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Chapter 17: Horizontal and Vertical Design

Introduction

Since there are many different, and acceptable, methods of creating horizontal and vertical geometry using GEOPAK, this chapter will not dictate the exact methods to use. Instead we will describe the different methods that can be used and provide a workflow for a macro that will check the horizontal alignment design for kinks, once completed. This chapter will be in three sections: Horizontal Design, Vertical Design, and Macros.

Horizontal Design

There are four methods of setting a horizontal alignment: Coordinate Geometry (COGO), Graphical COGO, Horizontal Alignment Generator, and Store Graphics. Any of these methods are acceptable to CFLHD. Each one of these methods has their advantages and disadvantages, although graphical COGO and the horizontal alignment generator are so similar that we will address these tools together. This chapter will describe each of the above listed methods and indicate their advantages and disadvantages. **Regardless of the method used, the final alignment must be drawn into MicroStation using the GEOPAK D&C Manager, with the CFLHD .ddb file.** This will assure that the elements are drawn with the correct symbology, matching the CFLHD standards.

Coordinate Geometry

Coordinate Geometry can be accessed using Project Manager by selecting the Coordinate Geometry button.

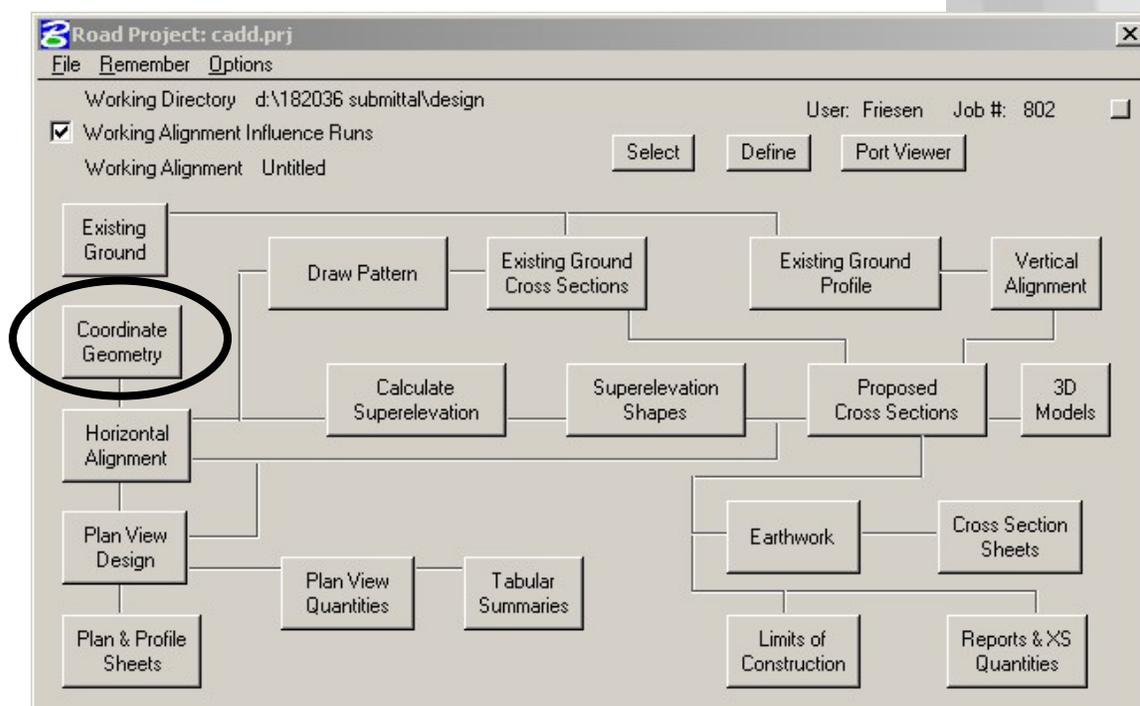




Figure 17-1: Accessing COGO Through Project Manager

You can also select the Coordinate Geometry button on the GEOPAK main dialog box.



Figure 17-2: Accessing COGO Through Road Tools Icon

Either method will bring up the following Coordinate Geometry start up dialog box:

Figure 17-3: COGO Settings

If you are using Project Manager, the appropriate information should already be in the correct fields. Otherwise, the Job Number and Operator code will have to be entered. Project Name and Subject are optional fields. Press the OK button to bring up the Coordinate Geometry window.

You can create the horizontal geometry by typing commands in at the COGO command line, by creating an input file with a sequence of COGO commands and loading it into COGO, or by using the dialog box driven Store Curve From Tangents, Locate Traverse, etc., tools that are accessed from the COGO pull down menus to generate the commands. If you use the input file method, remember that the COGO input file name can only be 8 characters long, must have the job number as the last three digits in the name, and the extension has to have an "i"+ the operator code. (i.e. XXXXX470.ijb), where the i stands for input file.

Advantages.



- This method allows the user to have more precise control over tangent bearings, control point coordinates, etc., than with Store Graphics, if done properly.
- The user can set visualization on to view progress of design.

Disadvantages.

- Commands for the command line and input file methods are difficult to memorize
- Small adjustments are hard to make
- Process is time consuming

Uses.

- Reviewing both horizontal and vertical alignments
- Creating output of alignments for printing
- Tweaking alignments that were created using store graphics, or any of the other methods.
- Storing as-built centerline chain and profiles, especially those for which there are only hard copy paper plans.

Graphical COGO / Horizontal Alignment Generator Overview

Graphical COGO and the Horizontal Alignment Generator, allow the user to create coordinate geometry elements, much the same as the original COGO tools, but with a much more graphic and user-friendly process. Graphical COGO and the Horizontal Alignment Generator can be accessed by selecting:

