will need to make changes under the SETUP dialog and then use the segment labeling tools to make the changes to your Map. Following is an explanation of the different segment labeling tools. To access the tool, simply select the tool by clicking on the circle to the left of the tool name and then click the **GO** button to see the action:



Create: Creates labels based on the contents and positions you have specified.

Update: Updates the position of the labels if changes are made. Update will not change the label contents.

Update & Create: Updates and creates the labels based on the contents and positions you have specified.

Show: Shows the labels after they have been hidden.

Hide: Hides the labels from view. This function does not delete the labels.

Remove: Deletes the labels from the Map.

You can also specify which segments you want to be labeled. The default option is for all segments to be labeled. You can choose different options using the following selection tool located at the bottom of the SEGMENT LABEL view:

All Segment Labels: Creates labels on all segments in the current Job.

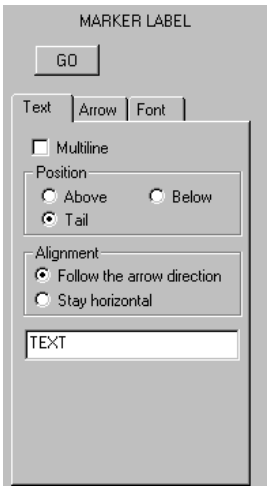
Topic: Creates labels on all segments in the current Topic. When this option is selected, a pull-down menu will appear allowing you to specify the Topic.

Selected Features: Creates labels on all selected segments in the current Job.

Segment: Choosing this option will create a label on one segment. Your mouse pointer will turn into a crosshair allowing you to click on the segment to highlight it.

11.2 Marker Label

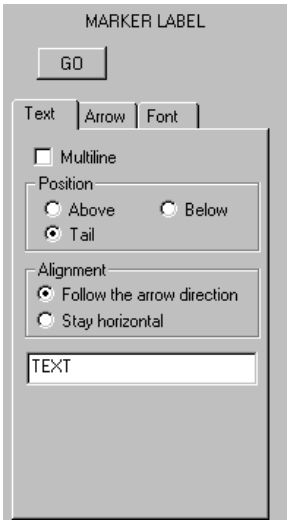
The Marker Label function is a quick and convenient way to add markers (arrows with text labels) to your Map. These markers can be customized for efficiency and convenience by setting size, location and font. When you select the Map/Label/Marker Label, the following label view is displayed:



There are three options available in the MARKER LABEL dialog. Each option is discussed in the following sub-sections:

Text:

Use the text section to specify what text, if any, is to be included in the marker. Also, the position and alignment of the marker can be specified. The following dialog is displayed:



Multiline: Check this box to enable multiple lines of text to be included in the marker. The default is for the text label to be all in one line.

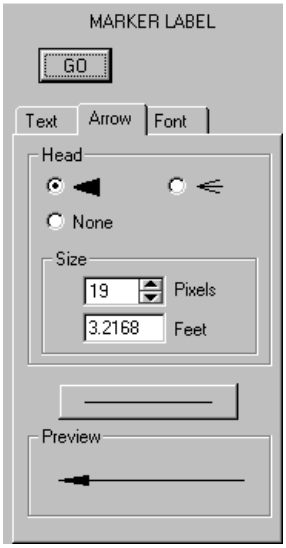
Position: Choose the position of the text with respect to the marker. Available options are for the text to be above the marker, below or attached to the tail.

Alignment (Tail position only): If you have selected “Tail” for position, then you will have the option to have the text rotate with the marker (follow the arrow direction) or stay horizontal.

TEXT BOX: Type the desired text label in this box. When Multiline is checked, the box will extend downward allowing text entry on multiple lines.

Arrow:

The Arrow section of the MARKER LABEL dialog allows customization of the marker itself. Options include changing the arrowhead style, size and line style. The following dialog is displayed after clicking on the “Arrow” tab:



Head: Choose a head type between the two head styles or choose “None” for no head.

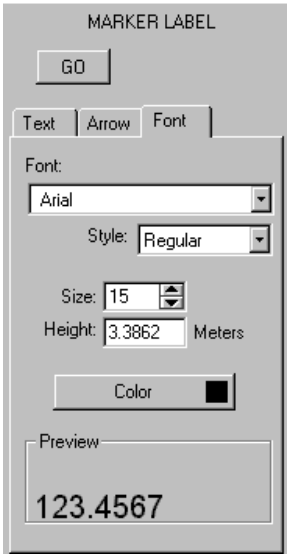
Head Size: Specify the size of the head (if one has been chosen) in either pixels or the specified units of measurement.

Alignment (Tail position only): If you have selected “Tail” for position, then you will have the option to have the text rotate with the marker (follow the arrow direction) or stay horizontal.

Line style: Click on the button with a line on it to choose from different styles of line patterns. The line pattern dialog will pop up with five different line styles to choose from. The line pattern dialog will also allow you to specify different colors and line sizes. A preview of the line marker will be displayed at the bottom of the MARKER LABEL dialog.

Font:

The Font section allows you to change the size, font and color of the text portion of the marker label. The following dialog is displayed for “Font”:



Font: Choose the font type.

Style: Specify the font style from one of the following: Regular, *Italic,* **Bold,** or ***Bold Italic.***

Size/Height: Specify a font size or height.

Color: Click on the **Color** button to pick a Font color.

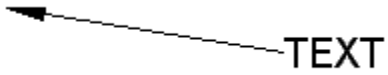
A Preview of the TEXT will be shown at the bottom of the MARKER LABEL dialog.

Once you have defined all of the setup parameters for marker labeling, you are now ready to add marker labels to your Map.

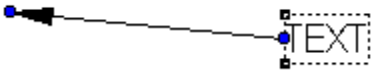
Click on the **GO** button at the top of the MARKER LABEL dialog so it is depressed.

Now, click once on your map to specify the point to which the marker will be pointing. Next, drag your mouse in a direction away from the initial point. Once you are satisfied with the position of the marker, click again once with your mouse to lock down the location of the marker.

An example of a completed marker label is provided:



The marker label may still be edited after it has been created. Click once on the marker label to show the “handles” for the selected label as follows:



These handles allow you to move and rotate the label. The handles are defined below:

 : ROTATE. Allows you to rotate and extend/shorten the marker. The pivot point will be the opposite blue dot.

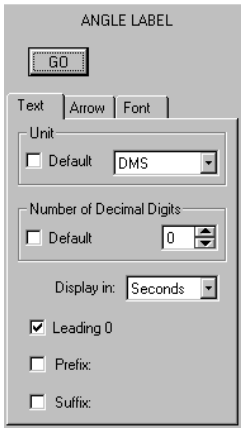
 : ATTACHMENT. Click on a different black box to define the point of attachment for the text with respect to the tail of the marker.

Please note: The attachment handles are only available when you choose the text position to be on the TAIL and the alignment to STAY HORIZONTAL.

A new “Labels” topic is created for your marker labels. This topic is marked by the following symbol: 

11.3 Angle Label

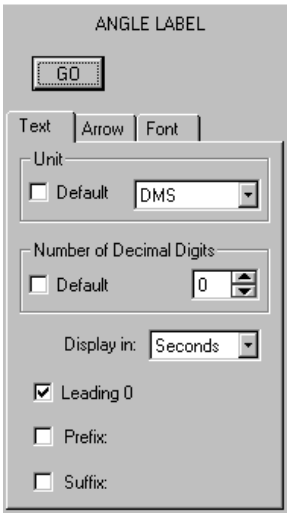
The angle label function provides a means for labeling angles in your job that occur in line and area features. When you select the Map/Label/Angle Label, the following label view is displayed:



There are three options available in the ANGLE LABEL dialog. Each option is discussed in the following sub-sections:

Text:

Use the text section to specify what text, if any, is to be included in the marker. Also, the position and alignment of the marker can be specified. The following dialog is displayed:



Unit: Mark the default check box if you want to use the global angle measurement units specified in your Job. To use a different unit of measure, uncheck the Default box and choose from the available options: DMS, Degree, Mils, or Grads.

Number of Decimal Digits: Specify the number of decimal digits to be used for angle labels. To stay consistent with the global settings of your Job, check the Default box.

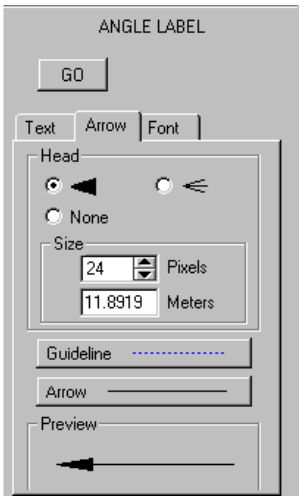
Display in: Choose to have the angle label displayed in Degrees, Minutes or Seconds by picking one of these options from the pull-down menu.

Leading 0: Place a check mark in this box if you wish to include a “zero” at the beginning of the label.

Prefix/Suffix: Place a check mark in either of these options and a text box will appear to the right of it allowing you to specify your own text for a prefix or suffix to be added to the label.

Arrow:

The Arrow section of the ANGLE LABEL dialog allows customization of the markers themselves. Options include changing the arrowhead style, size and line styles. The following dialog is displayed after clicking on the “Arrow” tab:



Head: Choose a head type between the two head styles or choose “None” for no head.

Head Size: Specify the size of the head (if one has been chosen) in either pixels or the specified units of measurement.

Alignment (Tail position only): If you have selected “Tail” for position, then you will have the option to have the text rotate with the marker (follow the arrow direction) or stay horizontal.

Guideline style: The guideline is used to show the angle boundary for supplemental angle labels. Click on the **Guideline** button to choose from different styles of line patterns for the Guideline. The line pattern dialog will pop up with five different line styles to choose from. The line pattern dialog will also allow you to specify different colors and line sizes. A preview of the line style is shown on the **Guideline** button.

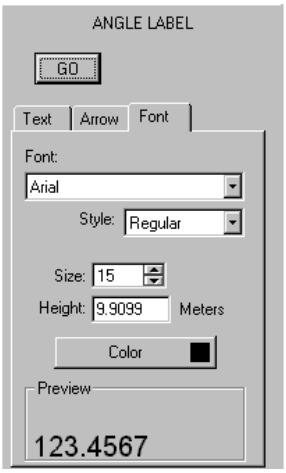
Arrow style: Click on the button with a line on it to choose from different styles of line patterns. The line pattern dialog will pop up with five different line styles to choose from. The line pattern dialog will also allow you to specify different colors and line sizes.

A preview of the line marker will be displayed at the bottom of the ANGLE LABEL

dialog.

Font:

The Font section allows you to change the size, font and color of the text portion of the marker label. The following dialog is displayed for “Font”:



Font: Choose the font type.

Style: Specify the font style from one of the following: Regular, *Italic,* **Bold,** or ***Bold Italic.***

Size/Height: Specify a font size or height.

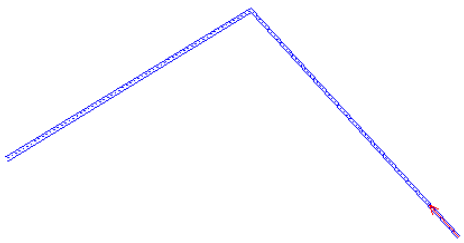
Color: Click on the **Color** button to pick a Font color.

A Preview of the TEXT will be shown at the bottom of the ANGLE LABEL dialog.

Once you have defined all of the setup parameters for angle labeling, you are now ready to add angle labels to your Map.

Click on the **GO** button at the top of the ANGLE LABEL dialog so it is depressed.

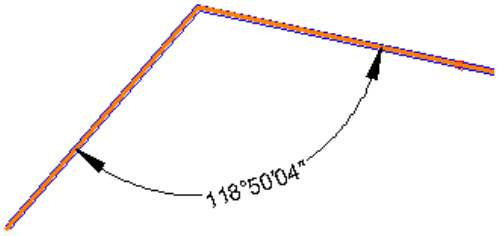
Assume you have a line with an angle in it that you want labeled. For example:



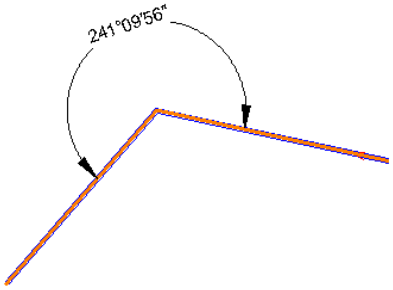
There are four different angles that can be labeled in the above example. Each of these is listed below. To select the angle, click once on one leg of the angle so it is highlighted. Next, click on the second leg of the angle so it is highlighted. The angle label will immediately appear. The angle labeled depends upon the location of your mouse.

As you move your mouse pointer around to different areas around the angle, you will notice the angle label changes automatically between the different angle measurements. Also, for each different angle measurement, you can move the mouse pointer around to change the position of the angle label (nearer or further away from the angle vertex). Following are examples of the different angle labels for the above line example:

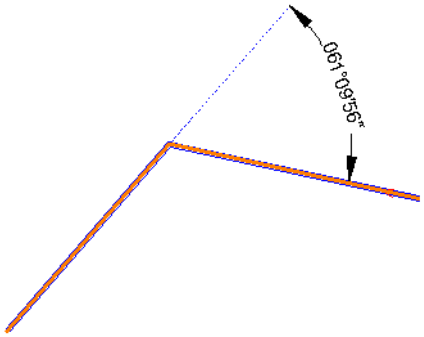
Internal angle:



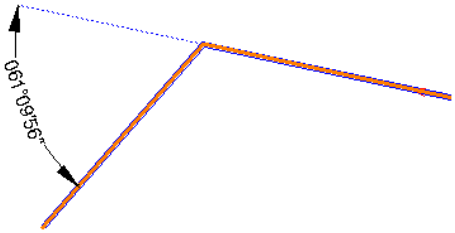
External angle:



Supplementary angle1:

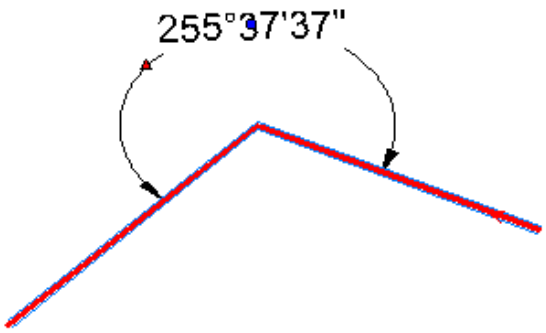


Supplementary angle2:



Once you are satisfied with the position of the marker, click again once with your mouse to lock down the location of the marker.

The angle label may still be edited/adjusted after it has been created. Click once on the angle label to show the “handles” for the selected label as follows:



These handles allow you to move and rotate the label. The handles are defined below:

: ROTATE. Allows you to rotate the text along the arc (when possible). When the font size is too large to fit the label within the angle, the text will be placed outside of the angle and the arc will be replaced by two arrows. In this situation, you will not be able to use the blue dot to rotate the text because there is no arc available.

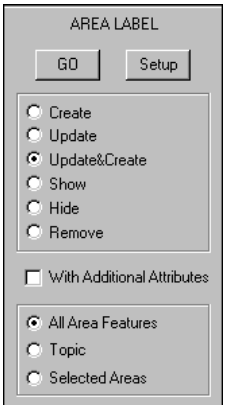
: MOVE. Click on the red arrow to move the location of the label with respect to the angle.

A new “Labels” topic is created for your marker labels. This topic is marked by the following symbol: ABC

Please note: Angle labels can only be created for line or area features. Angle labels may not be calculated between point features.

11.4 Area Label

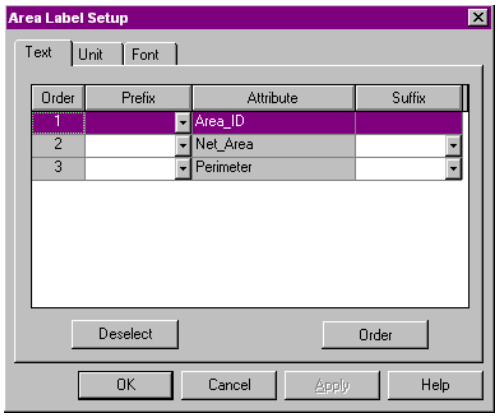
The area label function provides a method for labeling area features in your job that occur in line and area features. When you select the Map/Label/Angle Label, the following label view is displayed:



Click on the Setup button to access the Setup menu. There are three options available in the Area Label Setup dialog. Each option is discussed in the following sub-sections:

Text:

Click on the Text tab at the top of the screen to access the Text setup window. The Text setup window will be used to define the order of the text labels as well as defining any prefixes or suffixes for the labels. The Text setup dialog is displayed as follows:



Order: Click on the **Order** button to change the order in which the labels will be displayed. Once clicked, the **Order** button will stay depressed. Click once (in the order column) the row of the label that you want to show first, then click the second row and so on. Once complete, the **Order** button will automatically turn off.

Prefix: Click on the pull-down menu to choose a prefix for the specified row (if desired).

Attribute: This column shows the Attribute name that will be used to create the labels for the specified area.

Suffix: Choose a suffix (if desired) to add the units of measurement to the “Net_Area” label and “Perimeter” label.

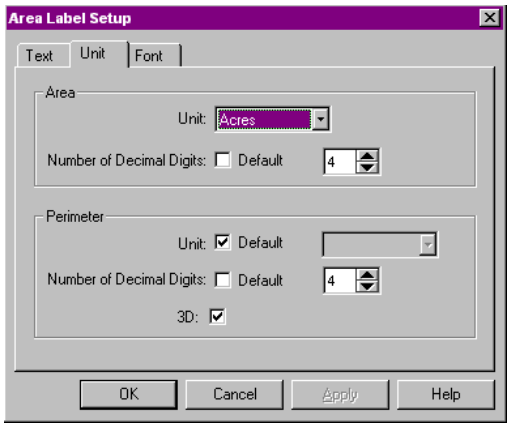
Select/Deselect: Click the **Deselect** button to exclude the highlighted row from being labeled. The order number will disappear to show it is not selected. To re-select it, simply highlight the row and click on the **Select** button again.

