

CHAPTER 1

THE INTERACTIVE GRAPHICS ROADWAY DESIGN SYSTEM

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THE INTERACTIVE GRAPHICS ROADWAY DESIGN SYSTEM

The Interactive Graphics Roadway Design System (IGrds), is a comprehensive computer software product used by engineers and technicians in the major processes involved in roadway design and contract plan development.

IGrds Roadway Design Processes

The major roadway design processes of IGrds are:

- Coordinate Geometry and Survey Computation
- Horizontal and Vertical Alignment Design and Vertical Geometry
- Reduction of Terrain Data from Field Survey/ Photogrammetry
- Extraction of Terrain Data from Displayed Renditions of Digital Terrain Models (DTM's)
- Roadway Design Cross Section Definition and Computation
- Transfer of Design Surfaces to Various Digital Terrain Models (DTM)
- Roadway Design Cross Section Modification
- Earthwork Quantities Processing
- Contract Plan Preparation and Drafting

IGrds also has applications for roadway route location, right-of-way design, bridge layout, and bridge geometry. The system is modular and uses an integrated database.

IGrds Options

IGrds is available in two options:

- IGrds-IG provides full design and route location functions. It uses a unique "interactive graphics" concept to interact with the user during the IG command input process and during processing. Its complete integration with Bentley's MicroStation lets users interact with the CADD system without exiting from IGrds. IGrds/IG can be executed in the MicroStation 95, SE, J, and V8 environment.
- IGrds-AN provides a subset of the IGrds-IG automation tools to assist in the design of roadways. It uses the traditional "batch processing" methods of supplying all of the input in fixed alphanumeric records at the time system processes are executed. Output is in the form of printed reports and hard copy graphic plots.

The project files produced by IGrds-AN can be the basis for updates, revisions, and refinements to the design using IGrds-IG. The primary purpose of IGrds-AN is to bring old batch data sets forward to the current environment.

DTM Processing Capability

The IGrds/DTM interface provides for extracting cross sections and profiles from displayed DTM surfaces for use by IGrds. It also provides for preparing design surface data for input to various DTM systems. The DTM processing capability within IGrds only requires a 3D design file with the DTM triangles displayed. This allows any DTM vendor that can display the DTM triangles in a 3D design file to be compatible with IGrds. See Chapter 7 for a complete discussion regarding the IGrds DTM processing capabilities.

Manuals

This manual provides instructions for use of the IG Option of IGrds. It is intended to serve as both a reference manual and a training tool. It is supplemented by the IGrds Concepts Manual, which explains in more detail the background and concepts of IGrds features which are common to both the AN and IG Options. System documentation that describes how the system is organized and managed is also provided primarily for use by System Managers. The IGrds AN Option User Manual may also be helpful to IG Option users.

General Capabilities

The following lists examples of the various steps of design and drafting for which IGrds provides support capabilities. With IGrds, a roadway designer/draftsperson can:

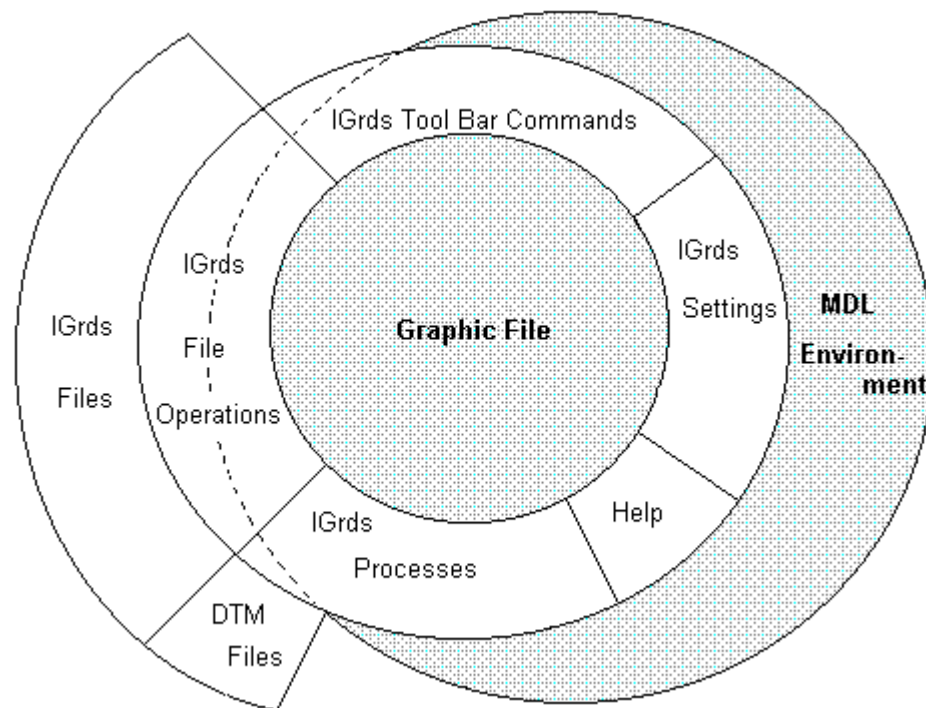
- Import survey data (ROW, topographic) electronically
- Reduce, error check, modify and store terrain data in cross section form
- Reduce, error check, modify and store geometric survey data
- Perform geometric calculations, and produce graphic output, listings and plots
- Describe, compute, display and plot horizontal roadway alignments
- Describe, compute, display and plot vertical roadway alignments
- Design roadway templates, medians, special ditches, and slopes (including benched slopes)
- Compute earthwork volumes (including mass diagram plots)
- Compute, display and plot cut/fill catch and ditch lines
- Compute, display and plot right-of-way need lines
- Compute, display and plot interchange and intersection layouts
- Compute, display and plot original ground and design cross sections
- Define, display and plot plan views of roadways
- Perform bridge geometry calculations
- Compute vertical clearances between structures and roadways
- Create 3D rendered views of roadways
- Produce detailed design data listings for each section designed, including construction staking tabulations