**Applications>GEOPAK ROAD>Geometry>Graphical
Coordinate Geometry, or**

**Applications>GEOPAK ROAD>Geometry>Layout
Horizontal Alignments**

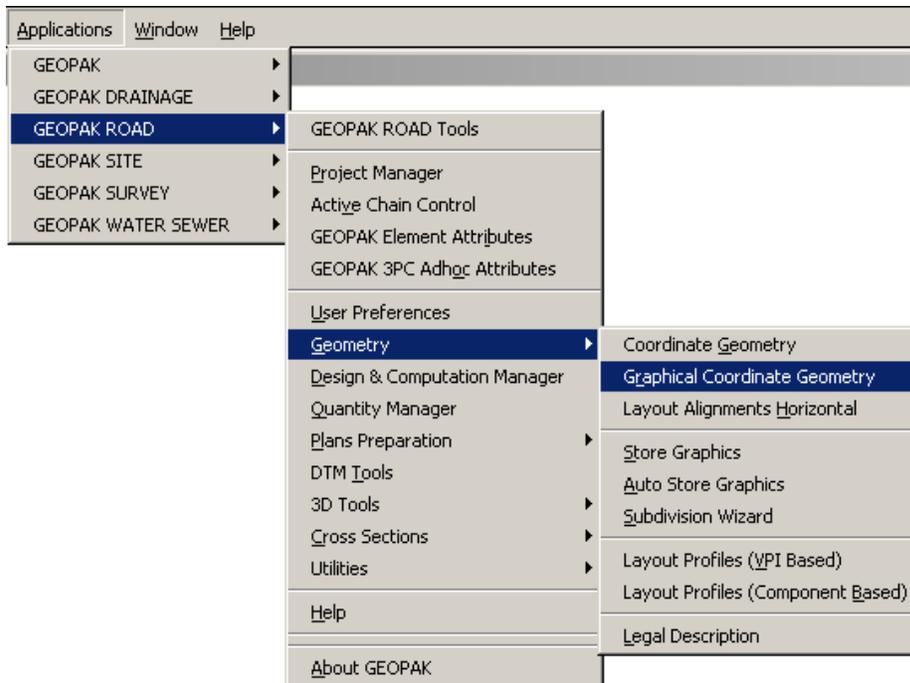


Figure 17-4: Accessing Horizontal Alignment Generator and Graphical COGO

Or by selecting the icons from the main GEOPAK Road tool box.

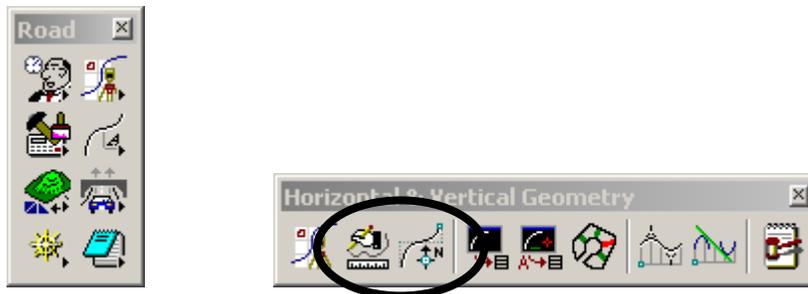


Figure 17-5: Horizontal Alignment Generator and Graphical COGO Icons

When using either of these tools, the original COGO window must be active. If the COGO window is not active when the tool is selected the following dialog box is displayed.



Figure 17-6: COGO Alert



Selecting **Yes**, will then activate the desired tool.

The Horizontal Alignment Generator can also be accessed using Project Manager by clicking on the Horizontal Alignment button on the flow chart and selecting Graphical Element Based geometry. Graphical COGO cannot be accessed directly from Project Manager

Graphical COGO

The Graphical COGO tool frame, shown below contains tools for creating COGO elements such as lines, points, curves, modifying COGO elements, manipulating elements, and grouping elements.



Figure 17-7: Graphical COGO Tool Frame

From the main Graphical COGO tool frame, shown above, additional tools may be accessed from each of the four main tool boxes.

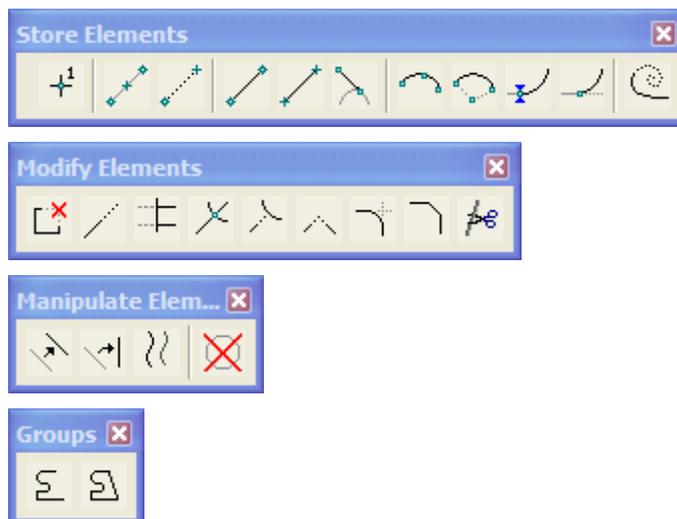


Figure 17-8: Graphical COGO Tools



The Graphical COGO tools shown above, and those in the Horizontal Alignment Generator, look and act the same as many MicroStation tools. However, these tools are not relying on the accuracy of MicroStation graphics, but rather the much more accurate GEOPAK coordinate geometry engine.

Horizontal Alignment Generator

When selecting the Horizontal Alignment Generator the first time, the following dialog box is displayed.

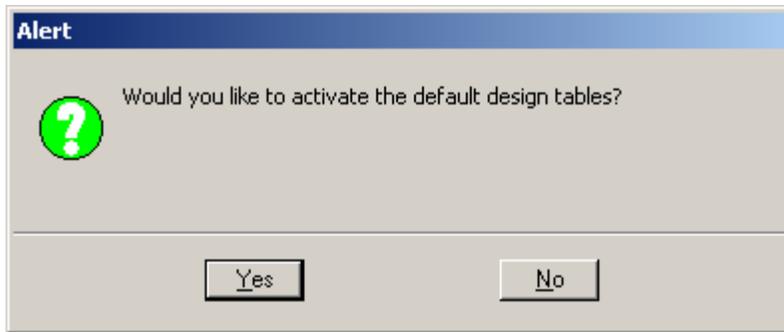


Figure 17-9: Horizontal Alignment Generator Startup Options

If No is clicked, the dialog closes and no dialogs open. Once Yes is selected, the following dialog box is displayed.