Choose **OK** to accept these settings and return to the Label View or **Cancel** to abort these changes and return to the Label View screen.

Please note: Additional attributes may be used. To do so, make sure you put a check mark in the box for “With Additional Attributes” in the main AREA LABELS view. Select or unselect the desired Attributes associated with the area. Also, use the above described method to specify the order in which the labels will be displayed.

Unit:

The Unit Setup dialog is used to define the units of measurement, decimal precision and other display settings for area and perimeter labels. After clicking on the Unit tab, the following dialog is displayed:



Area, Unit: Click on the pull-down menu to specify the measurement units for Area labels. Available options are: Acres, Hectares, Sq. Meters and Sq. Feet.

Area, Number of Decimal Digits: Specify the number of decimal digits to be used for length labels. To stay consistent with the global settings of your Job, check the Default box.

Perimeter, Unit: Mark the default check box to use the global measurement units specified in your Job. To use a different unit of measure, uncheck the Default box and choose from the Meters, Feet (Int'l), KM, Miles or US Feet.

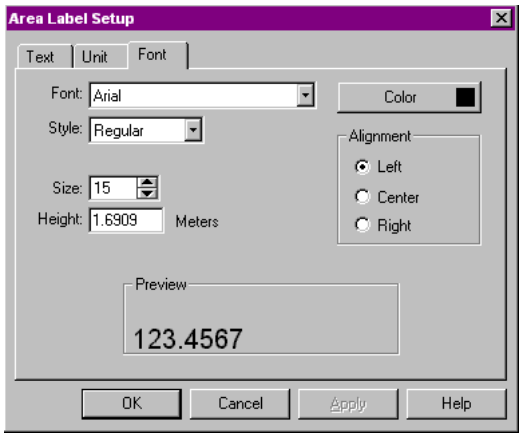
Perimeter, Number of Decimal Digits: Specify the number of decimal digits to be used for perimeter labels. To stay consistent with the global settings of your Job, check the Default box.

Length, 3D: Label perimeters with slope distance.

Choose **OK** to save your settings and return to the AREA LABEL view or choose **Cancel** to abort changes.

Font:

The Font Setup dialog is used to define the font type, size/height, style, color and alignment for area labels. After clicking on the Font tab, the following dialog is displayed:



Font: Choose the desired font type from the pull-down menu.

Color: Click on the Color button to specify a color.

Style: Click on the pull-down menu and choose a font style: Regular, *Italic,* **Bold,** or ***Bold Italic.***

Font Size/Height: Specify a font size or height.

Alignments: Choose the justification for the area label from the options of: Left, Center or Right.

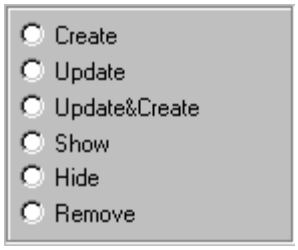
A preview of the font selection will be displayed at the bottom of the screen.

Choose **OK** to save your settings and return to the AREA LABEL view or choose **Cancel** to abort changes.

Once you have defined all of the setup parameters for segment labeling, you are now ready to label your data.

In the AREA LABEL view, you can specify which areas are to be labeled.

To make changes to all of the labels, you will need to make changes under the SETUP dialog and then use the segment labeling tools to make the changes to your Map. Following is an explanation of the different area labeling tools. To select a tool, click on the circle to the left of the tool name and then click the **GO** button to see the action:



Create: Creates labels based on the contents and positions you have specified.

Update: Updates the position of the labels if changes are made. Update will not change the label contents.

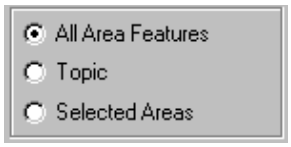
Update & Create: Updates and creates the labels based on the contents and positions you have specified.

Show: Shows the labels after they have been hidden.

Hide: Hides the labels from view. This function does not delete the labels.

Remove: Deletes the labels from the Map.

You can also specify which areas you want to be labeled. The default option is for all areas to be labeled. You can choose different options using the following selection tool located at the bottom of the AREA LABEL view:



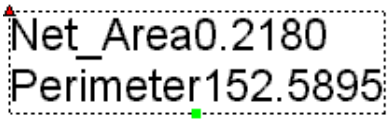
All Area Features: Creates labels on all areas in the current Job.

Topic: Creates labels on all areas in the current Topic. When this option is selected, a pull-down menu will appear allowing you to specify the Topic.

Selected Areas: Creates labels on all selected areas in the current Job.

Now that you have labels in your Map View, you may want to make some changes to customize the labels to your needs.

First, click once on any label. You will see the label gets selected with a dashed line around it along with some symbols. This will look like the following:



The different symbols allow for quick customization of the label:


: MOVE. Click and drag on this symbol to move the label to a new position.


: SIZE. Click and drag on this symbol to resize the text label.

Section 12 - Field Work in CMT-SURVEY

The Field Work menu in CMT-SURVEY lets you collect data directly into CMT-SURVEY using an electronic Total Station.

Before collecting data, first select the desired angle system and units of measurement under the **View/Configure** menu and the **Map/Coordinate System** settings, respectively. Specific settings for instrument, measurement conditions and repetition modes are discussed in the section titled **Field Work Setup**.

Horizontal Angle Measurements

The data to be entered into the "horizontal angle" data fields in the CMT-SURVEY is the conventional angle right or angle left measurement. Angle right is the angle in the horizontal plane measured clockwise from the backsight direction to the foresight direction. On the other hand, a deflection angle measures the angle between the foresight direction and the direction from the backsight point to the occupied station. So if the deflection angle of a foresight target is 0, then the foresight target and the backsight target are on opposite sides of the instrument. Put another way, the difference between the angle right measurement and the deflection angle measurement is half a circle, or 180°.

Deflection angles are commonly used for roadway design and surveys that proceed along a fairly straight course, so deflection angles are usually quite small. If you employ the deflection angle system, use the following method for taking the measurements. To conform to the procedures used by CMT-SURVEY for measuring horizontal angles, a backsight measurement must be taken before the foresight measurement. Use the face opposite from the one that is normally used for the backsight measurement. Use the normal face for the foresight measurement. This will have the effect of reversing the foresight and backsight readings. That is, the backsight reading will be 180°, and the foresight reading will be close to 0. With a transit, it is customary to record a deflection angle as a small, positive angle value followed by a right or left designator, e.g. 7.5 R or 10 L. With a theodolite, however, the angles right - angles left setting is typically set just once for an entire job. In this case, when an angle deflecting to the left is measured, for example 10L, it will appear as 350° when in “angles right” mode. The same is true for an angle deflecting to the right when in “angles left” mode.

Vertical Angle Measurements

Select the appropriate vertical system for displaying collected field work data. When you do a stakeout job, CMT-SURVEY always uses the vertical distance system to display the data.

CMT-SURVEY assumes that the total station is set to output zenith angle and slope distance. When you select the VERT DIST mode, CMT-SURVEY will compute the horizontal and vertical distances. Therefore, please set your total station to measure zenith angle and slope distance even when you have selected VERT DIST as the vertical system to use in CMT-SURVEY.

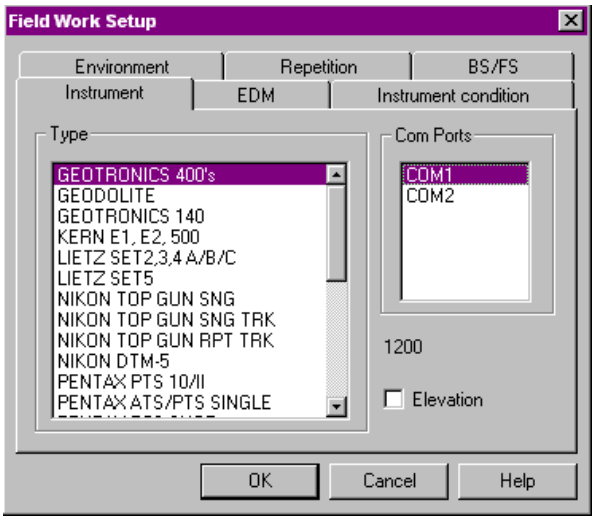
Point ID in Measurement Data

The Point IDs in the measurement data records are the Feature IDs of the survey points. Although you may easily change the Feature ID of a survey point, it is not advisable to do so. When you change the Feature ID of a survey point via its Feature Properties screen, the Point ID of the survey point in the measurement data stays unchanged. You could edit the

measurement data to change the Point ID, but generally we do not recommend altering the measurement data.

12.1 Field Work Setup

The FIELD WORK SETUP screen presents a number of sub-menus and is accessed by choosing **Field Work/Field Work Setup**. The following dialog is displayed:

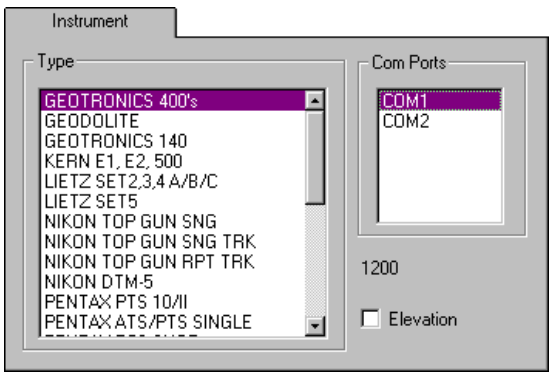


Select the setup option by clicking the corresponding tab at the top of the screen.

Some of the setup functions such as Instrument, Instrument Condition and Environment affect how raw measured data or the adjusted coordinate data will be corrected. Specify the corrections to be made if the conditions (e.g. curvature of the earth, atmospheric refraction, pressure, temperature, scale factor, etc.) affect the measurement accuracy and therefore need to be taken into consideration. This correction is applied to the raw data obtained from the total station when you click the **Measure** button. The corrected data displayed in CMT-SURVEY will be different from the data displayed on your total station.

12.1.1 Instrument Setup

Use the "INSTRUMENT SETUP" screen to specify elevations, instrument port and the instrument type.



Type: Choose the instrument ID by scrolling through the list.

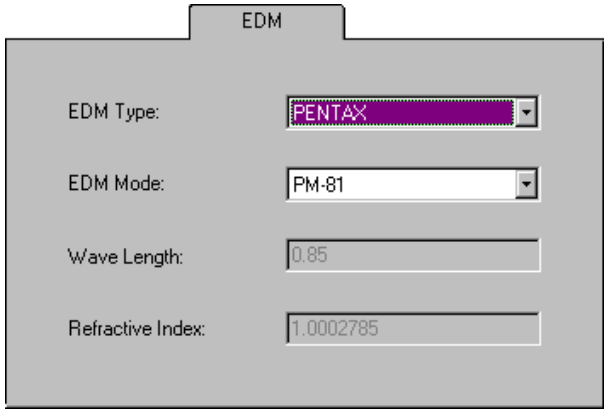
COM Ports: Choose from available ports to specify the port the instrument will be connected to.

Elevation: Enter a check mark in this box to globally enable all references to elevation or height fields/measurements

Click **OK** to save these settings and return to the Map View.

12.1.2 EDM Setup

The EDM SETUP screen will permit you to enter data for atmospheric correction.



EDM Type: Choose the EDM Type from the dropdown menu.

EDM Mode: Select the desired EDM mode.

Wave length: If you have selected a particular EDM type and mode, the wavelength for the EDM selection will be automatically displayed and cannot be changed. If you select "OTHER" as the EDM type, then you can enter an appropriate wavelength value.

Refractive Index: The refractive index for the EDM selection will be automatically displayed and cannot be altered by you. If you select "OTHER" as the EDM type, then you can enter an appropriate refractive index value.

The following EDM types and modes are supported by CMT-SURVEY 6.5:

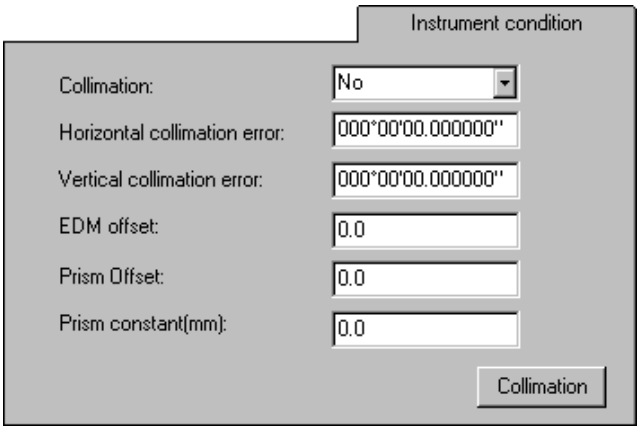
PENTAX: PM-81, MD, OTHERS
GEODIMETER: 710,6BL,8, 6A, 6000, OTHERS
H.P.: 3800,3805, 3808,3820, 3810
KERN: 500, 501, OTHER
K&E: AR I, AR S,II
NIKON: ALL
P.I.: BEETLE, CITATION
SOKKISHA: RED MINI 2, RED 1, SDM-1C, OTHERS
TOPCON: DM-C2, OTHERS
WILD: DI3S,TC1,DI4, DI20, DI5S, DI1000, DI2000, DI3000,TC2000, TC1600, DI3
ZEISS: ELDI 1,2,3,SM4, ELTA 2,4, ELTA 3,20,46R,SM41,E-ELTA 3,4,6,ELDI 4, ELDI 10

OTHER: Other types of equipment

12.1.3 Instrument Condition Setup

You may enter and store instrument correction factors. The measured data will be corrected according to your entries for the instrument condition setup.

If the instrument is correcting for these conditions, then the data collector should not be correcting for the same. It is acceptable that no correction be performed by either the instrument or the data collector.



Collimation: This field allows you to specify whether the collimation values in the following two fields will be used to correct measured data. This correction will modify the horizontal and vertical angles. If the data is not measured in a set or is measured in an odd set, the collimation values will be added to the measured data; otherwise, they will be subtracted from the measured data.

Horizontal Collimation: Enter the instrument horizontal collimation error. If desired, you can get this value from actual measurements.

Vertical Collimation: Enter the instrument vertical collimation error. If desired, you can get this value from actual measurements.

EDM Offset: Enter the vertical offset from the scope to the EDM, in feet or meters depending on the unit used for the coordinate file. This value is used for EDM correction. (See Section 6.2.2.)

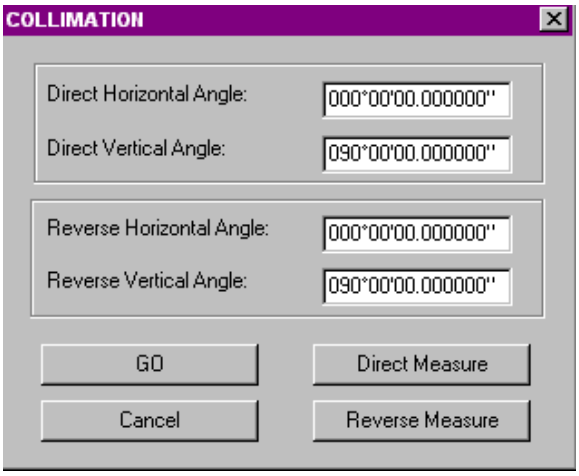
Prism Offset: Enter the vertical offset from prism in feet or meters depending on the unit used for the coordinate file. This value is used for EDM correction.

Prism Constant (mm): Enter the distance addition constant for the prism. The unit used for this value is always millimeters.

This correction will modify the slope distance received from the total station when the Measure button is clicked.

This correction is always applied if the prism constant is not set to zero.

Click on the COLLIMATION button to set the collimation value using actual measurements. To obtain the collimation value, you will need to make two measurements. The following dialog is displayed:



Direct Measure: First, move the cursor to either the Direct Horiz. Angle or the Direct Vert. Angle field and click Direct Measure. The data will be automatically entered into these two fields.

Reverse Measure: Then, repeat the Direct Measure process with the cursor at either the Reverse Horiz. Angle or the Reverse Vert. Angle field.

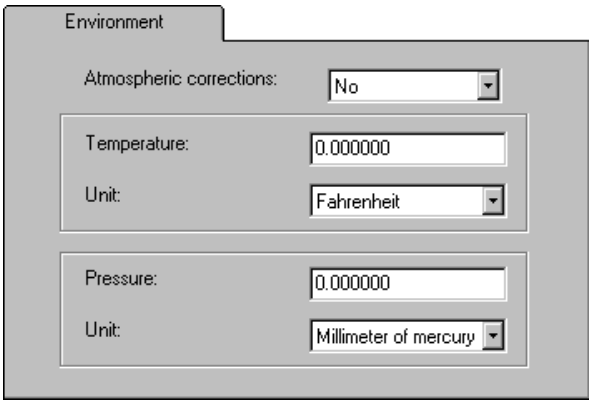
GO: The difference between the direct and reverse measurements will be computed and automatically entered into the Vert. Collimation and Horiz. Collimation fields in the Instrument Condition Setup screen.

Cancel: Aborts the Collimation computation and returns to the Instrument Condition Setup screen.

12.1.4 Environmental Corrections

You may specify the environmental conditions that CMT-SURVEY should correct for.

If the instrument is correcting for these conditions, then the software should not be correcting for them also. It is permissible, however, that no correction be performed by either the instrument or the data collector. The following dialog is displayed when you click on the Environment tab:



Atmospheric Corrections: Choose “Yes” to enable atmospheric corrections, or “No” to disable it.