- Export construction staking data, including alignments, geometric elements, and design cross section information
- Store design criteria and calculations for further processing
- Create plan and profile views as a direct result of each command during the design process
- Display topographic data on the screen display and accurately superimpose the design displays with the topography
- Measure topographic features in relation to alignment and geometric data by "pointing" and measurement commands
- Designate elements upon which geometry commands are to operate by "pointing" at the element
- Identify roadway or geometric elements upon which a command is to operate by cursor "pointing" to previously displayed data on the screen
- Use MicroStation graphic elements directly in IGrds geometric computations or create IGrds geometry elements from MicroStation elements.
- Manage screen displays by using MicroStation graphic commands for zoom, pan and windowing
- Dynamically move and/or copy design graphics or entire views from one location to another
- Issue commands to annotate and label roadway design display graphics
- Issue commands to set workstation and project parameters
- Use MicroStation drafting system capabilities to enhance, modify, or upgrade design graphics without leaving the IGrds/IG system
- Use the plotting capabilities of MicroStation drafting system software to produce plots of graphic data produced from IGrds/IG

OVERVIEW OF IGrds / MDL

The schematic diagram below shows the major IGrds functions which operate as MDL applications in the MDL/MicroStation environment. The inner ring depicts the IGrds Graphic User Interface (GUI) top level menu selections. Note that IGrds Files are not under MDL. The Personal Computer also depicted below is a key component of the user interface.

All of the IGrds Components are discussed on the facing page.



Graphic User Interface (GUI)

The IGrds GUI provides user control of all IGrds functions as well as certain graphic system functions via

- The Personal Computer
- The GUI menus, dialog and message responses

The GUI is discussed in more detail in the next section. Other IGrds components are discussed below:

MDL Environment

MDL/MicroStation provides drafting support as well as support for graphic applications such as IGrds. The IGrds GUI was developed using MicroStation Development Language (MDL).

File Functions

All IGrds functions which involve opening, closing, selecting, saving, etc., files are accessed through the Top Level Menu under **Files** as discussed under File Operations in Chapter 2.

Settings

All IGrds functions which set or revise parameters, change graphic settings are accessed through the Top Level Menu under **Settings** as discussed in Chapter 2.

Tools - Commands

Commands refer to IGrds functions which perform single purpose tasks according to user input and selections (e.g., intersect two lines). They generally may be executed in any logical sequence to achieve the desired result. They are accessed under **Tools** on the Top Level Menu as discussed in *Paths to IGrds Commands* in this Chapter.

Processes

Processes are operations that operate on data entered using IGrds commands. These include Design and Earthwork computations, cross section plotting, etc. They are accessed under **Processes** on the Top Level Menu as discussed in *Paths to IGrds Commands* in this Chapter.

Help

A variety of displays designed to assist the IGrds user are available under **Help** on the Top Level Menu. These functions are discussed in more detail in Chapter 2.