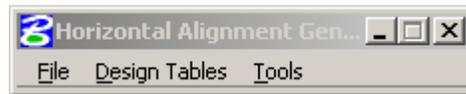


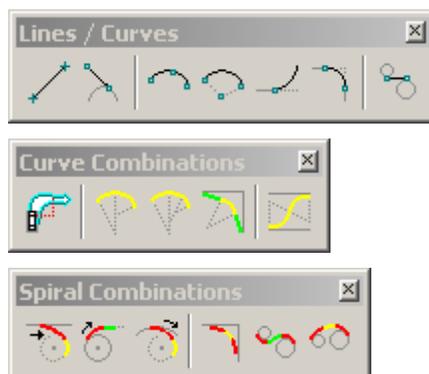
Figure 17-10: Horizontal Alignment Generator Menu

The file pull-down menu allows the user to set preferences for how newly created elements will be displayed, how to name elements, and which geometry tables to use as a default. The Design Tables menu allows the user to view the settings for the current default design tables. The tools menu activates the COGO tools that will be used to create geometry elements. Selecting **Tools>Main** accesses the following tool frame.



Figure 17-11: Horizontal Alignment Generator Tool Frame

From the main tool frame, shown above, additional tools may be accessed from each of the six main tool box icons.



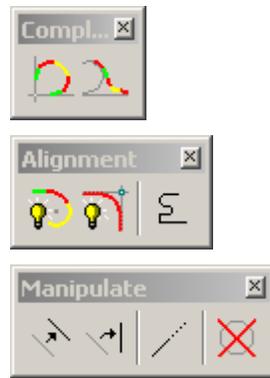


Figure 17-12: Horizontal Alignment Generator Tools

Each of the tool boxes shown above, as well as the tools from Graphical COGO, may be used together to create any combination of geometry, from the simplest to the most complex.

Advantages

- Using these tools to set a horizontal alignment, if done properly, is just as accurate as traditional command line COGO.
- The user does not have to remember syntax of COGO commands.

Disadvantages

- The Graphical COGO and Horizontal Alignment Generator tools can be complicated.
- the process is slower than using store graphics, as detailed below.

Uses

- When the geometry is known, as the input of As-Built alignments.
- When the user wants to give exact bearings and distances.

Store Graphics

The store Graphics procedure is the simplest and quickest method to create a horizontal alignment. The user can use standard MicroStation draw utilities to layout the alignment then use the Store Graphics tool to store the alignment into COGO. In one sense, the Store Graphics is the “least accurate” of the methods that can be used to create horizontal alignments because it relies on the limited precision of the MicroStation elements to determine the geometry of the alignment.



Store Graphics will make slight adjustments to the graphical element locations as required to force each element in the chain to be exactly tangent to the immediately preceding element and the immediately following element. These adjustments are always minor (e.g. the coordinates of a curve's PC and/or PT may be adjusted a few millimeters to force the curve to match the tangents exactly) but they do occur and the user has no control over them. So in this sense, Store Graphics is "less accurate" than the other methods. However, if the graphical elements were drawn correctly then the chain that gets stored into the gpk file is exactly as "accurate" as a chain stored using any of the other methods.

This command cannot be accessed using Project Manager, but can be accessed the following two ways. From the GEOPAK pull down menus select, **Applications>GEOPAK ROAD>Geometry>Store Graphics**, or select using the icon shown below.



Figure 17-13: Store Graphics Icon

Advantages

- Use simple MicroStation commands to layout alignment, adjustments to alignment are quick, and, the only point numbers used are on the alignment (usually just the first and last).

Disadvantages

- Not as accurate as COGO. Store Graphics makes minor adjustments to the as-drawn elements in order to get them to tie together mathematically.
- Cannot draw spirals using MicroStation commands. If spirals are needed, you must use Horizontal Alignment Generator to create that element, then you may continue using MicroStation commands.

Uses

- For long alignments with many elements.



Vertical Design

There are two tools used to set proposed vertical alignments, and both are acceptable to CFLHD. The VPI based Vertical Alignment Generator has been used by engineers and designers since the early days of GEOPAK. This tool, although having been around for years, is still a user-friendly, accurate method for creating and storing vertical alignments. The second method is the Component Based Vertical Alignment Generator. This tool is much newer than the VPI based tool, and has yet to be fully utilized by most GEOPAK users. Both these methods are just as accurate and depending on your preference, as easy to use. Regardless of the method you use for creating proposed vertical alignments, there is only one process for creating the existing ground profile.

CFLHD's preferred method for cutting existing ground profiles is Intersection mode.

After completion of the existing and proposed profiles, they must be drawn into MicroStation using the GEOPAK D&C Manager, with the CFLHD **.ddb** file. This will assure that they will be placed with the correct symbology.

Draw Profile Tool - GEOPAK 2004

New to GEOPAK 2004 is a streamlined way to create existing ground profiles, and plot both existing and proposed profiles. The Draw Profiles tool is not available through project manager, but can be accessed by selecting **Applications>GEOPAK ROAD>Plans Preparation>Draw Profiles**, as shown below.