Temperature: Enter the temperature.

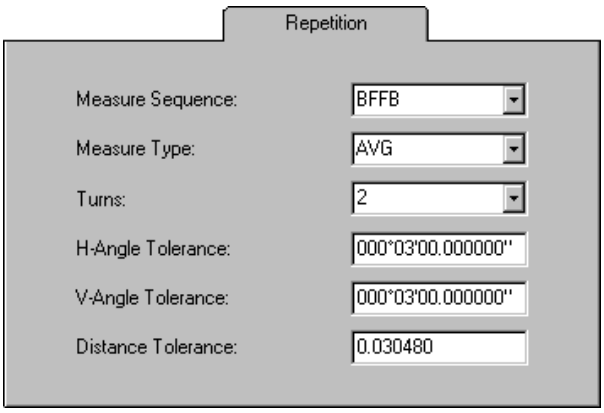
Unit: Specify the temperature units by choosing Fahrenheit or Celsius.

Pressure: Enter the pressure.

Unit: Specify the pressure units by choosing inches of mercury, millimeters of mercury, or millibars.

12.1.5 Repetition Setup

Use this screen to specify how repetition data is to be collected:



Measure Sequence: Click the dropdown menu for available options:

The BFBF sequence collects with face 1, a backsight and then the foresights, then collects with face 2 the backsight again and then the foresights again.

The BFFB sequence collects with face 1 a backsight and then the foresights, but then collects with face 2 the foresights in reverse order and then the backsight.

The BBFF sequence first collects all the backsight measurements, alternating face 1 with face 2, then collects all foresight measurements, again alternating face 1 with face 2. This sequence is primarily used where working conditions prevent ease of movement around the instrument (mining, for example).

Measure Type: Click the dropdown menu to choose between single distance measurements and average distance measurements.

If single distance mode is selected then a distance measurement is made on the first measurement set only; the other sets just measure angles. If average distance mode is selected then a distance measurement is made with each measurement.

Turns: Click the dropdown menu to select the total number of measurement sets to take. **Note that each BFFB, BFBF or BBFF measurement sequence involves two turns (sets).** Therefore, only an even number of turns is permitted, from 2 to 16.

H-Angle Tolerance: Enter the maximum horizontal angle error that will be tolerated. Make sure you enter the tolerance value in the same unit system you are using for horizontal angle measurements. Keep in mind that the tolerance criterion will be applied to the horizontal angles, not the horizontal measurements (readings). A horizontal angle is the difference between the horizontal measurements to two different points. When working with a horizontal angle measurement set, the difference between the first horizontal angle value and the value for the same horizontal angle obtained in any subsequent turns are checked against the specified tolerance. For example, the following BFFB measurement set meets the tolerance specification of 0.02 decimal degrees even though there is a large difference between the first and second measurement readings for each point.

Point	Measurement	Horizontal Angle	
BS 2	10.00		
FS 3	30.00	30.00 - 10.00	= 20.00
FS 4	140.00	140.00 - 30.00	= 110.00
FS 5	270.00	270.00 - 140.00	= 130.00
FS 5	290.01		
FS 4	160.00	290.01 - 160.00	= 130.01
FS 3	49.99	160.00 - 49.99	= 110.01
BS 2	30.01	49.99 - 30.01	= 19.98

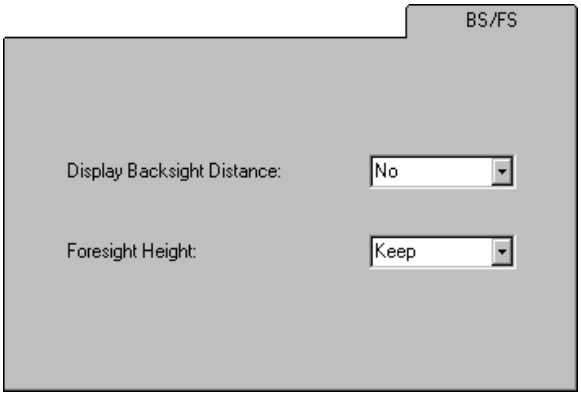
If the difference between the first horizontal angle value and the value for the same horizontal angle obtained in any subsequent turns exceeds the specified tolerance, a warning beep will be sounded. You then have the option of retaking the measurement or accepting the data anyway.

V-Angle Tolerance: Enter the maximum vertical (angle or distance) error that will be tolerated. Make sure you enter the tolerance value in the same unit system you are using for vertical angle measurements. If the difference between the first measurement of a vertical angle and a subsequent measurement of the same vertical angle exceeds the tolerance you specified, the latter measurement is deemed out of tolerance.

Distance Tolerance: Enter the maximum distance (slope or horizontal) error that will be tolerated. Make sure you enter the tolerance value in the same unit system you are using for distance measurements. If the difference between the first distance measurement and a subsequent distance measurement for the same point exceeds the tolerance you specified, the latter distance measurement is deemed out of tolerance.

12.1.6 BS/FS Setup

The BS/FS Setup dialog is displayed when you click on the BS/FS tab:



Display Backsight Distance: Choose **Yes** to have CMT-SURVEY prompt you for the backsight distance data. Choose **No** if you do not wish to measure backsight distance data. For high precision surveying, and to provide a check that the correct backsight point is sighted, use backsight distances. If the distance measured to the backsight point does not agree with the computed distance, a tolerance warning will be displayed. This can be used as a way to verify

that the correct backsight point is indeed sighted. (**The tolerance used here is the distance tolerance specified in the Repetition Setup)**

Foresight Height: Choose “Keep” to keep the foresight height (rod height), or “Clear”, to clear the data entered in the previous record. This field will not be visible if field elevations are disabled.

Keep the field data when the data entered in the previous point is normally reused in the current point. For example, if the rod height is constant, then set the HEIGHT field to keep its data. If instead a field is set to CLEAR, then the field will be made 0 when advancing to a new foresight point. Of course, data that is KEPT may still be changed.

12.2 Field Work Procedure

The "Field work" section is used for entering raw field data. Radial topography (side-shots) and traverses, or combinations of both, may be entered into a single job file. In addition, the CMT-SURVEY software allows measurement sets to be taken to improve accuracy.

The following discussion covers some basic concepts and practices used in surveying as well as how they pertain to the CMT-SURVEY Software. The Field Work data input screens are described in Sections 12.2 through 12.7. The tutorial in Section 12.11 includes a field work example.

12.2.1 General Notes on Data Collection

Field measurement data (raw data) may be entered by hand or recorded from a survey instrument. As data is entered, you can see the instrument point, the back-sight control point and the foresight point clearly marked with the corresponding symbols in Map View.

CMT-SURVEY automatically computes the coordinates of a survey point whenever sufficient measurement data has been recorded for that point and immediately displays the survey points in Map View.

If you toggle the **View/Measurement** option on, you will also see the lines representing the measurement data. Section 12.8 describes the measurement data records view and the associated functions.

After collecting field data, you may wish to adjust the survey to minimize errors or to take into account the averaged data in the measurements. **Survey Adjustment** is discussed in Section 12.9.

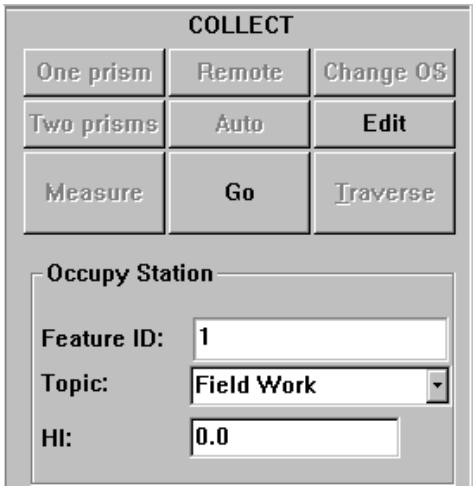
If you wish to fit the survey points to a different set of control points, please use the **T/R/S Least Squares Fit** function in the COGO menu.

12.2.2 Field Work/Collect

The **Field Work/Collect** routine handles all data collection activities and provides three main data entry screens. The OCCUPY STATION screen is discussed in Section 12.3. The BACKSIGHT screen is discussed in Section 12.4. The FORESIGHT screen is discussed in

Section 12.5. **The general procedure is to enter data into each screen, then click a Function button to execute the corresponding command.**

After selecting Field Work/Collect, the following dialog is displayed to the right of the Map View:



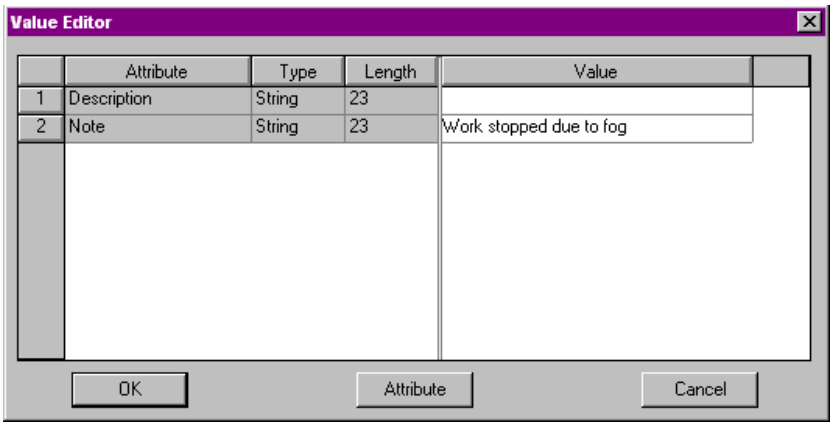
The data input panel may be turned off at any time by clicking on the “Disable Data Input” icon:  .

The “Toggle Mouse” icon is used to control your mouse pointer and what it can select. When you select Field Work/Collect, the “Toggle Mouse” icon is automatically depressed and turned on. In this mode, your mouse pointer will select items for the field work data input panel. When this icon is toggled off, then you can click on and select items in the Map View as normal.

Please Note: The “Toggle Mouse” icon is used for selecting items for the data fields in the data input panel. You can toggle this icon off to select items in your map as you normally would. The “Toggle Mouse” icon may be toggled ON and OFF without interrupting the Field Work data collection session.

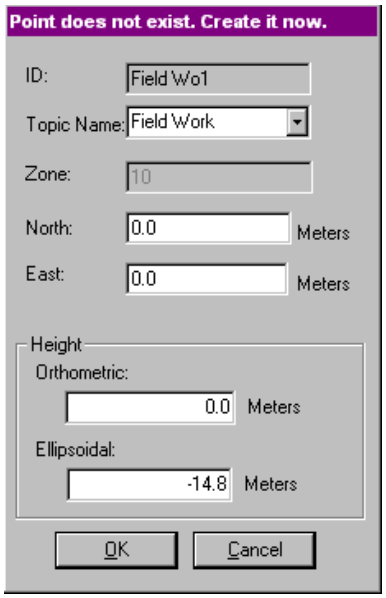
12.3 Occupy Station

Field data entry always begins with an occupy station activity. Enter the station point number and the topic name from the list of available topics in the pull-down menu. Enter the height of the instrument (HI) if elevations are being carried. Alternatively, you may click on the Feature ID: box and then click on the point in the Map View that you want to assign as the Occupy Station. Click on **Go** to advance to the BACKSIGHT screen. If the station point has not been previously defined, CMT-SURVEY will prompt you to create the point. Click on the **Edit** button to access the Value Editor screen for entering in descriptive Value information for the default Attributes and any other Attributes you may have added. The Value Editor screen is displayed after clicking on the **Edit** button:



To enter a Value, simply click on the empty cell and type in the information. Select OK to save changes and return to the Collect screen. Click on the **Attribute** button to access the Sheet Update screen for Attribute editing.

The following screen is displayed for creating the Occupy Station point:



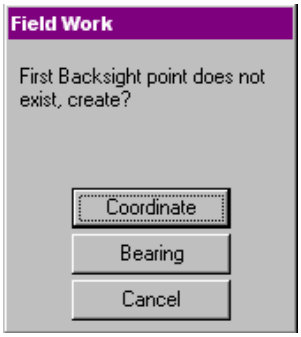
Enter the coordinates and height of the Occupied Station in this dialog. If the coordinates of the point are not known, use assumed coordinates, such as Northing=1000, Easting=1000, Elevation=100 for a local coordinate system.

The Occupied Station point is displayed with a tripod symbol on top of it for easy visual reference of the Occupy Station: 

12.4 Record Backsight

Next, the **BACKSIGHT** screen is displayed which allows measurement and entry of the backsight reading and point number. The following dialog is displayed to the right of the Map View for Backsight reading entry:

Click on the point in your map to establish it as the Backsight point. The Backsight point will be represented with the following symbol in the Map View: . Click the **Store** button to store the Backsight point reading and proceed to the Foresight screen. If the Backsight point has not been previously defined, then CMT-SURVEY will prompt you to create the Backsight point. The following dialog is displayed:



Coordinate: Create the point by manual input of coordinates for the new point (as shown in the creation of a point for an Occupy Station).

Bearing: Display the reference direction screen to enable calculation of the Back Reading via a Bearing between two points. For this option, the Backsight point will be created at a default distance of **100 feet** from the instrument point. (This distance can be changed). Click the **Store** button to record the displayed Bearing and return to the Backsight screen or click on the Measure button to take a reading from your instrument.

Cancel: Cancel this function and return to the Occupy Station screen.

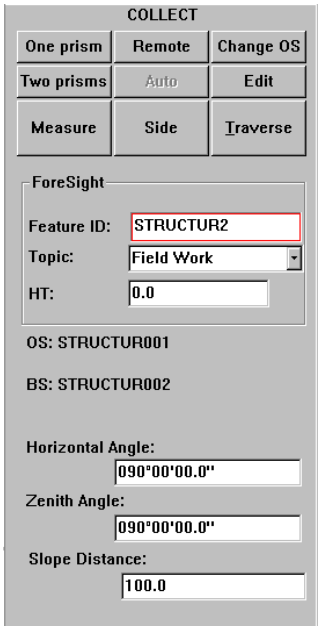
Manually enter the back reading or click on the **Measure** button to obtain the back reading directly from the instrument.

Click on the **Change OS** button if you wish to use a different point as the Occupied Station.

If sets of foresight measurements are to be taken, do not click on Measure or Store, but click on the **Set** button; sets of measurements will be recorded. Section 12.7 outlines the various procedures to use for recording sets of measurements.

12.5 Record Side-Shot or Traverse Point

The **FORESIGHT** screen is used to record measurements to side-shot points as well as traverse points. The Foresight screen is displayed after establishing the Backsight reading:



To record side-shots, enter the foresight data or click on the **Measure** button to get the data from the instrument. Click on the **Side** button to record the data. The next available foresight point number is automatically displayed. Continue to use "Side" to record each measured side-shot point. When the side-shot measurements are completed and the next point is a traverse point, measure or enter the data, then click on the **Traverse** button; the measurement will be recorded and the program will return to the OCCUPY STATION screen with the last foresight point set to be the current occupied station point.

To improve the accuracy of a traverse, you may want to take a measurement to the next traverse point as soon as you have set up on the station, before taking the side-shot measurements. To use this method, simply record the foresight point as a "**temporary side-shot**" point and then take the actual side-shot measurements. After taking all side-shots, traverse to the "temporary side-shot" point by entering its point number and then clickong **Traverse.** Do not enter the measurement data again; it will be ignored if you do.

If the prism cannot be placed at the object or at the desired distance, you may use the **remote object method** or **offset shot method** to collect the required data. (See Section 12.6)

Repeat the Process

Continue to record traverse and side-shot measurements as the job requires.

12.6 Foresight options

The Offset Shots and Remote Objects options are available for foresight data collection. These are described below.

12.6.1 Offset Shots

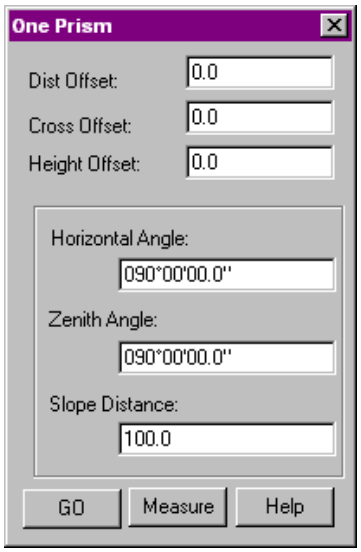
Use the **offset shot** method when the prism cannot be placed at the object but its position relative to the object can be determined (e.g. by taping).

Two methods are provided for making an offset shot. The “One prism” method lets you record the measurements to the prism and manually enter the offset data. The “Two prism” method makes use of a pole on which two prisms are mounted at a known distance from each other. Separate measurements are made to the two prisms from which the location of the inaccessible point is calculated.

To use an offset shot method, **click on the Offset function in the FORESIGHT screen**.

One Prism Method

With the “One prism” method, the foresight measurement data determines the location of the prism. The offset data "relocates" that point to the location of the object. To get the **distance offset**, project the horizontal distance between the prism and the object onto the vertical plane containing the instrument point and the prism. To get the **cross offset**, project the horizontal distance between the prism and the object onto the plane that contains the object and is perpendicular to the distance offset. The **height offset** is the vertical distance between the prism and the object. All three offsets are used in calculating the position of the offset target. The following dialog is displayed after clicking on the **One** Prism button:



Distance Offset: This is the distance between the object and the prism projected onto the line of intersection between the horizontal plane and the vertical plane defined by the prism and the instrument point. Enter a positive value if the object is further away from the instrument point than the prism; otherwise, enter a negative value.