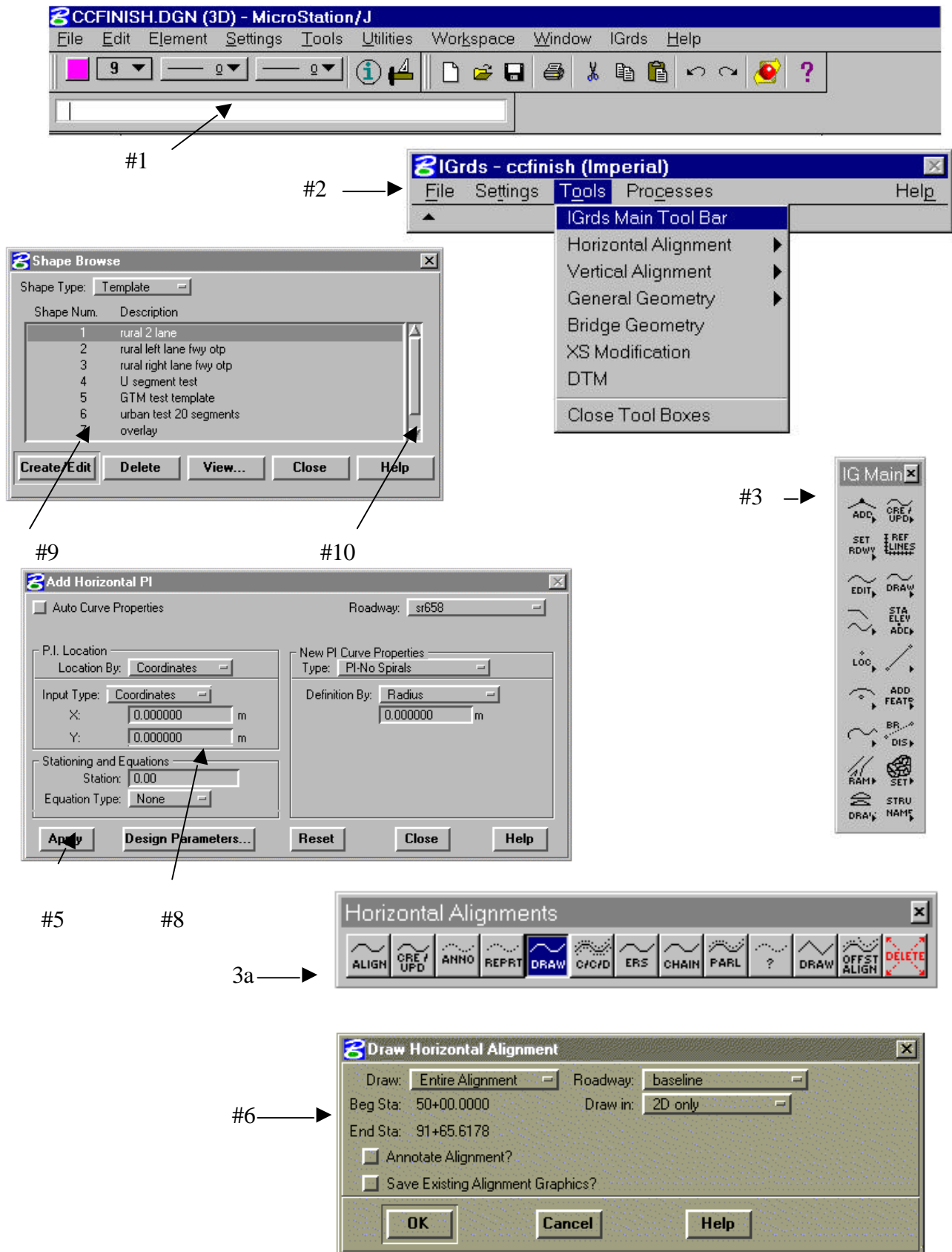


Figure 1-1 - General GUI Features

OVERVIEW OF IGrds / GUI

This section describes the general GUI features that are used by IGrds. Several different GUI standards have evolved during the past few years. MDL is generally based on the Motif standard which was issued from the efforts of the Open System Foundation, a consortium of computer vendors. Figure 1-1 on the facing page shows some representative IGrds GUI features. The items listed below are keyed to this figure.

- MicroStation Menu Bar (#1)

The graphic system menu bar.

- IGrds Menu Bar, Pull Down Menu (#2)

A graphic display of a list of categories to be selected. The pull down menu appears in a rectangular area on the screen when a category is selected. It disappears when a command group is activated.

- Tool Palette (#3), Tool Settings Window (#3a)

Tool palettes contain icons that, when activated, initiate an action. There are two types of tool palettes: icon command frames and tool boxes. Icon command frames are generally oriented vertically and are used to activate various tool boxes. Tool boxes are generally used to activate commands. They feature the ability to display various text boxes, toggle buttons, options buttons, etc., within the Tool Settings window that are used to solicit user information. Tool boxes can be reconfigured at will and “docked” against the sides of the MicroStation main window..