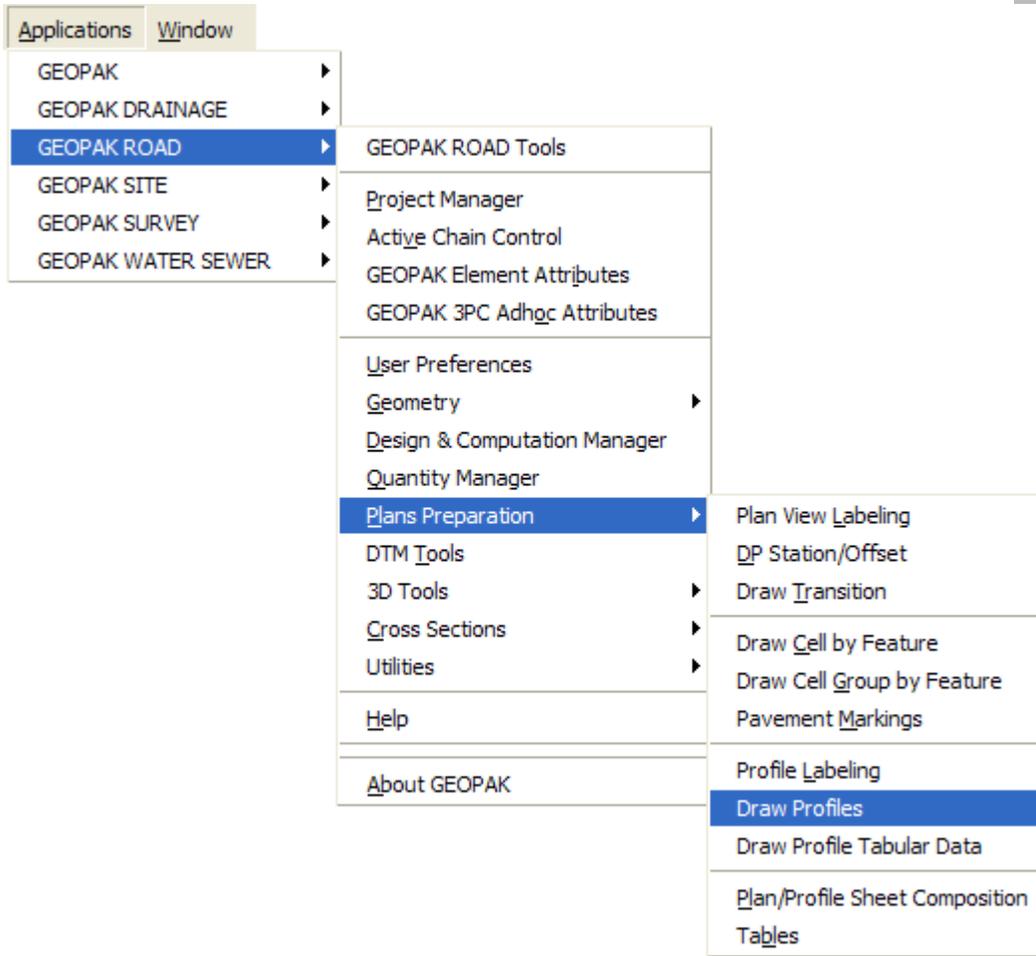


Figure 17-14: Select Draw Profiles

The Draw Profiles tool may also be accessed from the Plans Preparation tool palette as shown below.



Figure 17-15: Draw Profile Icon

All that is needed for this tool is a horizontal alignment and a **.tin** file. This tool allows for the creation of an existing ground profile in much the same way as the original GEOPAK 2001 tool, but does so behind the scenes, with increased efficiency and a much cleaner workflow. This tool also allows the user to draw profiles into MicroStation using the D&C Manager DDB settings ensuring adherence to the CADD standards. Also, with the Draw Profiles tool, there is no need to delete before re-drawing updated profiles.

Workflow 1: Creating an existing ground profile



1. *Select the Draw Profiles tool using one of the methods described above.*

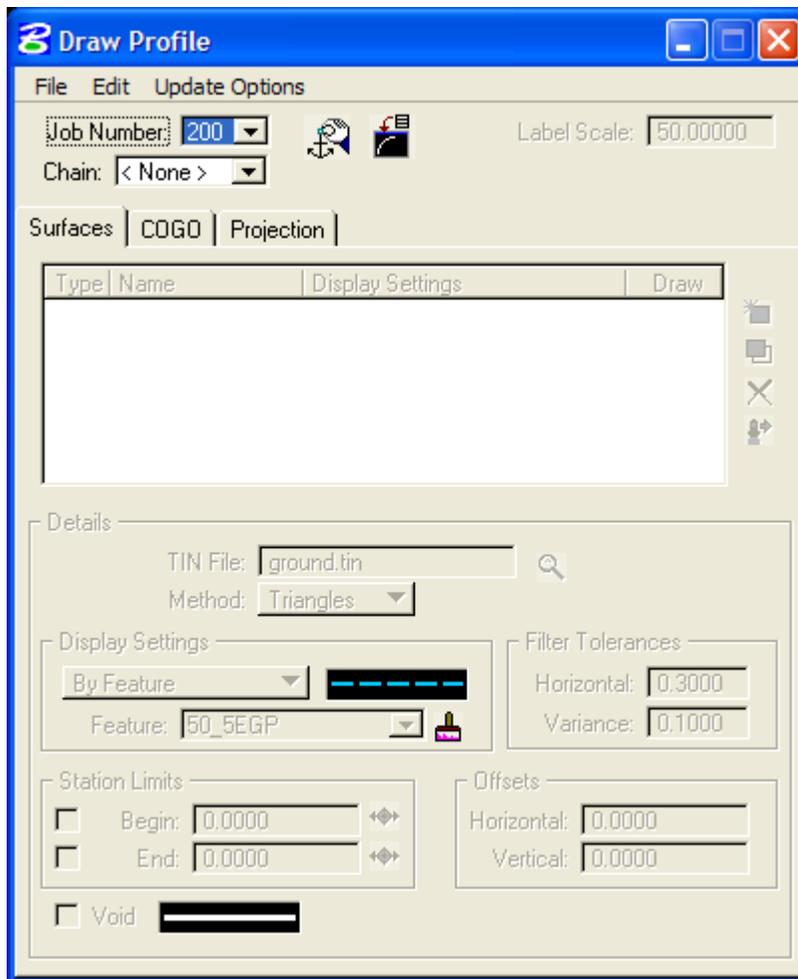


Figure 17-16: Draw Profile Dialog Box

2. *Select the job number where the chain is stored and the associated chain.*
3. *Select the Dialog Profile Cell Control icon , located to the right of the job number. The following dialog box will appear.*

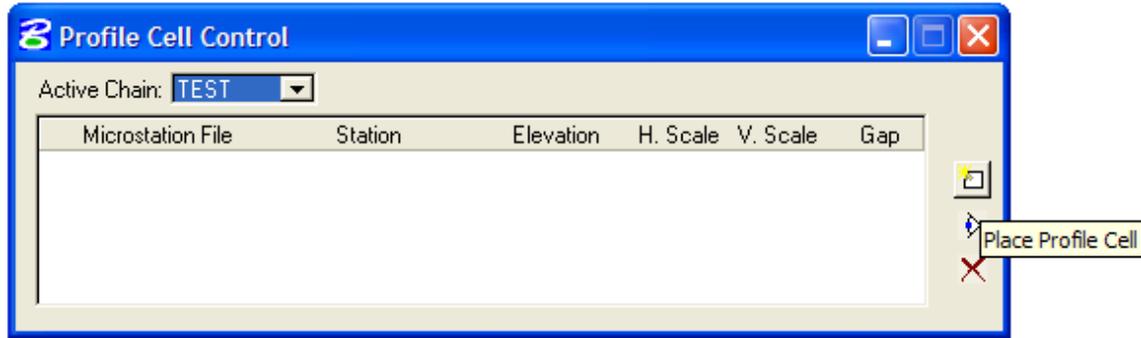


Figure 17-17: Profile Cell Control

4. Select the Place Profile Cell icon on the top right side of this dialog.
5. Once selected the following dialog box is activated allowing the user to set the station and elevation for the origin of the profile, set the horizontal and vertical scale, and set the top and bottom ranges for the cell. Notice how similar this dialog looks to the D&C Manager dialog for placing a profile cell.