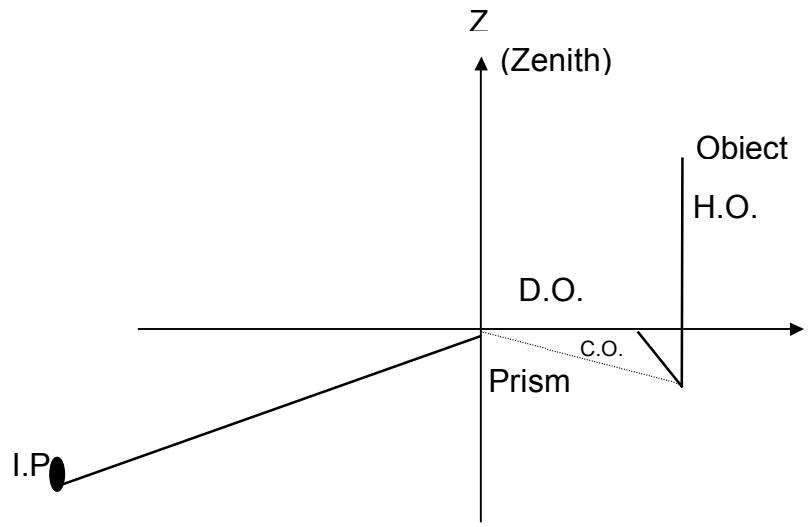
Cross Offset: This is the distance between the object and the vertical plane defined by the prism and the instrument point. Enter a positive value if the object is located to the right of the prism as viewed from the instrument point; otherwise, enter a negative value.

Height Offset: This is the difference in height between the object and the prism. Enter a positive value if the object is higher than the prism; otherwise, enter a negative value.

Click on the **Measure** button to get the angle and distance measurements of the prism. These will be automatically placed into the "Horizontal Angle", "Zenith Angle" and "Slope Distance" fields. If you had clicked **Measure** from the main FORESIGHT screen, the values measured will already be shown in these fields.

Click on the **GO** button to compute the adjusted measurement values based on the measured values of the prism and the offsets entered. The computed values are automatically placed into the "FORESIGHT" screen. Click **Side** to store the data if it is acceptable.

The following diagram illustrates the position of the object in relation to the prism. The instrument point (I.P.) lies in the plane defined by the X-axis and the Z-axis. The distance offset (D.O.), cross offset (C.O.) and height offset (H.O.) are mutually perpendicular.



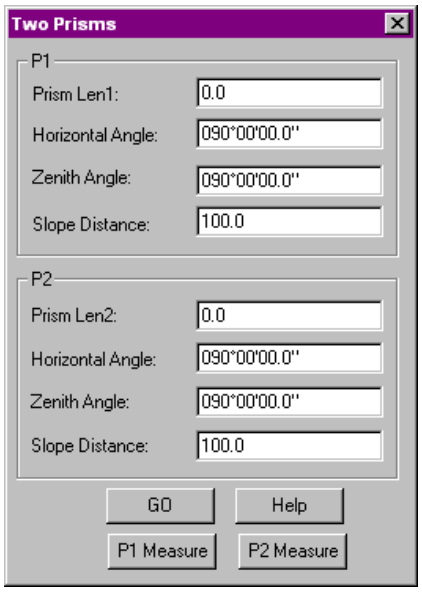
Note: To obtain correct results from offset computation, it is necessary that you set the rod height to zero before clicking on the **One Prism** button. After doing the offset shot, re-enter the correct rod height into the FORESIGHT screen.

Two Prisms Method

The “Two prisms” method uses a pole with two prisms mounted a known distance apart on it. You take a measurement to one of the prisms, and then you take another measurement to the other prism. Based on this information, CMT-SURVEY will determine the measurement values to the hidden point at the tip of the pole.

Please note: To obtain correct results from offset computation, it is necessary that you set the rod height to zero before clicking on the **Two Prisms** button. After doing the offset shot, re-enter the correct rod height into the FORESIGHT screen.

From the Foresight dialog box, click on the **Two Prisms** button to display the following:



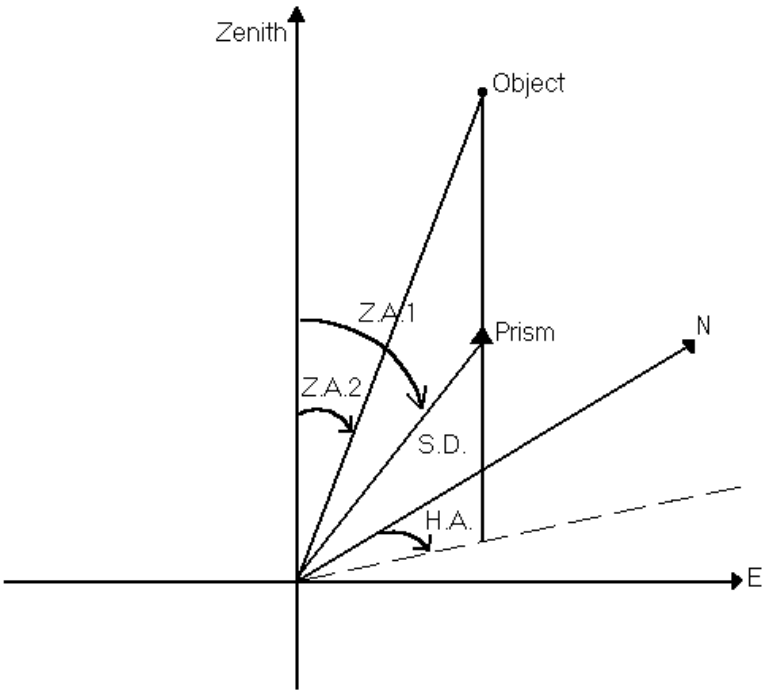
For P1, enter the distance from the far prism to the tip of the pole then click **P1 Measure** to take a shot at that prism.

Enter the distance from the near prism to the tip of the pole then click **P2 Measure** to take a shot at that prism. When done, click on the **GO** button to return to the FORESIGHT screen. The adjusted measurement values will be displayed in the FORESIGHT screen. Click on the **Side** button to store the data if it is acceptable.

12.6.2 Remote Object

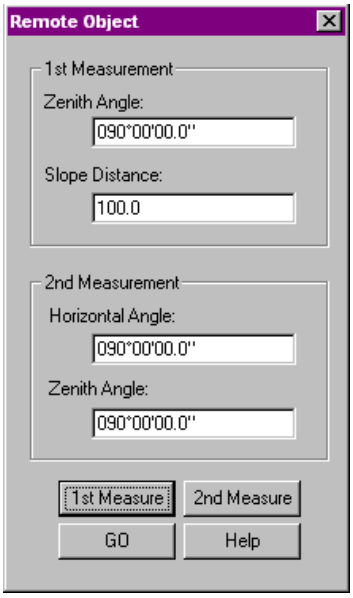
When you cannot place the prism at an object because it is out of reach, you can use the **remote object** method to record its position if you can place the prism at the same horizontal distance as the object.

You will make a measurement to the prism and then record the direction to the object. CMT-SURVEY will calculate the correct angle and distance values from the instrument to the object.



Please note: To obtain correct results from remote object computation, it is necessary that you set the rod height to zero before clicking on the Remote button. After doing the remote object shot, re-enter the correct rod height into the FORESIGHT screen.

Suppose the next point you need to record is the tip of a tall pole and you don't feel like climbing up there to place the prism. **Enter "0" into the "HT:" field in the FORESIGHT screen**, then click on the **Remote** button to display the following dialog:



Following is an outline of the procedure for using the **Remote Object** function:

1. Place the prism beneath the object (say, at chest height on the pole), then click the **1st Measure** button to get the vertical angle and slope distance measurements. The data will be automatically entered into the two fields: Zenith Angle and Slope Distance fields under the 1st Measurement section. If the vertical system used is set to VERT. DIST., then measurements are still taken off zenith angle and slope distance in order to compute the vertical distance.
2. Point the instrument directly at the object (the tip of the pole) and click the **2nd Measure** button to get the true horizontal and vertical angle measurements to the object. These values will be automatically entered into the Horizontal Angle and Zenith Angle fields under the 2nd Measurement section.
3. Click on the **GO** button to compute the true distance to the object and return to the FORESIGHT screen. The computed value will be automatically entered into the SLOPE DISTANCE field of the FORESIGHT screen. The data in the Horizontal Angle field and the second Zenith Angle field of the REMOTE OBJECT screen will be copied to the corresponding fields of the FORESIGHT screen. Click on the **Side** button in the FORESIGHT screen to store the data.

Example 1:

You need a measurement to the center of a large tree. Assume the angle right to the tree center is 105.3 degrees and the distance to the tree center is 25.9 feet.

First enter “0” into the "HT:" field in the FORESIGHT screen. Place the prism beside the tree at the correct distance from the instrument. Click on the **1st Measure** button from the REMOTE OBJECT screen to measure the distance to the prism. The slope distance reading is 25.9. (Assume the zenith angle reading is 89.5.)

Next, aim the instrument at the center of the tree and click on the **2nd Measure** button to get the angle measurements. The Horizontal Angle reading is 105.3. (Again, assume the zenith angle reading is 89.5.)

Now, click on the **GO** button to place the calculated distance into the FORESIGHT screen. The horizontal measure will show 105.3, the vertical measure will show 89.5, and the distance measure will show 25.9. All of the data has been combined properly to give a result that would have been obtained if the prism had been set inside the tree.

Example 2:

You need a measurement to the top of a power pole. Assume the power pole is 30 feet away from you, and has a height of 40 feet. (If you could put a prism on top of such a pole, you would find the slope distance is 50 feet and the zenith angle is 36.5212).

First enter “0” into the "HT:" field in the FORESIGHT screen. Place the prism at the base of the pole. Click on the **1st Measure** button from the REMOTE OBJECT screen to measure the distance to the base of the pole. If, for example, the prism is one foot higher than the instrument, then the zenith angle reading will be 88.0527, and the slope distance reading will be 30.0166.

Next, aim the instrument at the top of the pole and click on the **2nd Measure** button to get the angle measurements. Here, the zenith angle reading is 36.5212; let's assume the horizontal angle reading is 105.3.

Now, click on the **GO** button to place the calculated distance into the FORESIGHT screen. The horizontal angle will show 105.3 (same as was measured), the vertical angle will show 36.5212 (same as was measured), and the slope distance will show 50.4088 (this value is computed from the input data). The REMOTE OBJECT screen combines both sets of measured data to produce the result that would have been obtained if the prism had been set atop the pole.

12.7 Using Sets to Improve Accuracy

Various methods may be used to improve the accuracy of a survey by taking more than one measurement to a point. Two methods, and the data entry procedures to use with the CMT-SURVEY, are described below.

The data recorded for the multiple measurements will be used when you execute the **Field Work/Adjustment** function (Section 12.9). Within the Field Work/Collect function, no adjustment or angle averaging is performed on the measurement sets. You can use the **View/Measurement** function (Section 12.8) and click the “Summary” button to view the averaged angle and distance values for multiple measurements.

12.7.1 Repetition Angles

Measure a **repetition angle** (also called an **accumulation angle**) by taking repeated measurements to the backsight and foresight targets that define the **single angle** to be measured. Begin with a backsight reading of 0, then use the previous foresight angle for each new backsight reading so as to double, triple, quadruple, etc. the measured angle. The repetition angle method can only be used on theodolites with upper and lower motions (clamps).

The procedure for measuring a repetition angle with CMT-SURVEY is shown below:

1. In the Repetition Setup screen under Field Work/Field Work Setup, verify that the **repetition sequence** is **BFBF**, and that the desired number of turns in the measurement set is specified. Also confirm the acceptable tolerances.
2. From the BACKSIGHT screen, click on the **Set** button to begin a set of measurements.
3. Aim at the backsight target, clear the horizontal reading to 0, and record the backsight measurement. Click the **Store** button to advance to the "FORESIGHT" screen.
4. With the UPPER motion, aim at the foresight target and click **Side** to record the foresight measurement. This is the angle measurement from the backsight to the foresight.
5. Click **Endset** from the "FORESIGHT" screen to end the first turn (set) and begin the second turn (set) of measurements. The program will prompt you to reverse the instrument and then return to the "BACKSIGHT" screen.

6. Plunge the scope (to minimize collimation error), then with the LOWER motion aim at the backsight target and record the backsight measurement. This measurement should be the same as the previous foresight measurement. Click the **Side** button to proceed to the "FORESIGHT" screen again.
7. With the UPPER motion, aim at the foresight target and record the foresight measurement. This measurement will be double the previous foresight measurement. If the angle computed from the measurement is not within tolerance, you will be notified immediately to take corrective action. Click the **Side** button to record the measurement and return to the "BACKSIGHT" screen again.
8. Steps 5 and 6 are repeated for the number of turns specified in step 1.

12.7.2 Direction Sets

When multiple readings are used to improve accuracy, the direction set method of measuring angles makes the most of the measured data. With this method, you can take measurements for **any number of foresight points** within a measurement set. Up to 16 measurement sets (8 measurement sequences) can be made for each collection of points. The measurement sequence can be BFFB, BFBF or BBFF. Therefore, you may specify only an even number of measurement sets to be taken. Direction sets and repetition angles are measured in a similar fashion, although the lower motion is not used for direction sets, so any type of theodolite may be used for direction sets.

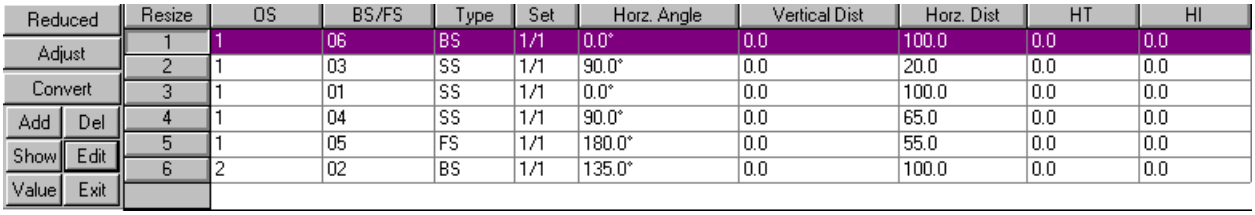
The procedure for measuring direction sets with CMT-SURVEY is shown below:

1. In the Repetition Setup screen under Field Work/ Field Work Setup, check that the repetition mode is set to: BFBF, BFFB, or BBFF and an even number of turns (sets) to be taken in the measurement is specified as desired.
2. From the BACKSIGHT screen, click the **Set** button to begin taking the first set (turn) of measurements.
3. Aim at the backsight target, and record a backsight measurement. The backsight measurement may have any value, including 0. Click the **Store** button to advance to the "FORESIGHT" screen.
4. Aim at a foresight target and take foresight measurement. This is the angle measurement from the backsight to the foresight. **Click Side to record the measurement**; the point number will automatically increment to the next unused point number.
5. Repeat step 3 for each foresight point in the measurement set. When all foresight points have been measured, click **Endset** to end the first set (turn) and begin the next set of measurements. The program will prompt you to reverse the instrument and then continue with the next measurement set. The distance and angle values obtained from this first measurement set will be used as a reference for determining if the values obtained from subsequent measurement sets are within tolerance.
6. Plunge the scope (to minimize collimation errors) and, depending on the sequence selected in the "Repetition Setup" screen, sight the backsight (for BFBF) or the last foresight (for BFFB).

7. Make sure you cover all the foresight points when taking the foresight measurements. If a distance or angle value is not within tolerance, you will be notified immediately to take corrective action.
8. When the second measurement set is finished, the program will prompt you for the third measurement set, and the process continues until all the measurement sets have been taken.

12.8 Viewing Measurement Data

Select the **View/Measurement** function to display the measurement data records:



Resize	OS	BS/FS	Type	Set	Horz. Angle	Vertical Dist	Horz. Dist	HT	HI
1	1	06	BS	1/1	0.0°	0.0	100.0	0.0	0.0
2	1	03	SS	1/1	90.0°	0.0	20.0	0.0	0.0
3	1	01	SS	1/1	0.0°	0.0	100.0	0.0	0.0
4	1	04	SS	1/1	90.0°	0.0	65.0	0.0	0.0
5	1	05	FS	1/1	180.0°	0.0	55.0	0.0	0.0
6	2	02	BS	1/1	135.0°	0.0	100.0	0.0	0.0

Click the **Show** button and turn on the display of traverse and side-shot paths. The measurement paths will be displayed in the Map View.

If you wish to see more of the Map displayed, use View/Sheet to turn off the Sheet View, then click the Zoom-Fit icon.

To create a Line Feature from the displayed traverse path, click the **Convert** button. A dialog will appear asking you to confirm the name of the new feature. A new topic will automatically be created for you containing the new feature.

Click the **Reduced** button to see the reduced data. If there are multiple measurement sets in the data, the angles and distances displayed are the averaged values.

To add a description or a note to a survey point, highlight the corresponding record, click the **Value** button and enter the information.

To edit a measurement, highlight that record and then click the **Edit** button. A dialog will appear that allows you to change measurements for that record. When finished making edits, click on the OK button and you will be prompted to perform an Adjustment based on the new measurement data.

To add a measurement, click the **Add** button.

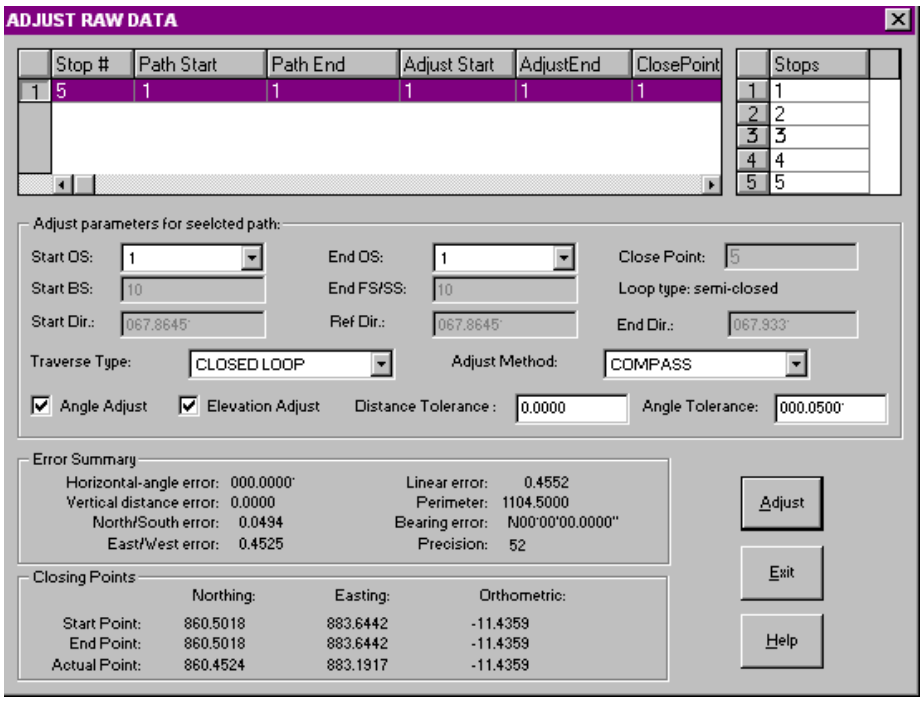
To delete a measurement, highlight that record and then click the **Delete** button.

CAUTION: Do not make changes to the measurement records if you are not absolutely sure of what you are doing.

12.9 Survey Adjustment

The Field Work/Adjust option is used to adjust a traverse and balance any measurement errors that have occurred. **Only the point coordinates are changed; the raw field data measurements are always preserved.**

When you select Field Work/Adjust, or click the **Adjust** button from the Measurement View, the **Adjust Raw Data** screen is displayed:



The Adjust Raw Data screen displays the traverse paths to be adjusted, the number of stops in the path, the starting and ending point numbers for the paths as well as the type of the traverse path. If any traverse path is not to be adjusted when you click the **Adjust** button, then remove the check mark from the corresponding **Adjustment** box.

Before performing a traverse adjustment, first check the data in the **Adjustment Parameters for Selected Path** section.

Specify the beginning and ending traverse points. For a closed-loop traverse, the first and last points are the same. For an end-ties traverse, the last point must be a control point. CMT-SURVEY will automatically select these for you, but they may be changed.

Enter the angle and distance tolerances into the respective data entry fields.

Generally, CMT-SURVEY will determine the traverse type for you. Available options are **OPEN TRAVERSE, CLOSED LOOP TRAVERSE** and **END TIES TRAVERSE**.

Available **Adjust Methods** are: Compass, Transit and Least-Squares.

Place a check mark in the **Angle Adjust** box if angle adjustment is desired. If an adjustment method other than Compass or Transit is selected, then angle adjustment will automatically be performed as is appropriate for the adjustment method. If angle adjustment is selected for

Compass or Transit, the angular error is distributed evenly to each angle in the traverse. In this case, you will see no angle errors in the Error Summary.

If angle adjustment is not selected, no angle adjustment will be performed. In this case, the total angle error will be shown in the horizontal angle error (HA-E) field of the RAW CLOSURE screen.

Place a check mark in the **Elevation Adjust** box if elevation adjustment is desired. When no elevation adjustment is selected, the total elevation error will be shown in the Error Summary and no error distribution is performed. When elevation adjustment is selected, the elevation error is distributed to each leg of the traverse, and 0 elevation error is shown in the Error Summary screen.

Based on the selected adjustment method and the type of traverse path, CMT-SURVEY displays the raw closure errors in the **Error Summary** section. The **Precision** value is the ratio of the length of the total traverse to the linear error. In general, a precision value of 5000 or higher indicates that there are no gross errors.

Coordinates for the starting and ending points are displayed in **Closing Points** section at the bottom of the screen.

If the closure information looks satisfactory, then perform the adjustment by clicking on the **Adjust** button.

The adjusted survey points will be conferred the **"3D Fixed"** status. This is displayed in the Feature Properties screen of each point. If you perform another adjustment on a previously adjusted job, you will be prompted to overwrite the existing traverse and side-shot points with the new adjusted points.

Please Note: A closed-loop or end-ties traverse needs to meet certain requirements on how the ending measurements are taken in order to be successfully adjusted. These requirements must be taken into consideration when you are collecting data with the Surveyor's Assistant program in the field.

Last OS of closed loop traverse with internal BS must be the same as the internal BS.

Last OS of closed loop traverse with external BS must be the same as the first OS point.

End-ties traverse must have last OS at a control point.

Last FS of closed loop traverse with internal BS must be the same as the first OS point.

Last FS of closed loop traverse with external BS must be the same as the first BS.

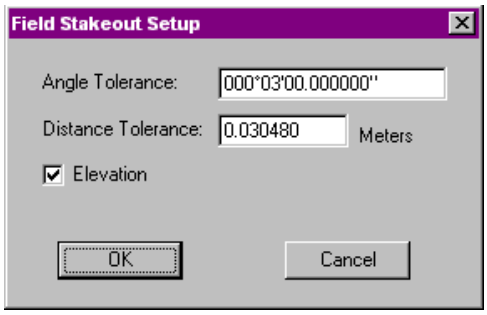
End-ties traverse must end with FS to an azimuth mark.

12.10 Stakeout

In addition to the powerful GPS Stakeout functions, CMT-SURVEY also provides Staking functions for your Total Station. The following sections describe the different Stakeout options available for CMT-SURVEY under the Field Work menu.

12.10.1 Stakeout Setup

When you select Field Work/Stakeout Setup the following dialog is displayed to specify acceptable tolerances during the stakeout process:

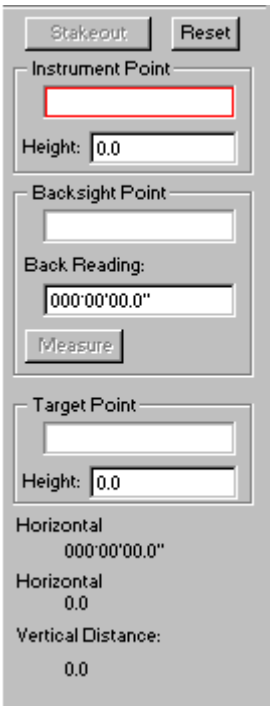


Specify the acceptable angle and distance tolerances in the above dialog. The angle system and units of measurement displayed reflect those global settings under the View/Configure menu and the Map/Coordinate System settings, respectively. Place a check mark in the Elevation box if you want these tolerances to apply to elevation readings (vertical plane) as well as data in the horizontal plane.

Please note: Note that the stakeout data may be stored only when both the horizontal angle measurement and the distance measurement are within the specified tolerances.

12.10.2 Point Stakeout

Use the Point Stakeout function to stake out individual points, or points along a line or area. Select Field Work/Stakeout/Point Stakeout to display the following dialog:



Instrument Point: Specify the instrument point number.

Height (Instrument): Specify the instrument height.

Backsight Point: Specify the backsight point number.

Back Reading: Enter the backsight reading; or, click the **Measure** button to take the reading from the instrument.

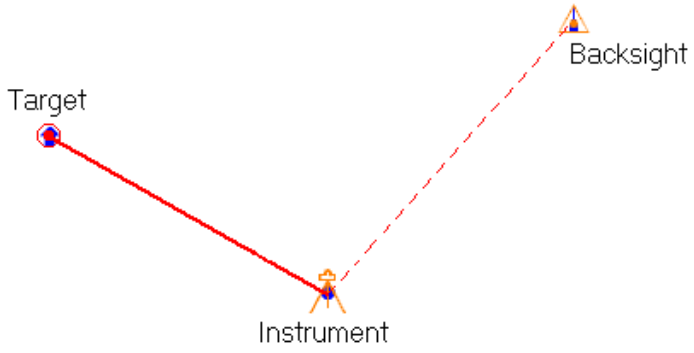
Target Point: Specify the foresight point number for the point you wish to stake.

Height (Target): Specify the rod height.

Please note: For entry of the points of "Instrument" and "Backsight", you may either type in the Point ID itself, or (when the field has a red box in it indicating it is active) you can use your Mouse pointer and click on the point in your Map View. Only points in the current Job may be selected.

After the Instrument, Backsight and Target Points have been specified, CMT-SURVEY will automatically provide you with the Horizontal Angle and Distance measurements as well as Vertical Distance to the Target Point.

The Map View graphically shows each of these points and will look similar to the following:



After all data has been entered in the required fields, the **Stakeout** button will become active at the top of the screen. The **Reset** button will erase all data entered and reset the fields to zero. When you click **Stakeout**, the STAKEOUT POINTS frame will be displayed to show you the difference between the desired and measured values for the angles and distances:

Auto: Sets CMT-SURVEY to auto-tracking mode for continuous position update (only for use with instruments that have the auto-tracking function).

Measure: Takes a new measurement from your instrument.

Store: Stores a point at the current location of the rod.

Exit: Exits the STAKEOUT POINTS screen and returns to the previous frame.

Each time you take a new measurement by clicking the **Measure** button, CMT-SURVEY will update the difference between the desired and measured values for the angles and distances. (To test this in the office, simply punch in some numbers close to the expected values.) This process is repeated until the measurement is within tolerance. Initially, the angle and distance shown are the values computed from the previous screen. These will be replaced with the actual measured values when a measurement is taken.

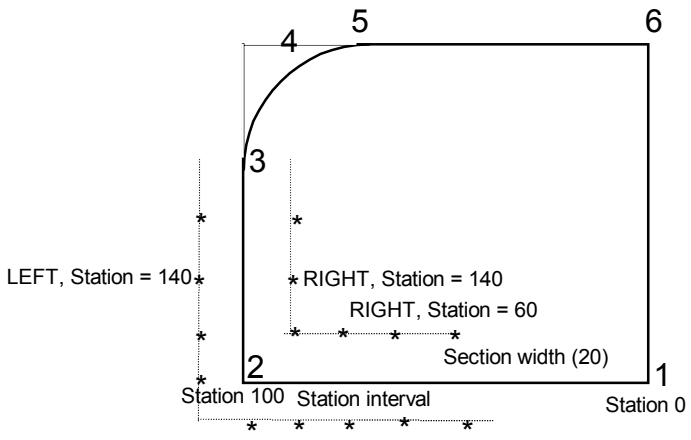
Use the displayed angle and distances to the point to aim the instrument in the direction specified and place the target at the distance specified, then click the **Measure** button.

When the data is within tolerance, a beep will be sounded and the Save Meas. Button will be made active. When this happens, set the stake in the ground and take another measurement. If the stake position is acceptable, click the **Save Meas.** button to record the measured data and return to the STAKEOUT LOCATION screen. **You will notice that the Target Point number has automatically advanced to that of the next point in your job file.** Repeat the point staking process until all points in the job have been staked.

Click the **Store** button to save the stake point location when it is within tolerance, if you wish.

12.10.3 Offset Stakeout

Use the offset stakeout routine when you have a defined figure and need to stake an identical figure at a fixed offset distance. For example, in road design you may have the data recorded for the centerline. To allow you to define the points for the roadsides, enter the width of the road from the centerline to the edge of the road. Enter an interval to specify the distance between the successive points you are staking on the offset. CMT-SURVEY will automatically advance to the next stake point at the click of a button. See the following diagram for definition of notation for offset staking.



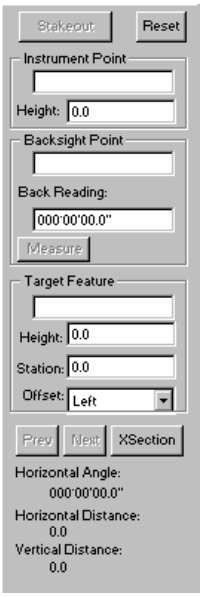
This diagram for offset stakeout uses the following data:

FIGURE:	= 1	(L:1-3, A:4, 5-6,1)
STATION INTERVAL	= 20	
SECTION WIDTH	= 20	(same for Right and Left)
CROSS SLOPE	= –5	(same for Right and Left)
CURB HEIGHT	= 0	
CURB WIDTH	= 0	(same for Right and Left)

The "*" points are the road boundary points to be staked. The inside "*" points are at the RIGHT direction of FIGURE 1 and the outside "*" points are at the LEFT direction.

In the above illustration, the intersection of the lines formed by the outside "*" points will not be automatically created by CMT-SURVEY. You can use the “COGO Intersect” routine to solve for this point by entering point 1, the azimuth for line 1-2, point 3, the azimuth for line 3-2 and the proper offsets. Use the “Point Stakeout” function to stake this point.

Click on **Offset Stakeout** from the Field Work/Stakeout Menu to display the OFFSET STAKEOUT frame. This screen allows you to locate the instrument, select an offset direction, select a figure, select an offset value, and set the initial backsight reading to be used in the offset stakeout procedure:



Instrument Point: Specify the instrument point number (or click on it in the Map View).

Height (Instrument): Specify the instrument height.

Backsight Point: Specify the backsight point number (or click on it in the Map View).

Back Reading: Enter the backsight reading manually; or, click the **Measure** button to take a reading from the instrument.

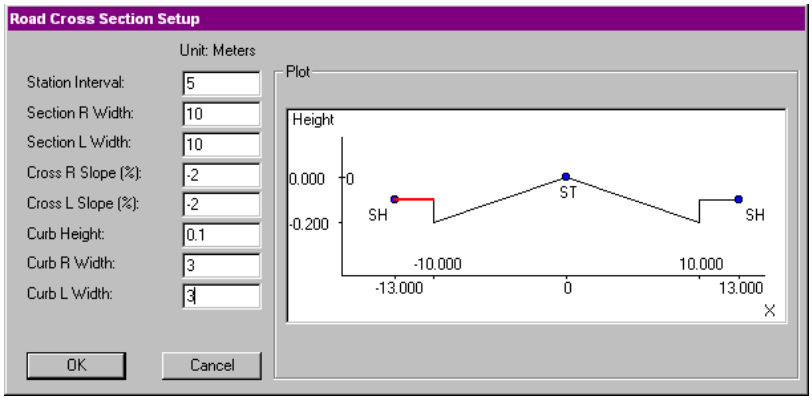
Target Feature: Specify the line or area figure number of the figure to be used for the offset calculations (or click on it in the Map View).

Height (Target): Specify the rod height.

Station: Specify the distance along the figure from the setup station from which the offset will be taken. This field will be automatically incremented by a predefined interval when you select **XSection**. The interval is specified in the ROAD SECTION screen which you can call up by clicking the **XSection** button.

Offset: Specify the offset direction (LEFT, RIGHT or CENTER). This determines whether the offset points will be to the left, to the right or centered on the figure.

Click on the **XSection** button to define the road section in the ROAD SECTION screen. The ROAD SECTION screen is used for defining the section interval as well as the offset and elevation of the boundary point of the road with respect to the centerline. After these are defined, CMT-SURVEY uses the station, offset and elevation information to compute the coordinates of the stake points which it then uses to stake the road boundary.



Station Interval:	Specify the interval distance between successive stations.
Section R/L Width:	Specify the perpendicular distance from the figure line to the hinge point on the right/left side.
Cross R/L Slope (%):	Enter the right/left cross section slope percentage for each offset point, omitting the percentage sign. This is the ratio between the height of the centerline and the section width, multiplied by 100.
Curb Height:	Specify the height of the curb. If the curb has no height, enter 0. The unit is specified at the top of the screen.
Curb R/L Width:	Specify the width of the curb on the right/left side. If the curb has no width, enter 0.

A graph of the road section is displayed to the right of the data entry fields.

Click **OK** to save the information entered in the ROAD SECTION screen and return to the OFFSET STAKEOUT screen or click **Cancel** to abort.

The following information is displayed in the Offset Stakeout screen after completion of all fields:

Horizontal Angle: Horizontal angle to the point.

Horizontal Distance: Horizontal distance to the point.

Vertical Distance: Vertical distance to the point.

After you have defined the road section and completed data entry in the OFFSET STAKEOUT screen, click the **Stakeout** button to go to the STAKEOUT POINTS screen which displays the difference between the desired and measured values for the angle and distances:

Auto: Sets CMT-SURVEY to auto-tracking mode for continuous position update (only for use with instruments that have the auto-tracking function).

Measure: Takes a new measurement from your instrument.

Store: Stores a point at the current location of the rod.

Exit: Exits the STAKEOUT POINTS screen and returns to the previous frame.

Save Meas.: Saves the Stakeout measurement data and creates a point at the target.

Prev: Moves to the previous station.

Next: Moves to the next station.

Each time you take a new measurement by clicking the **Measure** button, CMT-SURVEY will update the difference between the desired and measured values for the angle and distances. To test this in the office, simply punch in some numbers close to the expected values. This process is repeated until the measurement is within tolerance. Initially, the angle and distance shown are the values computed from the previous screen.

A screen plot for the offset staking is shown in the STAKEOUT POINTS screen for easy visual reference of distance and direction needed. Any discrepancies between the measured position and the target position will be displayed above the graph. When within tolerance, these Fields will be shown in green and will indicate: “Distance OK” or “Direction OK”. If outside tolerance, the following fields will be displayed in red along with the corrective distance or direction information. The following fields are displayed:

Horizontal Angle: Horizontal angle to the point.

Horizontal Distance: Horizontal distance to the point.

Vertical Distance: Vertical distance to the point.

SHORT/LONG: Distance long or short of the desired point.

RIGHT/LEFT: Distance left or right of the desired point.