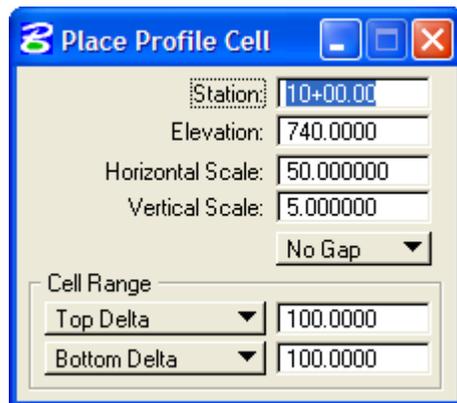


Figure 17-18: Place Profile Cell

6. Once this dialog box has been populated, the user may place the cell where desired. The Profile Cell Control dialog box will now be populated.

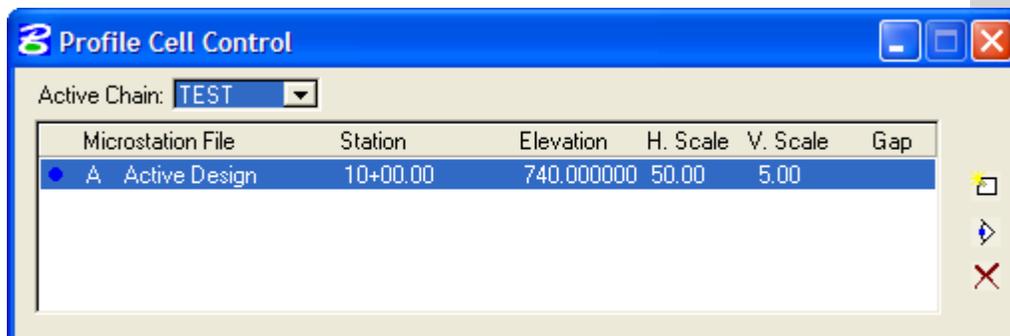




Figure 17-19: Profile Cell Control

7. *Dismiss the Profile Cell Control dialog box and return to the Draw Profile dialog. Notice that before placing the profile cell everything below the chain name on this dialog box was grayed out.*
8. *This dialog box is now active and the user is now able to populate the Surfaces and COGO tabs.*

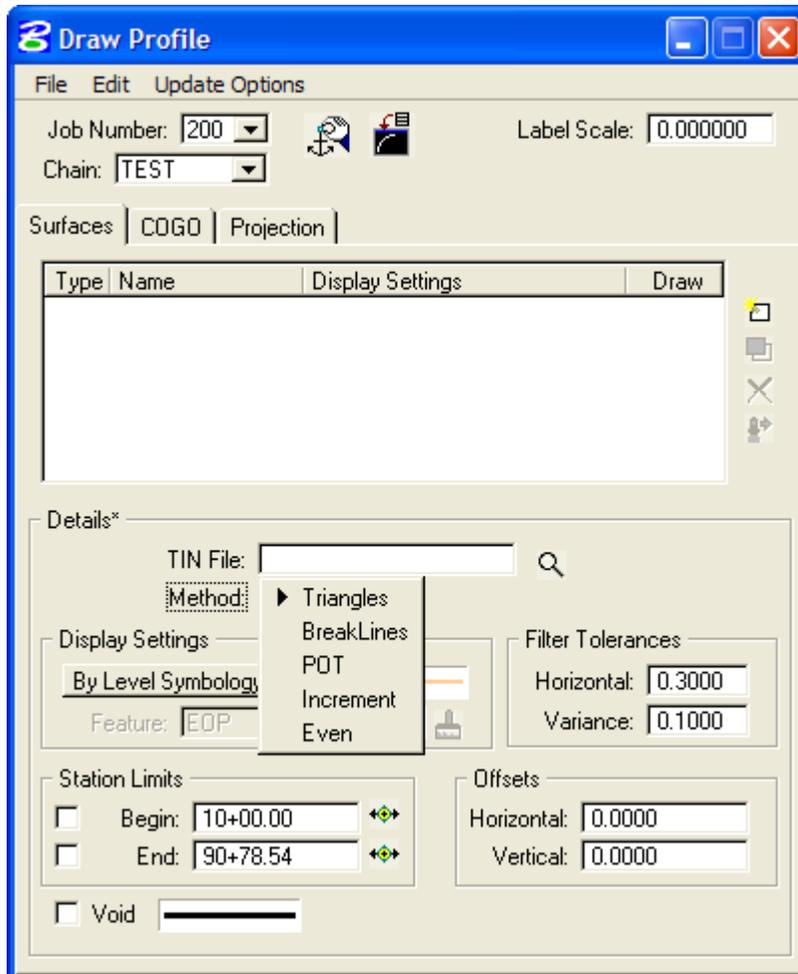
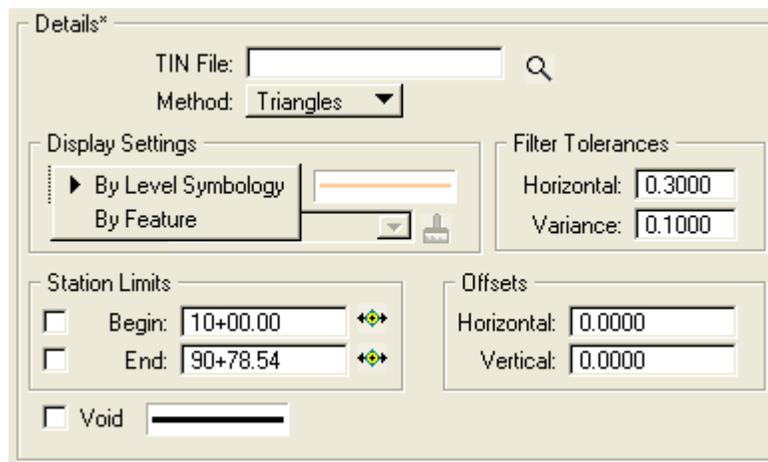


Figure 17-20: Draw Profile Method

9. *Begin by selecting the correct .tin file.*
10. *Once the .tin file is selected the user must now decide how to cut the existing ground profile. The options shown above; Triangles, BreakLines, POT, Increment, and Even, are the same options allowed in the original Ground Profile tool. Select the Triangles option.*
11. *Next the user must tell GEOPAK how to draw the profile with the correct symbology. Previously, the user would use the D&C Manager exclusively to accomplish this. As shown below, the*



Draw Profile tool will use either the D&C Manager or allow the user to input symbology.