Use the displayed angle and distances to the point to aim the instrument in the direction specified and place the target at the distance specified, then click the **Measure** button.

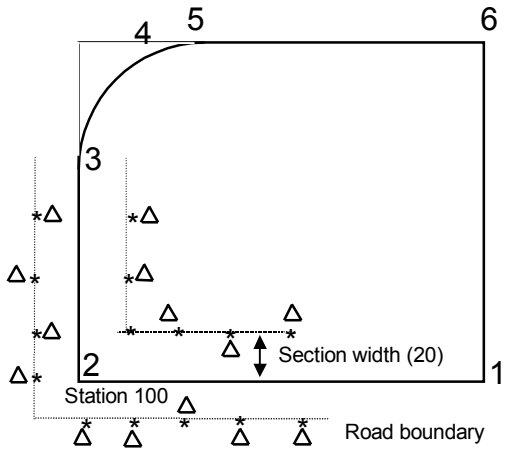
Click the **Store** button to save the current stake location when it is within tolerance, if you wish.

When the data is within tolerance, a beep will be sounded and the **Save Meas.** button will be made active. When this happens, set the stake in the ground and take another measurement. If the stake position is acceptable, click the **Save Meas.** button to record the measured data.

Click the **Next** button to advance to the next offset stakeout point and increment the station value by the interval defined in the ROAD SECTION screen.

12.10.4 Slope Stakeout

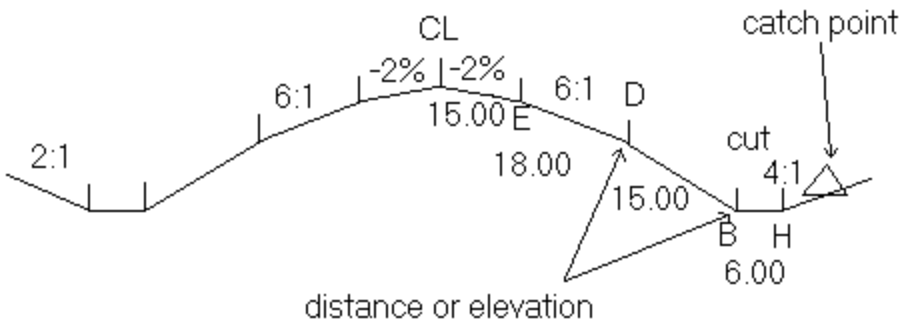
Slope staking is very similar to offset staking with the exception that the road section provides for multiple cross slopes as well as a positive or negative side slope. The following diagrams define the notation used in this section.



This diagram for slope stakeout uses the following data:

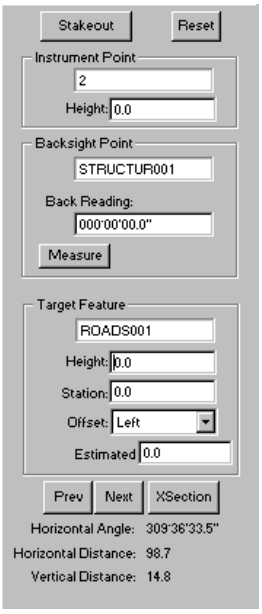
FIGURE	= 1 (L:1-3, A:4, 5-6,1)
STATION INTERVAL = 20	
SECTION WIDTH	= 15
CROSS SLOPE	= –2
DIST1	= 18
CROSS SLOPE1	= –6
DIST2	= 15
CROSS SLOPE2	= –4
DITCH WIDTH	= 6 (distance between hinge point and boundary point)
SIDE SLOPE	= 2

The "*" points are the road boundary points. The "Δ" points are the **catch points** that you want to find. Because the surface of the ground may not be at the same elevation, the catch points may not be as regular as the road boundary points. Following is a diagram of the road section for this example.



The technique for finding a **catch point** is not easy. First, this is a trial and error approach to locating the catch point. The measured data must be consistent with the road section. CMT-SURVEY will tell you the error in the current measured data with respect to the road section. This error will be helpful in locating the catch point but it is not an absolute error such as you find in the other stakeout methods. The error is dependent on the horizontal and vertical distances defining the slope from the boundary point to the catch point. These distances are measured values as well. The boundary point will be a known point after the road section is setup. Find the catch point by trying several stake points. For three-dimensional slope staking, it will be helpful if you can keep one of the variables constant. For example, try to keep the horizontal angle the same while moving the stake in or out to the required horizontal distance, then move the stake up or down to the required vertical distance.

The slope staking function allows you to define all the instrument data, the offset direction, the figure path, the current station distance, estimated cut/fill and the backsight reading. To call up the SLOPE STAKEOUT screen, select **Field Work/Stakeout/Slope Stakeout**.



Instrument Point: Specify the instrument point number (or click on the Point in the Map View).

Height (Instrument): Specify the instrument height.

Backsight Point: Specify the backsight point number (or click on the Point in the Map View).

Back Reading: Enter the backsight reading manually; or, click the **Measure** button to take a reading from the instrument.

Target Feature: Specify the figure number of the figure to be used for the offset calculations. You may also click on the Figure in the Map View to select a figure from the current job.

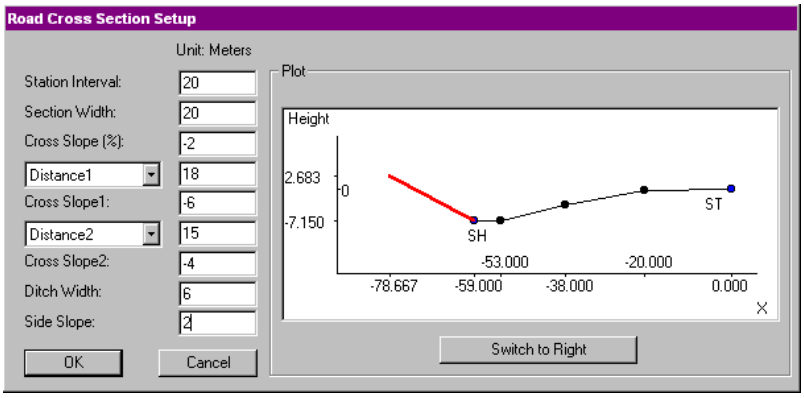
Height (Target): Specify the rod height.

Station: Specify the distance along the figure from the setup station from which the offset will be taken. When you click the **Next** button, this field will be automatically incremented by the interval you specified in the ROAD SECTION screen.

Offset: Specify the offset direction (LEFT or RIGHT). This determines whether the offset points will be to the left or to the right of the figure.

Estimated: Specify the estimated cut/fill for the catch point of the slope stakeout.

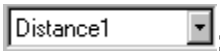
To enter the road section data, click the **XSection** button to call up the ROAD SECTION screen. The ROAD SECTION screen is used for defining the section interval as well as the cross slopes, ditch width and side slope for each side of the road. CMT-SURVEY uses this information to help you find the catch point.



Station Interval: Specify the interval distance between successive stakes.

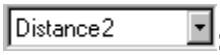
Section Width: Specify the width of the central segment of the road.

Cross Slope (%): Enter the cross slope percentage for the central segment of the road, omitting the percentage sign. This is the ratio of the height of the central segment to the section width, multiplied by 100. Enter a negative value for a downward slope.



: Use the pull-down arrow to toggle between Distance1 and Elevation1.

Cross Slope1: Specify the cross slope that, in combination with Distance1 or Elevation1, defines the next segment of the road section. Enter a negative value for a downward slope.



: Use the pull-down arrow to toggle between Distance2 and Elevation2.

Cross Slope2: Specify the cross slope that, in combination with DIST2 or ELEV2, defines the next segment of the road section. Enter a negative value for a downward slope.

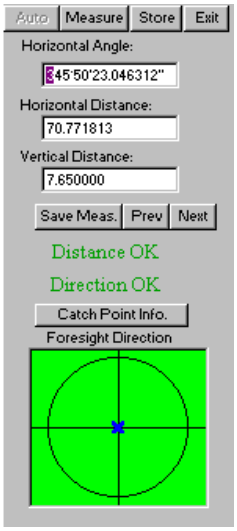
Ditch Width: Enter the ditch width.

Side Slope: Specify the side slope defined as the ratio between the horizontal distance from the boundary point to the catch point and the vertical distance from the boundary point to the catch point. (A side slope of 1 is 45 degrees.) This ratio can be positive only. The elevation computed by the measured data will decide whether the slope is positive or negative.

A graph of the road section is displayed to the right of the data entry fields for a visual reference.

Click **OK** to save the information entered in the ROAD SECTION screen and return to the SLOPE STAKEOUT screen or click **Cancel** to abort.

After you have defined the road section and completed data entry in the SLOPE STAKEOUT screen, click the **Stakeout** button to go to the STAKEOUT POINTS screen which displays the difference between the desired and measured values for the angle and distances.



Auto: Sets CMT-SURVEY to auto-tracking mode for continuous position update (only for use with instruments that have the auto-tracking function).

Measure: Takes a new measurement from your instrument.

Store: Stores a point at the current location of the rod.

Exit: Exits the STAKEOUT POINTS screen and returns to the previous frame.

Save Meas.: Saves the Stakeout measurement data and creates a point at the target.

Prev: Moves to the previous station.

Next: Moves to the next station.

Catch Point Info.: Displays the Catch Point Information screen.

Each time you take a new measurement by clicking the **Measure** button, CMT-SURVEY will update the difference between the desired and measured values for the angle and distances. To test this in the office, simply punch in some numbers close to the expected values. This process is repeated until the measurement is within tolerance. Initially, the angle and distance shown are the values computed from the previous screen:

Horizontal Angle: Horizontal angle to the point.

Horizontal Distance: Horizontal distance to the point.

Vertical Distance: Vertical distance to the point.

LONG/SHORT: Distance long or short of the desired point.

RIGHT/LEFT: Distance left or right of the desired point.

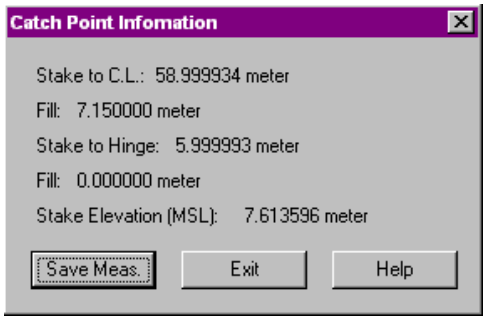
Use the displayed horizontal angle and the displayed distances to the point to aim the instrument in the direction specified and place the target at the distance specified, then click the **Measure** button.

Click the **Store** button to save the current stake location, if you wish.

A screen plot is shown at the bottom of the STAKEOUT POINTS screen for the slope staking. The solution point is marked as: .

When the data is within tolerance, a beep will be sounded and the **Save Meas.** button will be active. In addition, the **Catch Point Info** button will become active.

Click on the **Catch Point Info.** button to see information about the Catch Point:



Stake to C.L.: The horizontal distance from the centerline (figure line) to the catch point (current stake point).

Cut/Fill: The vertical distance from the curb height to the catch point.

Stake to Hinge: The horizontal distance from the hinge point to the catch point.

Stake Elevation: The elevation of the catch point.

Cut/Fill: The vertical distance from the curb height to the catch point.

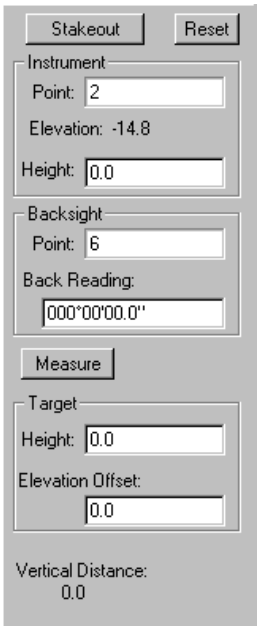
Click the **Exit** button to return to the STAKEOUT POINTS screen if the stake position is not acceptable.

If the stake position is acceptable, click **Save Meas.** to record the measured data, store the catch point coordinates and return to the STAKEOUT POINTS screen.

From the STAKEOUT POINTS screen, click **Next** to advance to the next slope stakeout point. The station value in the STATION field will be automatically incremented by the interval defined in the ROAD SECTION screen. Repeat the slope stake process until all stake points in the slope stakeout job have been staked.

12.10.5 Elevation Stakeout

Select Field Work/Stakeout/Elevation Stakeout to display the ELEVATION STAKEOUT frame. This screen allows you to locate the instrument, select an elevation offset with respect to the instrument elevation, and set the initial backsight reading to be used in the elevation stakeout procedure.



Instrument Point: Specify the instrument point number (or click on the Point in the Map View).

Height (Instrument): Specify the instrument height.

Backsight Point: Specify the backsight point number (or click on the Point in the Map View).

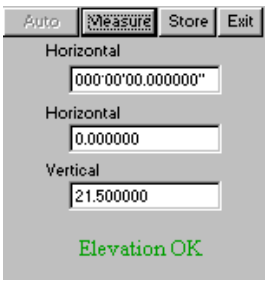
Back Reading: Enter the backsight reading manually; or, click the **Measure** button to take a reading from the instrument.

Target Height: Specify the rod height.

Target Elevation: Specify the rod elevation.

Vertical Distance: This field is automatically calculated and displayed based off of data entry in the target fields.

After you have completed data entry in the ELEVATION STAKEOUT screen, click the **Stakeout** button to go to the STAKEOUT POINTS screen.



Auto: Sets CMT-SURVEY to auto-tracking mode for continuous position update (only for use with instruments that have the auto-tracking function).

Measure: Takes a new measurement from your instrument.

Store: Stores a point at the current location of the rod.

Exit: Exits the STAKEOUT POINTS screen and returns to the previous frame.

Click the **Measure** button to get the measurements to the Foresight point. An example is shown in the above screen. Move the stake up or down until you see the message "Elevation OK". As you move the stake up or down you will see a message saying "CUT" or "FILL" along with the actual number needed to reach the target. (The stakeout tolerances are not functional for the elevation stakeout.) At this time, the stake point is lower than the instrument point by the distance specified in the **Elevation Offset** field in the ELEVATION STAKEOUT screen.

Click the **Store** button to store the stake point. Then continue with the next stake point.

12.11 Field Work Tutorial

This tutorial covers the following topics:

- Create a job named 2LOTS-2.
- Traverse a plot of land.
- Do a closed-loop traverse adjustment.
- Use COGO to divide the plot into two sections of approximately equal areas.
- Stake the division point.

Please Note: A sample file named **2LOTS.FMP** is included in your CMT-SURVEY software package. You will be entering the same data into the **2LOTS-2.FMP** job. If you do not wish to enter data at this time but just want to try the adjustment and COGO functions, then open the 2LOTS.FMP file and save it as 2LOTS-2.FMP to play with.

Set up the 2LOTS-2 Job

Use File/New to open a new Map file. Then use File/Save As to save it as 2LOTS-2.FMP.

Use **Map/Coordinate System** to select NAD 83 datum, UTM Zone 10 coordinate system and **US Survey Feet** distance unit.

Use **View/Configure/Angle and Cogo** to select Angle Unit = DMS, Azi. System = North, Anlge Dir = Right, Angle System = Azimuth, Vert. System = Zenith.

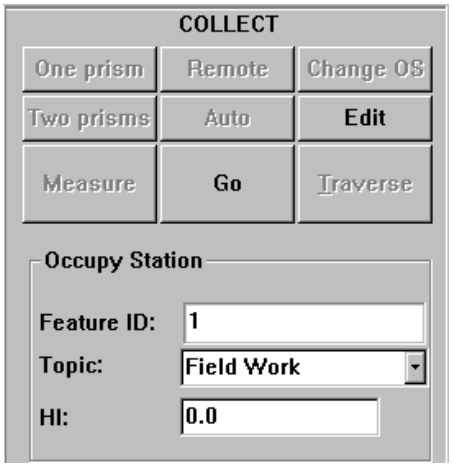
Use **View/Configure/Map** to set Number of Decimal Digits = 4.

Traverse a Plot of Land

CMT-SURVEY lets you to trigger measurements from your total station and input that data directly into the various Field Work screens. For our exercises, we will manually input the measurement data.

Step 1 Record the Occupied Station

All field work performed in CMT-SURVEY begins with OCCUPY STATION. Select **Field Work/Collect** to see the following screen:



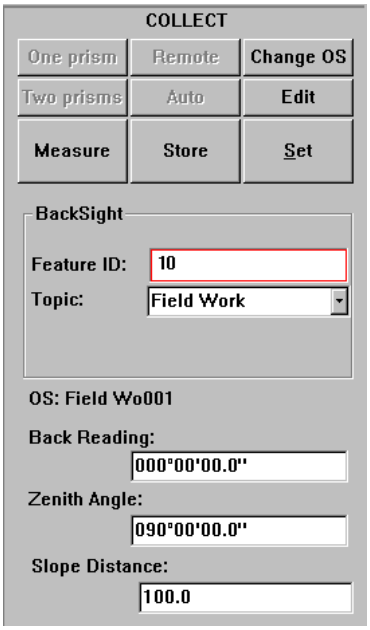
For this tutorial, we will keep the HI and HT (instrument height and target height) fields at "0.000".

Click the **Go** button to store the first OS record. Because Point 1 has not yet been created, you will be prompted to enter its coordinates. **Enter Northing = 1000** and **Easting = 501000**.

After entering data into a data field, press the **Tab** key on your keyboard to advance to the next field.

Step 2 Record the Backsight

Now, the BACKSIGHT screen is displayed. Change the Feature ID to "10".

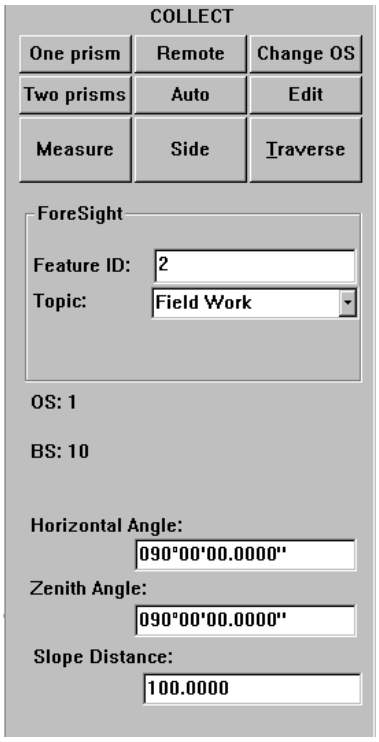


Accept "0.0000" as the Back Reading. (If you were using a total station to sight the back point, you would click the MEASR button to automatically record the back angle.

Click the **Store** button to record the backsight point. Since Point 10 has not yet been created, you will be prompted to enter its coordinates or bearing. **Enter Northing = 1000** and **Easting = 500900**.

Step 3 Record the Foresight Point

From the FORESIGHT screen, you can store a traverse record or a side-shot record. We will record a traverse point here. **Change the Feature ID to "2".**



Enter Horizontal Angle = 180 and Slope Distance = 200.

Then click on **Traverse** to store Point 2 as a traverse record and move to the next OCCUPY STATION screen.

Step 4 Repeat the Process

Notice that "2" is now the default Feature ID in the new OCCUPY STATION screen. Do not enter any data, but **click Go** to store this point as the new Occupied Station (OS). In the next BACKSIGHT screen, the Feature ID defaults to the previous OS point (Point 1). Again, do not enter any data, but **click Store** to store this point as the new BS.

In the next FORESIGHT screen, enter Horizontal Angle = 135 and Slope Distance = 300. Then click **Traverse** to store Point 3 as a traverse record and move to the next OCCUPY STATION screen.

Use the same procedure to complete the remaining traverse legs. The values to be entered are listed below. The last record is a side-shot.

Please make sure to change the Feature ID as necessary to agree with the following data set.

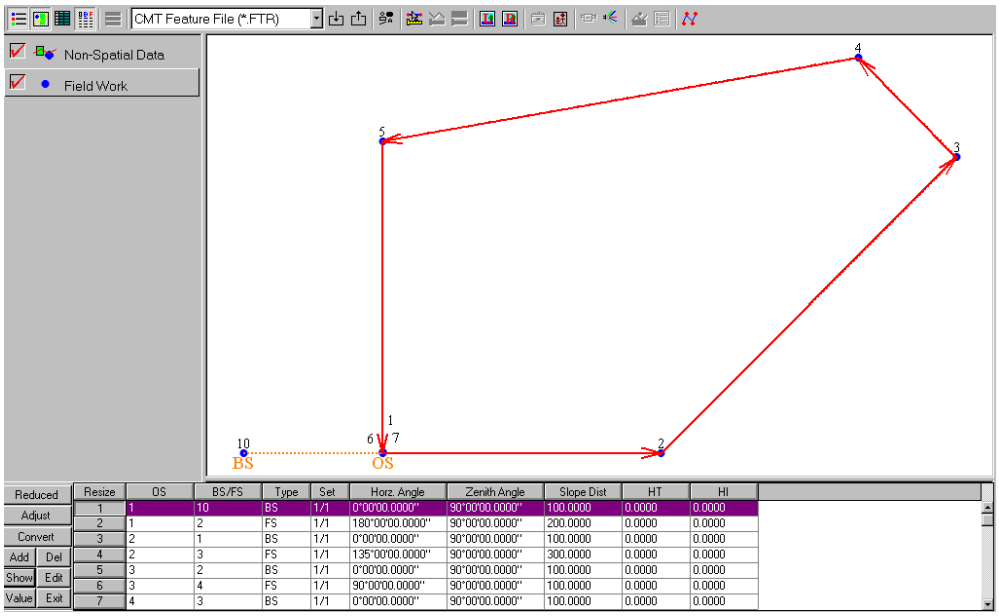
SCREEN	PT	HEIGHT	HORZ. ANGLE	ZENITH ANGLE	DISTANCE	BUTTON
OCC. STA.	3	0.00				GO
BACKSIGHT	2	0.00	0°			STORE
FORESIGHT	4	0.00	90°00'00"	90°	100.0000	**TRAVERSE**
OCC. STA.	4	0.00				GO
BACKSIGHT	3	0.00	0°			STORE

FORESIGHT	5	0.00	125°03'00"	90°	346.7500	**TRAVERSE**
OCC. STA.	5	0.00				GO
BACKSIGHT	4	0.00	0°			STORE
FORESIGHT	1	0.00	99°56'30"	90°	222.7500	**TRAVERSE**
OCC. STA.	1	0.00				GO
BACKSIGHT	5	0.00	0°			STORE
FORESIGHT	10	0.00	270°00'00"	90°	0.0000	SIDE

When finished with the data entry, click on the  icon to close the data input panel.

Viewing Measurement Data

Select the **View/Measurement** function to display the measurement data records. Click the Reduced button to see the reduced data. Click the **Show** button and turn on the display of traverse and side-shot paths. You should see a graph of the 2LOTS-2 job as shown in the following screen:



To obtain a text report of the coordinates in your 2LOTS-2 job, select **File/Print** then select **Coordinate**. Select **Fielddata** to view or print out the measurement data.

Adjusting the Traverse

Our 2LOTS-2 job contains minor measurement errors that may be minimized by performing an adjustment. To perform an adjustment to this job, select **Field Work/Adjust.**

Accept the displayed start and end points for the closed loop traverse.

Enter Angle Tolerance = 5 min and Distance Tolerance = 0.3 survey ft.

The Error Summary section displays the calculated errors.

Click on **ADJUST**.

As the errors are within the specified angle and distance tolerances, the traverse will be balanced without question.

Using COGO

We will now cut the land into two lots.

First, select Map/Add Feature by Point List and then select Add Area.

Enter "1-5" as the definition of the Area Feature of interest. This specifies the area enclosed by a line going from Point 1 to Point 5.

Now, use the Measure Area icon to see the area of the plot of land.

We wish to cut the area into two pieces, using Point 2 as a hinge for the division line. The piece on the west side is to be exactly 0.9 acre in size.

Select **Cogo/Hinge cut Area**.

Select the Area Feature you created above as the target area.

Select **Acres** as the area unit.

Enter Area = 0.9. **Enter "2" as the Hinge Node.**

For Include Point in List, select **Previous**.

Click on the **SOLVE** button.

Click the **STORE** button to store the solution. Enter 6. This means to use 6 as the ID of the division line, 7 as the beginning point ID and 8 as the ending point ID of the division line.

Click on the  icon to close the data input panel.

Point Stakeout

We can use the Point Stakeout function to help us put a stake on the ground at the hinge point **(Point ID = 8)** we found in the above COGO procedure.

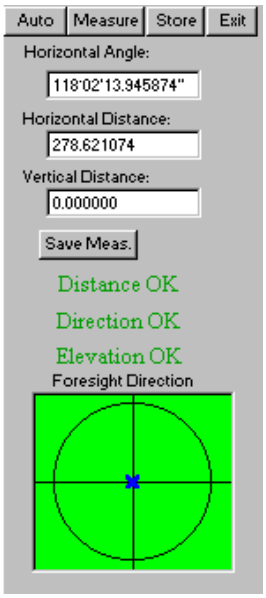
Select **Field Work/Stakeout Setup.**

Enter Angle Tolerance = 5 min, Distance Tolerance = 0.3 survey ft, Elevation = YES.

Select **Field Work/Stakeout/Point Stakeout.**

Enter Instrument Point = 1, Backsight Point = 10 and Target Point = 8. (You may use the mouse to select the points for these data fields.)

The horizontal angle and the distance from the instrument point to the target point are displayed. Click the **Stakeout** button to see the following screen:



Now, change the displayed Horizontal Angle to 117 degrees and the Horizontal Distance to 280 survey ft. CMT-SURVEY tells you that you are about 1.3 ft long and about 5 ft too far to the left. You will also see the current rod location in Map View.

For an actual job, you would try to move the rod closer to the target and click the **Measure** button to get new measurement data. When the data is within tolerance of the target location, the diagram showing the rod location relative to the target will be colored green.

For our exercise, change the Horizontal Angle to 118 degrees and the Horizontal Distance to 278.5 survey ft so we are within the specified tolerance.

This is where you would put in the stake. If you wish to store the stake point into the job, click **Measure** again then click the **Store** button.

Click on the  icon to close the data input panel.

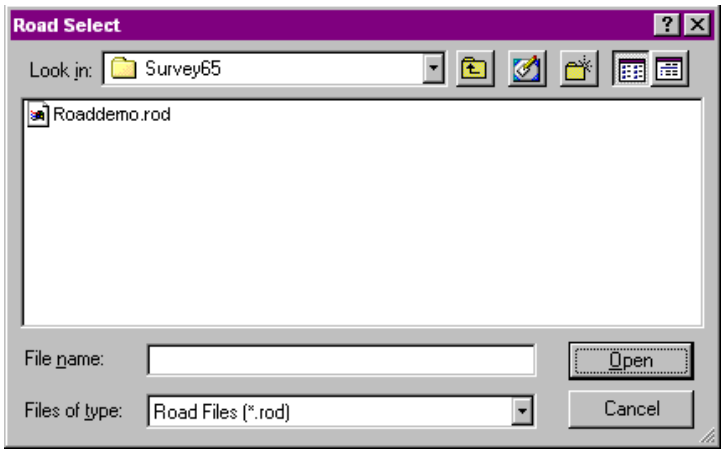
Section 13 - Road Design

The Road menu provides several options for defining and staking out a Road. This information can then be added to your jobs, or downloaded to your hand-held computer for field stakeout.

When you select Road from the Main Toolbar, the following options are provided: **New/Open**, Property, **Layout** and **Save**.

13.1 Creating or Selecting a Road File

The **Road/New/Open** option allows you to create a new Road file, or select an existing one. When you select Road/New/Open, the following dialog box is displayed:



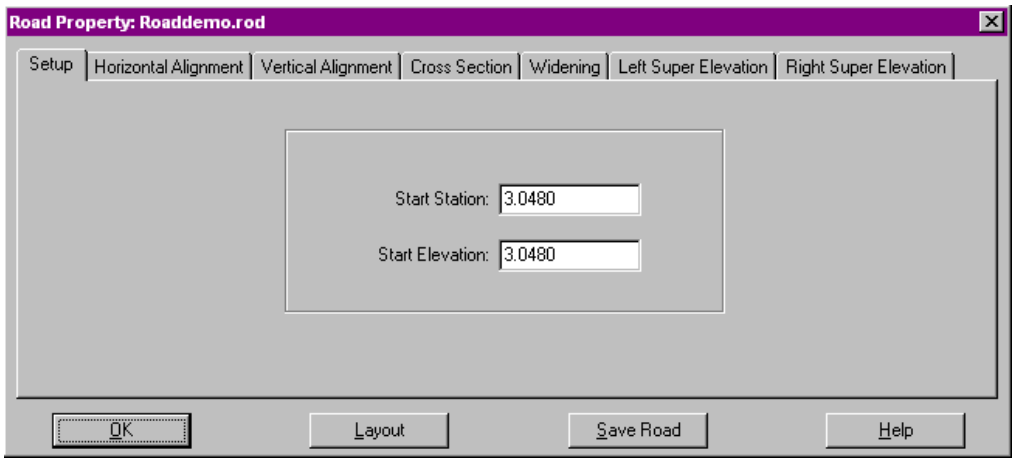
If you wish to use an existing road file simply double-click on the file or select the file and click the Open button it to activate it.

To create a new road file:

1. Select the New/Open option under the Road Menu.
2. Enter a new name in the File Name field.
3. Click the Open button to create the road. Once a Road has been created or selected, the Road Property dialog box will be displayed.
4. Use the Road Property dialog to specify the properties of the road, such as horizontal alignment, vertical alignment, etc. You can define new left and right templates or use existing templates to specify the cross-section for the road.
5. Use the Road Layout dialog box to place the road onto the map at the specified location.

13.2 Road Properties

After you have created or selected a Road file, you will want to assign properties to the Road. When you select **Road/Property**, the Road Property dialog box will be displayed:



The Road Property dialog box contains several pages for entering Road property information. These pages are described in the following sections.

13.2.1 Road Setup

The Setup page of the Road Property allows you to designate a starting station and starting elevation for your Road. All of the Road Property information that you supply will begin at this station number and elevation.

OK: Save the current settings of the active road file and returns to the Map View.

Layout: Display the layout dialog box. This function will allow you to place your road in the current job file.

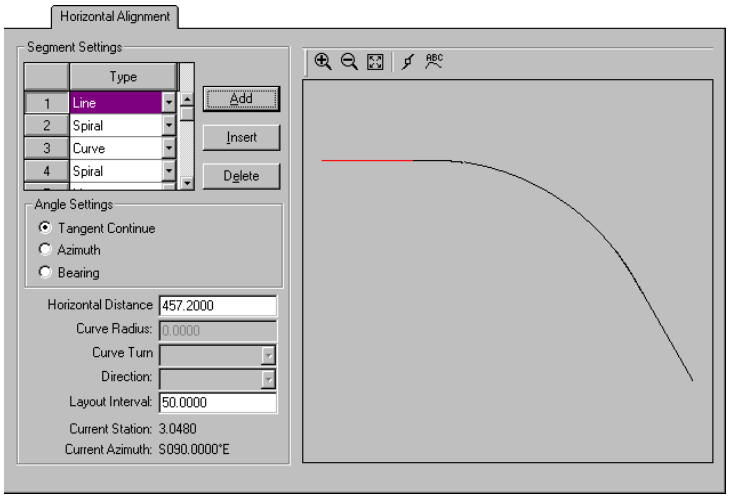
Save Road: Save the settings for the current road file to a new filename.

13.2.2 Horizontal Alignment

Horizontal Alignment is used to describe how the Road is laid out in the horizontal plane.

You will use the Horizontal Alignment page to define each change in direction for your Road, and also to define how far your Road will travel in the specified direction.

When you select the Horizontal alignment option in the Road Property dialog box, the following page is displayed:



Add: Appends a new segment record to this page.

Insert: Inserts a new segment record above the current record.

Delete: Deletes the segment current record from the page or dialog box.

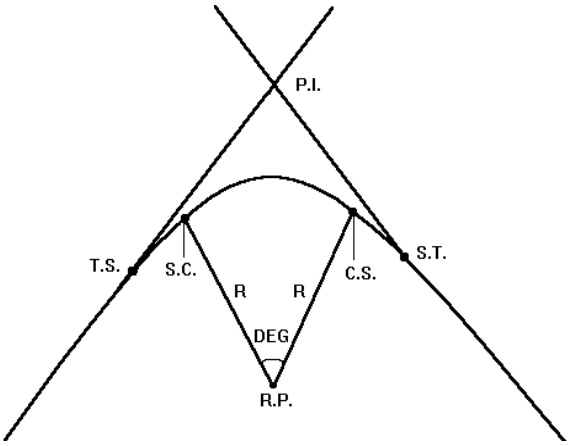
Type: Select the segment type from Line, Curve or Spiral. For line types, only horizontal distance and layout interval may be entered to define the line. Curves allow entry for all fields except direction. Spirals must use all fields to define the spiral.

Horizontal Distance /Spiral Length /Curve Length: Enter the length of the current segment. The current segment is highlighted in red in the graphical display window.

Curve Radius: Enter the radius of the curve or spiral.

Curve/Spiral Turn: Enter the direction of turn for the curve or spiral.

Direction (Spirals only): Specify the direction of the spiral from CS → ST or from ST → CS. See diagram below for more information about the different components of a spiral curve.



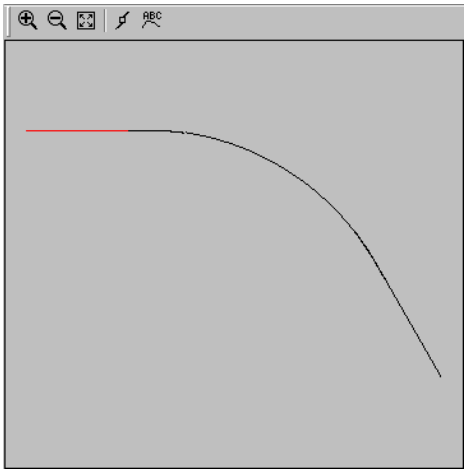
PI: Point of intersection

RP: Radius point

TS:	"Tangent to spiral curve" intersection point
SC:	"Spiral to circular curve" intersection point
CS:	"Circular to spiral curve" intersection point
ST:	"Spiral curve to tangent" intersection point
R:	Radius of the circular curve
DEG:	Angle subtended by the circular portion of the spiral curve, in degrees
DELTA:	Supplement of the angle between the incoming and outgoing tangents (equal to the central angle subtended by the entire spiral curve)
Layout Interval:	Specify the interval between the stakeout station locations.
Current Station:	The Current Station field displays the station number where the current segment of the road alignment will begin.
Current Azimuth:	The Current Azimuth field displays the azimuth at the point where the current segment begins.

You may use as many records as necessary to define the Horizontal Alignment of the Road.

The Horizontal Alignment dialog also provides a graphical display of the Horizontal Alignment of your Road, based on the data entered.