Details*

TIN File: 🔍

Method: **Triangles** ▼

Display Settings

▶ **By Level Symbology**

By Feature 🖌️

Filter Tolerances

Horizontal:

Variance:

Station Limits

Begin: ⬅️ ➡️

End: ⬅️ ➡️

Void

Offsets

Horizontal:

Vertical:

Figure 17-21: Display Settings

12. *Select By feature to access the D&C Manager.*
13. *Once selected, the paintbrush becomes active. Click on the paintbrush to access the D&C Manager.*

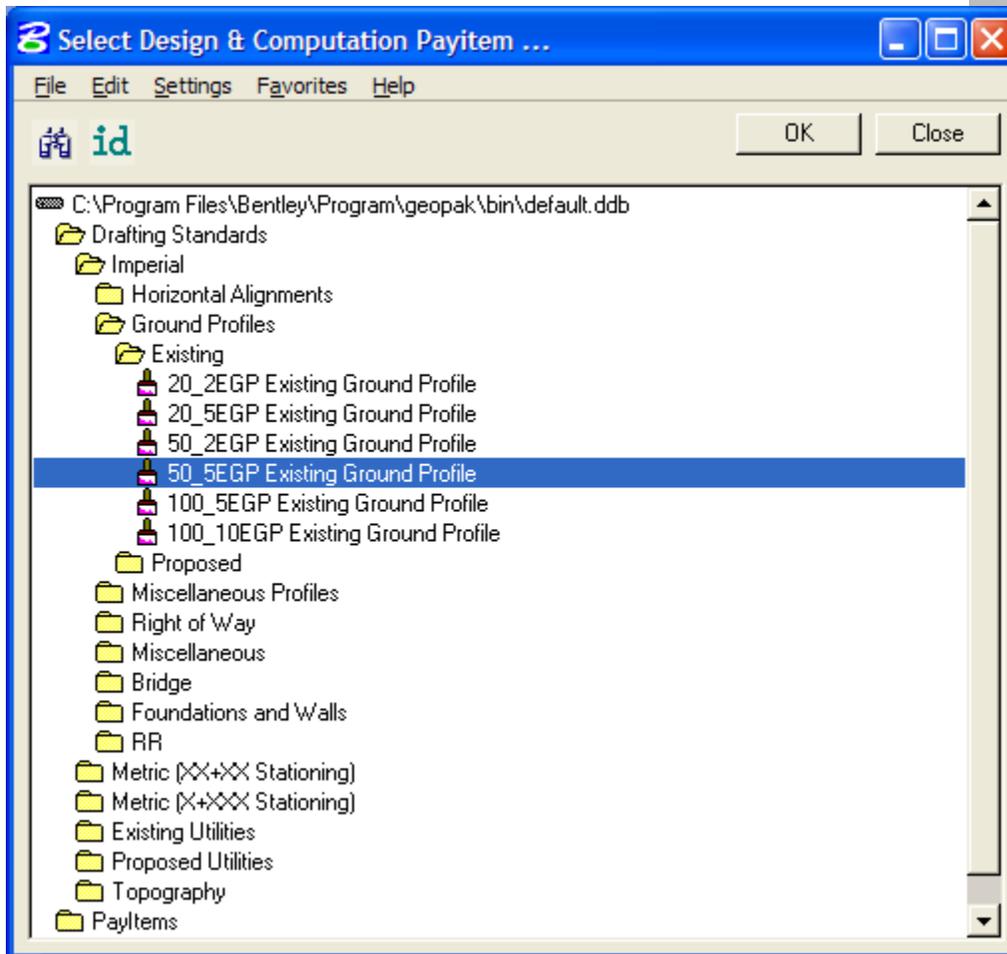


Figure 17-22: D&C Manager

14. Select the correct element, shown above as *Drafting Standards>Ground Profiles>Existing>50_5EGP Existing Ground Profile*.
15. Select the *OK* button in the upper right hand corner of the dialog box.

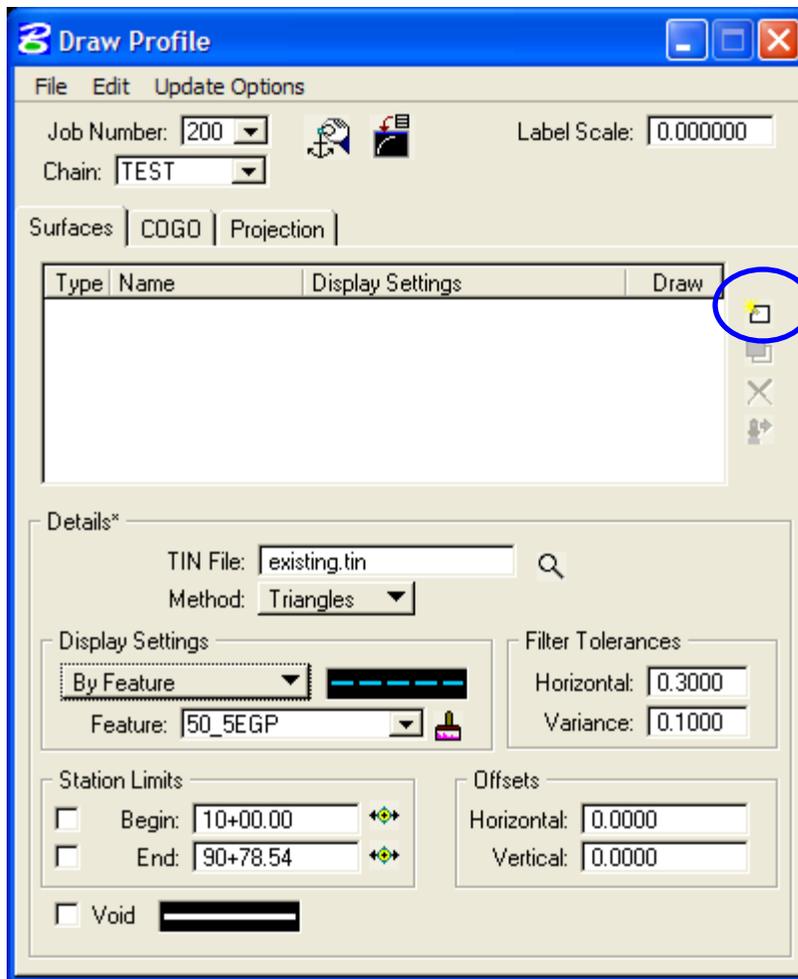


Figure 17-23: Add Surface

16. Once the above dialog box has been populated with the correct .tin file, the Method, and the symbology, select the Add Surface Settings icon, circled above.
17. Selecting the Add Surface Settings icon will populate the surface into the dialog box and instantly draw the profile onto the previously drawn profile cell.