: Zooms in on the plot

: Zooms out on the plot

: Scales the plot to fit inside the window

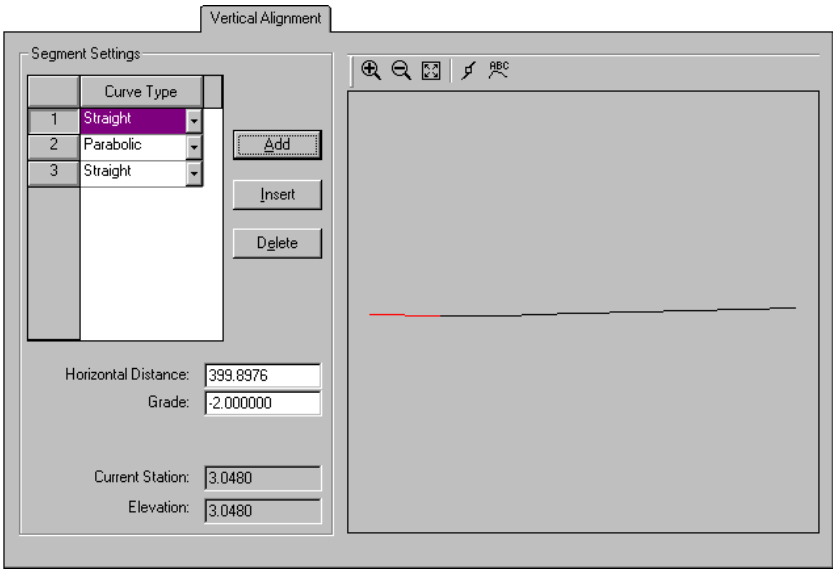
: Shows the location of the segments along the Road.

: Labels each segment of the road with the record number.

13.2.3 Vertical Alignment

The Vertical Alignment is used to describe how the elevation of the Road changes, through the use of straight grade or parabolic vertical curves. You will define where changes in grade occur, and how long the grade is maintained.

When you select the Vertical alignment option in the Road Property dialog box, the following page is displayed:



Add: Appends a new segment record to this page.

Insert: Inserts a new segment record above the current record.

Delete: Deletes the current segment record from the page or dialog box.

Curve Type: Select from Straight or Parabolic to define the current segment type. The current segment is highlighted in red in the graphical display window.

Horizontal Distance: Enter the Horizontal Length of the Grade or Parabolic Curve.

Grade: Enter the grade of the segment in percent slope. For Parabolic segments a beginning and ending grade will need to be entered.

Current Station: The Current Station field displays the station number where the current segment of the road alignment will begin.

Elevation: The Elevation field displays the elevation at the start of the current grade or vertical curve.

You may use as many records as necessary to define the Vertical Alignment of the Road.

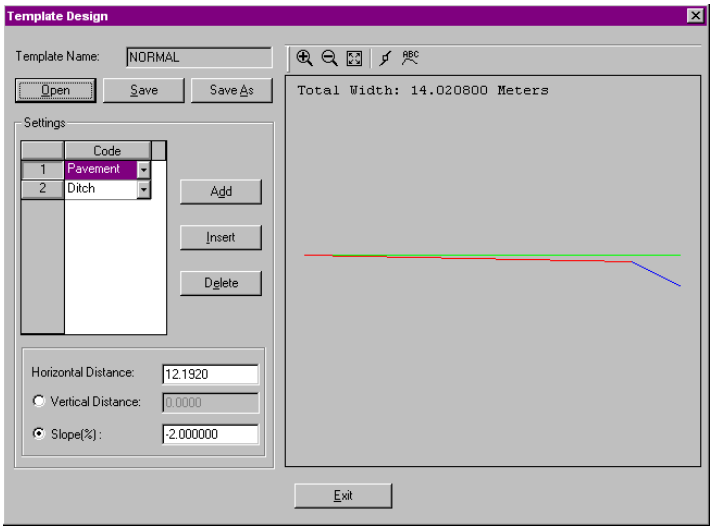
13.2.4 Cross Section

Once you have defined your Vertical and Horizontal Alignments, you are ready to create a Cross Section of your Road. You will need to assign the Templates to be used for specific station ranges of your Road. When you first enter the Cross Section option from the Road Property dialog, you will want to click on the **Template Design** button to define cross section templates. The creation of templates increases productivity in Road Design by reducing the number of repetitive steps to define your cross section.

A Template is used to describe a cross-section of a specified segment of the Road, given that the centerline of the Road has been established using the Horizontal and Vertical Alignments described above. Each Template describes segments of the Road that extend perpendicular to the centerline of the Road.

The Templates describe the Road width, curbing, sidewalks, ditches, etc., as well as the grading of the Road from the centerline out. Each Template describes one side of the Road between two specified stations.

When you click on the **Template Design** button from the Cross Section dialog, the following page will be displayed:



Open: Opens a template.

Save: Saves the current template under the current template name.

Save As: Saves the current template under a different name.

Add: Appends a new code record to this page.

Insert: Inserts a new code record above the current record.

Delete: Deletes the current code record from the page or dialog box.

Template Name: Display the name of the Template currently being used.

Open: Open an existing Template to view or modify.

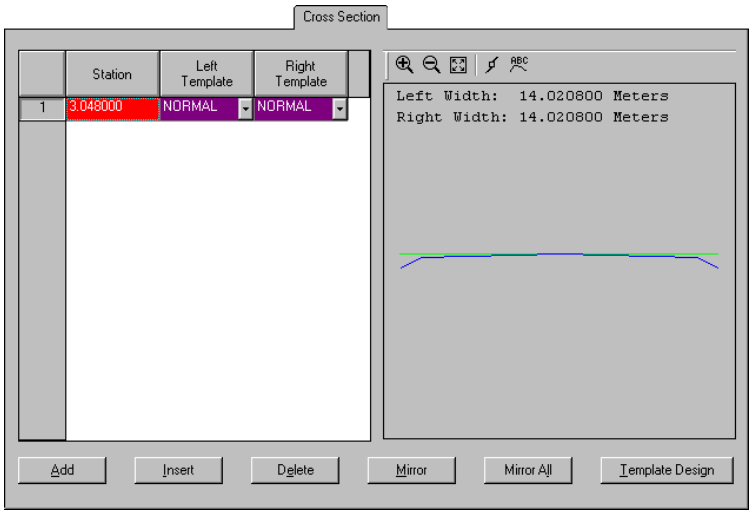
Code: This field is for a descriptive code of the Template segment. CMT-SURVEY provides some default codes (Pavement, Curb, Sidewalk, Ditch), or you may type in your own.

Horizontal Distance: Enter the Horizontal distance of the segment. The first segment in the Template starts at the centerline of the Road. Subsequent segments start at the end of the previous segment.

Vertical Distance: Enter the Vertical Distance of the segment. A positive value indicates a gradient above the centerline. Conversely, a negative value will indicate a downward gradient. As an alternative, you can enter the Slope as a percentage.

You may add as many segments (code records) as necessary to define the Template of the Road.

After definition of the templates, you are ready to design your Road Cross Section. Click on the **EXIT** button at the bottom of the page to exit and return to the Cross Section dialog. The following page will be displayed:



Add: Appends a new record to this page.

Insert: Inserts a new record above the current record.

Delete: Deletes the current record from the page or dialog box.

Mirror: Assigns the entered template to the blank template field in the same record.

Mirror All: Assigns the entered template to the blank template field for every cross section record.

Template Design: displays the select dialog box, which allows you to select a template from all existing templates.

Station:	Enter the Station number where the specified Template will be applied to the Road.
Left Template:	Specify which Template will be applied to the left side of the Road at the specified Station number.
Right Template:	Specify which Template will be applied to the right side of the Road at the specified Station number.

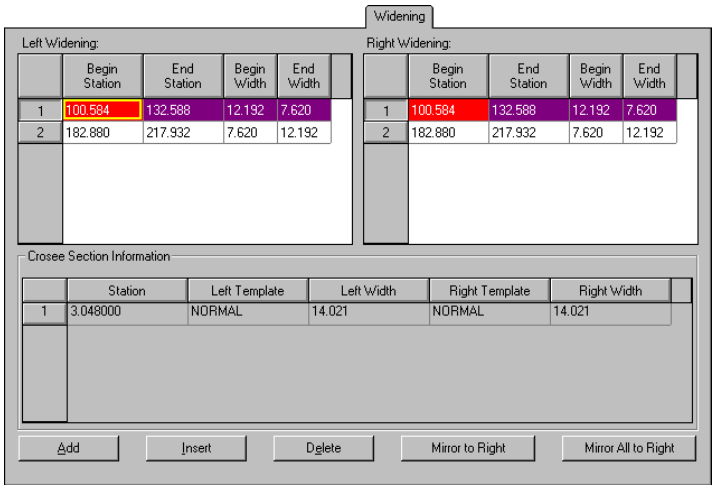
Use the Add, Insert and Delete buttons to create and remove records. Click on a pull down button to view a list of the available Templates from which you can make a selection. Click the **Mirror** button to apply the same Template to both sides of the Road for the current segment, or click the **Mirror All** button to apply the same Template to both sides of the Road over the entire course of the Road.

You may use as many records as necessary to define the Cross Section of the road.

13.2.5 Widening

Widening is used to temporarily modify the width of the inner-most segment of your cross-section. You can also do this with a new Template, but the Widening function provides for a smooth transition and requires less work. You can define separate Widenings for the left and right side of your Road.

When you select the Widening option from the Road Property dialog box, the following page is displayed:



Add: Appends a new record to this page.

Insert: Inserts a new record above the current record.

Delete: Deletes the current record from the page or dialog box.

Mirror to Right: Copies the current record in the left super elevation or widening page, to the right super elevation or widening page, or vice versa.

Mirror All to Right: Assigns the entered template to the blank template field for every cross section record.

Begin Station: Enter the station where the Widening will begin to be applied. You can see the station number in the Horizontal Alignment page.

End Station: Enter the station where the Widening will be completed.

Begin Width: Enter the width of the innermost segment of the Template at the Begin Station.

End Width: Enter the width of the innermost segment of the Template at the End Station.

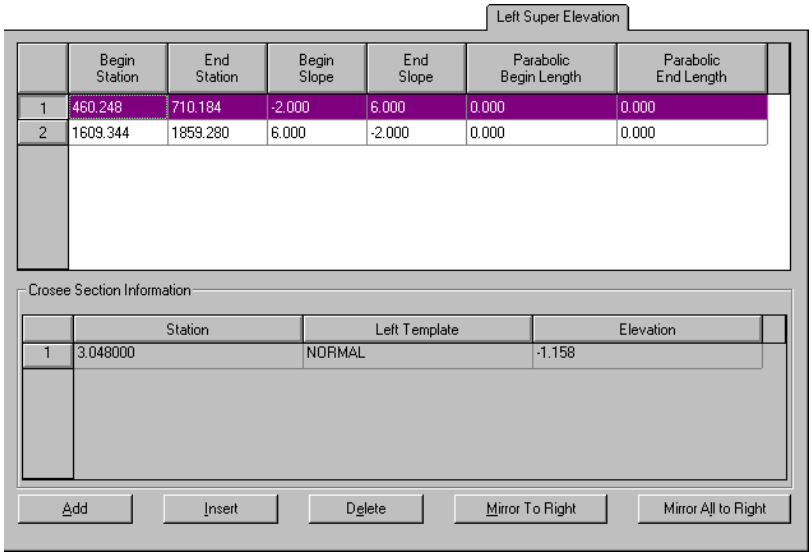
You may use as many records as necessary to define the Widening of the Road. Click the **Mirror to Right** button to apply the current width to the right side of the Road as well. Click the **Mirror All** button to apply all of the widths to the right side of the Road as well.

Please note: You must create a second Widening record which returns the Template to its original width, or the changes created by the Widening will carry through until a new Template is assigned to the Road.

13.2.6 Super Elevations

Super Elevations are used to temporarily change the grading of the center segment of the cross-section. Super Elevations are typically used to create banking in your Roads as they enter and leave curves. You will apply different Super Elevations to the left and right sides of the Road, so there are two pages available.

When you select the Left Super Elevation or Right Super Elevation option from the Road Property dialog box, the following page will be displayed:



Add: Appends a new record to this page.

Insert: Inserts a new record above the current record.

Delete: Deletes the current record from the page or dialog box.

Mirror to Right: Copies the current record in the left super elevation or widening page, to the right super elevation or widening page, or vice versa.

Mirror All to Right: Assigns the entered template to the blank template field for every cross section record.

Begin Station: Enter the station where the Super Elevation begins.

End Station: Enter the station where the Super Elevation ends.

Begin Slope: Enter the slope, in percent, at the beginning station.

End Slope: Enter the slope, in percent, at the ending station.

Parabolic Begin Length: If you will use parabolic transitions, enter the length of the parabola that smoothes the transition from the Begin Slope to the End Slope.

Parabolic End Length: If you will use parabolic transitions, enter the length of the parabola that smoothes the transition from the End Slope to the Begin Slope.

You may use as many records as necessary to define the Super Elevation of the road. Use the Add, Insert and Delete buttons to create and remove records. Click the **Mirror to Right** button to apply the current super elevation segment to the right side of the Road as well. Click the **Mirror All** button to apply all of the super elevation segments to the right side of the Road as well.

Please note: If you are not using a parabolic transition, you must create a second Super Elevation record to bring your grading back to that of the original Template.

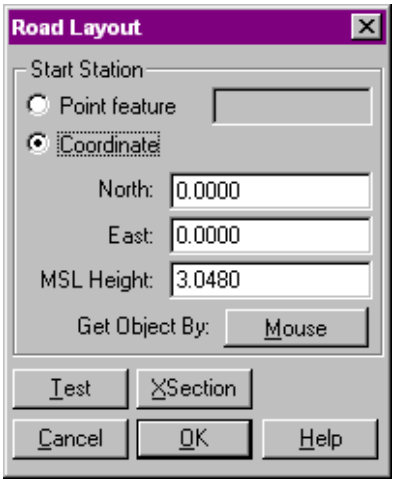
The functions of the Layout and Save Road buttons are detailed in Section 13.3 and 13.4.

13.3 Road/Layout

The Road Layout dialog box is used to assign the current Road file to a specific location in your current Map. After specifying the location for the road, click the Test button to see how the road

looks on your map. Click OK only if the road is exactly where you want it to be. When you click OK, the road and all the stakeout points will be added to your map.

When you select the Road/Layout menu option, or click the Layout button from the Road Property dialog box, the following Road Layout dialog box is displayed:



Mouse: Click on a coordinate location in the current job which will serve as the starting point for the centerline of your road.

Test: Lets you see how the road will be placed in the current job.

XSection: Displays the XSection dialog box. In this dialog box, you will see a profile of your road as you move from station to station.

Cancel: Cancels the Layout function and returns to the Map View or the Road Property dialog box.

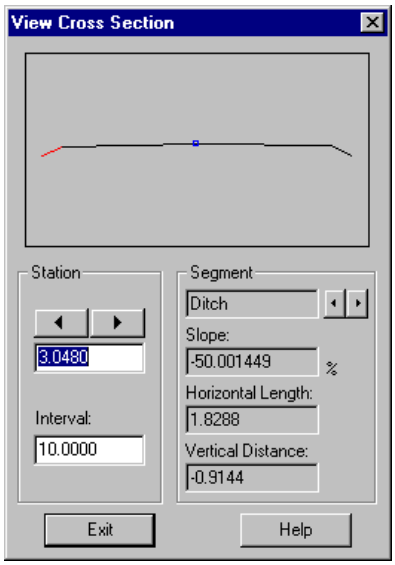
OK: Click the OK button only after you have used the "Test" Button to check the layout and determined that it is satisfactory.

Define the placement of the start of the Road centerline within your Job by Point Feature or by Coordinate.

Point Feature:	If you select the Point Feature method, enter the Point Number of the Point Feature in this field.
North, East, MSL Height:	If you select the Coordinate method, enter the starting coordinates in the appropriate fields.
Layout Interval:	Enter the interval at which you would like to determine coordinates along the Road for the purpose of creating a Line Feature of each Road segment, and for staking out the Road.

Click on the **Test** button to place the Road in your Job. If the position of the Road is correct, click the OK button.

Click on the **XSection** button to see a graph of the cross section of the Road.



Interval: Specify the interval at which you would like to move along the Road as you view it in the View XSection dialog box.

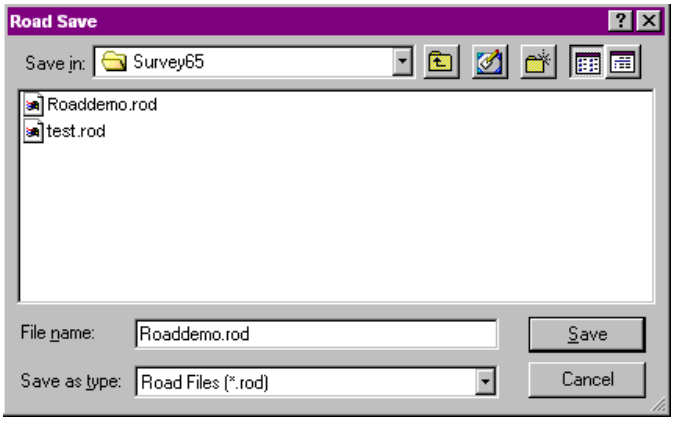
Station: This field displays the station number of the station that is currently being displayed.

Segment: Use the fields in this box to select a specific segment of the Road (highlighted in RED in the display) and the Horizontal Length, Slope and Vertical Distance for that segment will be displayed.

For example, click the right arrow until the center left segment is highlighted. The horizontal length, slope and vertical distance of the segment will be displayed.

13.4 Road/Save

The Road/Save menu option is used to save the configuration of the active Road file. When you select Road/Save, or click on the Save Road button in the Road Property dialog box, the Save Road dialog box below is displayed:



The Road Save dialog box operates like a standard Windows Save As dialog box. Enter the name of the Road to be saved and click the OK button to save it. If the Road already exists, you will be asked if you would like to overwrite the existing Road file.

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