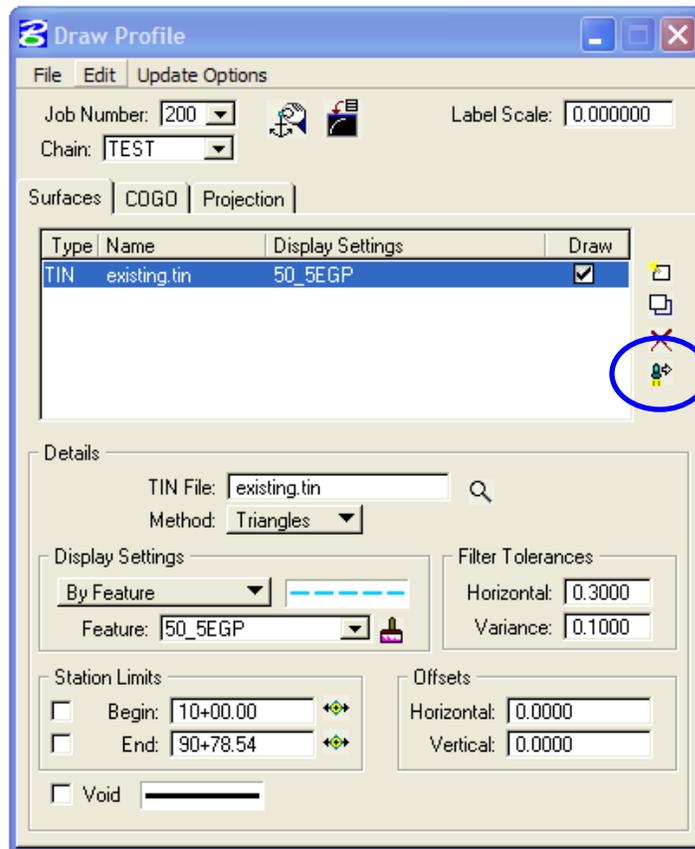


Figure 17-24: Store Surface in COGO

So far this workflow has allowed us to create the existing ground profile and draw it into MicroStation with the correct symbology. In the continuation of this workflow, we will store the profile into COGO and plot more information such as elevation and station labels, along with anything else that was previously available to be plotted from the D&C Manager.

18. To Store this profile into COGO, select the Store Surface in Cogo icon, circled above.



Figure 17-25: Store Profile

19. *Populate the Profile Name box with the desired name. Check the box labeled Store Profile in GPK.*
20. *Click Apply.*
21. *The profile is now stored in the GPK.*
22. *Dismiss the Store Profile dialog box and return to the Draw Profile dialog box.*
23. *Select the COGO tab and from the Profile Name box, select the correct profile.*

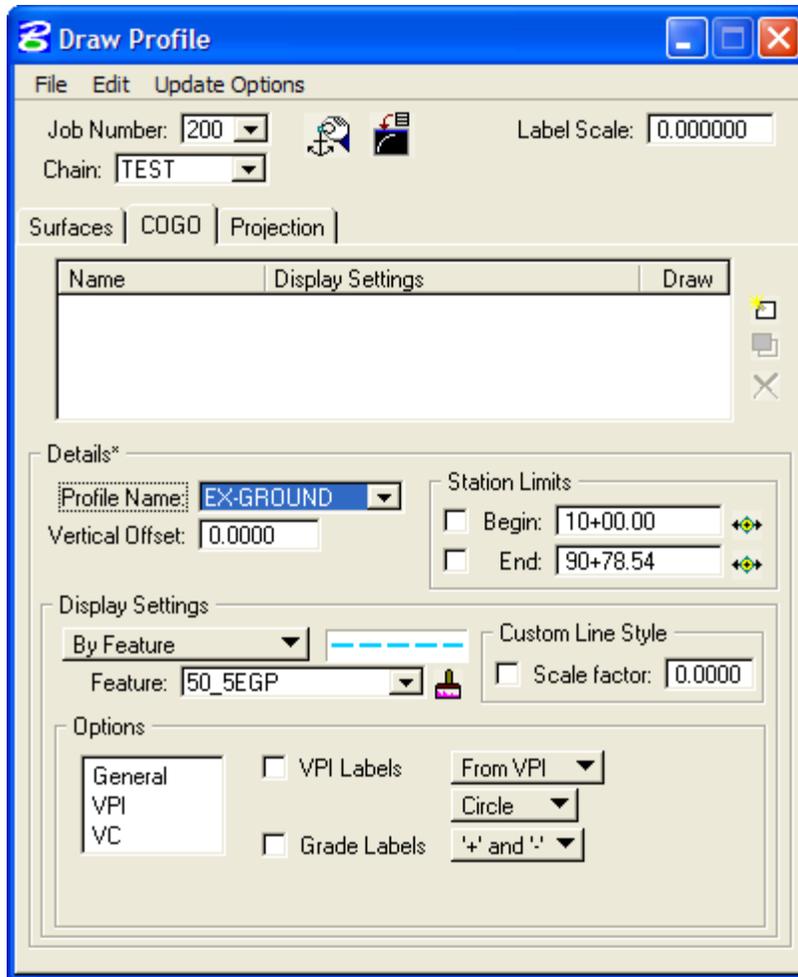


Figure 17-26: Draw Profile Dialog Box

24. Under the options section, located in the bottom quarter of the dialog box, select General.

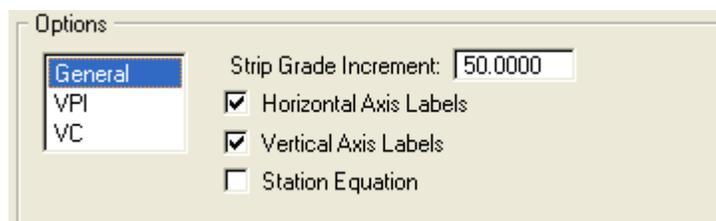


Figure 17-27: Profile Options

25. This allows the user to select the Axis labels and the Strip Grade Increment, if desired. The additional options are shown below.



Options

General	<input type="checkbox"/> VPI Labels	From VPI ▾
VPI		Circle ▾
VC	<input type="checkbox"/> Grade Labels	'+' and '!' ▾

Options

General	<input type="checkbox"/> Incremental Elevations	<input type="checkbox"/> VPC/VPT Label
VPI	<input type="checkbox"/> V.C. Parameters	
VC	<input type="checkbox"/> K Value	<input type="checkbox"/> External Length
	<input type="checkbox"/> Stopping Sight Distance	

Figure 17-28: Profile Options

26. From the options shown above the user has the same flexibility in drawing the profile into MicroStation that the D&C Manager afforded. Once the desired options have been selected click the Add Cogo Profile Settings icon, as shown below, and the profile will be complete.

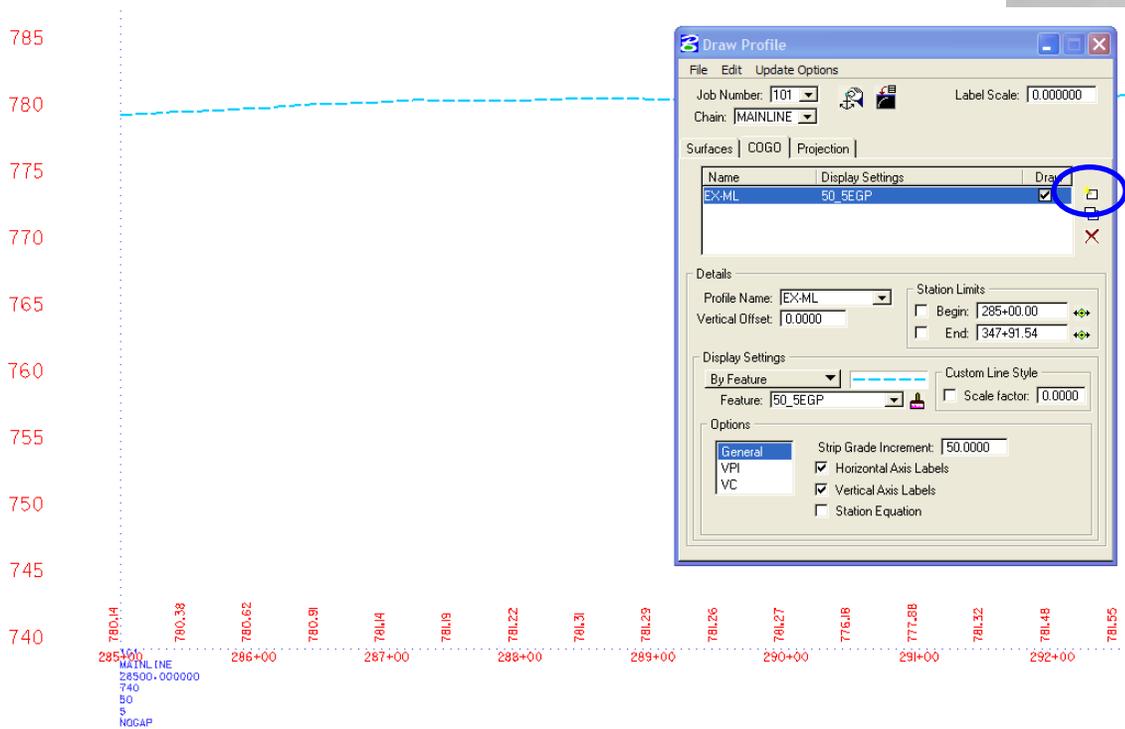


Figure 17-29: Profile Drawn Into MicroStation



New to GEOPAK 2004

Horizontal Design

In GEOPAK 2004 there have not been many enhancements to the workings of the existing coordinate geometry tools. The main COGO dialog box has been enhanced to include utilities for each type of COGO element such as points, lines, curves, chains, etc. The utility dialog box will allow the user to functions such as visualize, print, transpose, etc., for each element type. This allows the user to more efficiently work with each type of element independently. The new COGO dialog box, along with some of the utility dialog boxes is shown below.

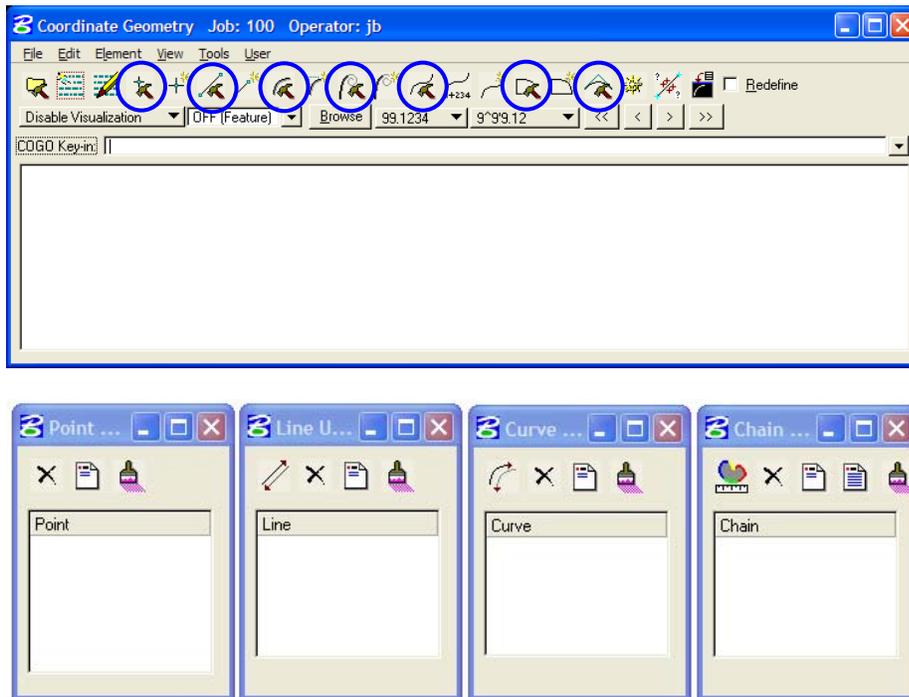


Figure 17-30: New COGO Tools