- Dialog Box (#4)

A rectangular area on the screen which contains several elements that control the input or operation of the program. It appears and disappears on the screen subject to user commands.

- Push Button (#5)

A rectangular area that, when chosen by the user, initiates an immediate action.

- Check Box and Toggle Button (#6)

A rectangular area that allows the user to turn on or off options.

- Option Button (#7)

A rectangular area that provides for selection of one of several options.

- **Text Box (#8)**

A rectangular area that accepts editable keyboard input from the user before initiating an action.

- **List Box (#9)**

A rectangular area that shows a list of available choices.

- **Scroll Bar (#10)**

A rectangular feature within Windows and List Boxes which enables the user to view more items.

UNDERSTANDING IGrds FUNCTIONS GETTING THE MOST FROM IGrds

IGrds provides a broad array of functions that can be accessed as the user desires to produce the desired results for the design scenario being addressed. To gain the most benefit from IGrds, users need to have a good understanding of the following topics which are discussed later in this chapter:

- The MDL/MicroStation Environment
- How to Start an IGrds Session
- Gateways to IGrds Functions - Top Menu Bar
- Paths to IGrds Functions
- Pull Down Selections
- Tool Palettes, Icons
- Dialog and Tool Boxes
- General Tools
- How to Select the Right IGrds Function
- IGrds Files
- Important Data Considerations

The MDL/MicroStation Environment

IGrds IG operates in the MDL/MicroStation Environment. The graphic interface was developed using MicroStation Development Language (MDL) which lets IGrds functions and MicroStation functions be used interchangeably. The user needs to understand use of MicroStation and the particular user installation procedures. MicroStation manuals and training are available elsewhere.

How to Start an IGrds Session

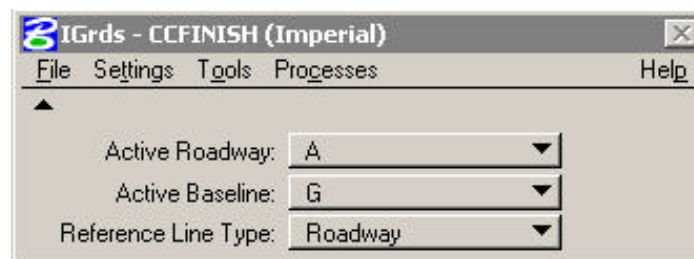
Use your installation's standard procedures to start MicroStation and open the desired graphic file to be related to the IGrds session. Make sure that all environment variables are set properly. (See the read.me file that accompanies the release.) Then type "mdl load igrds" to activate the IGrds interface. This will display the IGrds Top Level Menu bar with everything disabled except Files and Help.

Then pull down the File Menu and select either the New... or Open... working file options. If New is selected, type the new working file name and click on the OK button or press enter. IGrds will create new working files and become fully active (i.e., all commands no longer disabled).

If Open is selected, select the desired working file from the available list. IGrds will open the selected working file and become fully active. The current working file and Imperial/Metric unit designation for the project will appear in the caption bar of the IGrds main menu.

This makes all IGrds functions available.

Once the files have been created and/or opened the current settings (Active Roadway, Active Baseline, and Reference Line Type) can be viewed on the IGrds Menu Bar by selecting the expand icon. The Menu Bar will then expand to show the current settings as shown below:



The user has the ability, from this dialog, to change the Active Roadway, Baseline, and Reference Line type. Any change to the settings in the IGrds Menu Bar will be reflected throughout all other open commands. The collapse icon can be selected so that the Menu Bar appears in its original form:



The IGrds Top Menu Bar - The Gateway to IGrds Functions

The IGrds Top Menu Bar provides access to all IGrds functions via pull down menus for

- File
- Settings
- Tools
- Processes
- Help

Figure 1-2 illustrates how the top level menus serve as the gateway to IGrds functions.

Disabled functions are currently available by other methods as discussed in the following sections. The pull down menu items “>“ at the right have subsidiary items that may be selected.

Selections are made by placing the cursor on the top bar category desired and pulling down to the desired menu or submenu item. The categories are presented in more detail in the following pages.

Paths to IGrds Functions

The Top Bar Menu selection opens the gateway to paths which lead to the functions included in the five major function groupings. These paths may lead to

- Option Selections
- Tool Commands
- Dialog Boxes

Each of these features are discussed later in this Chapter.

Figures 1-4 through 1-12 illustrate the available paths. Notice that Figures 1-5 through 1-7 and 1-10 through 1-12 relate to Tool Commands which can be accessed via an alternate path using the IGrds Main Palette.

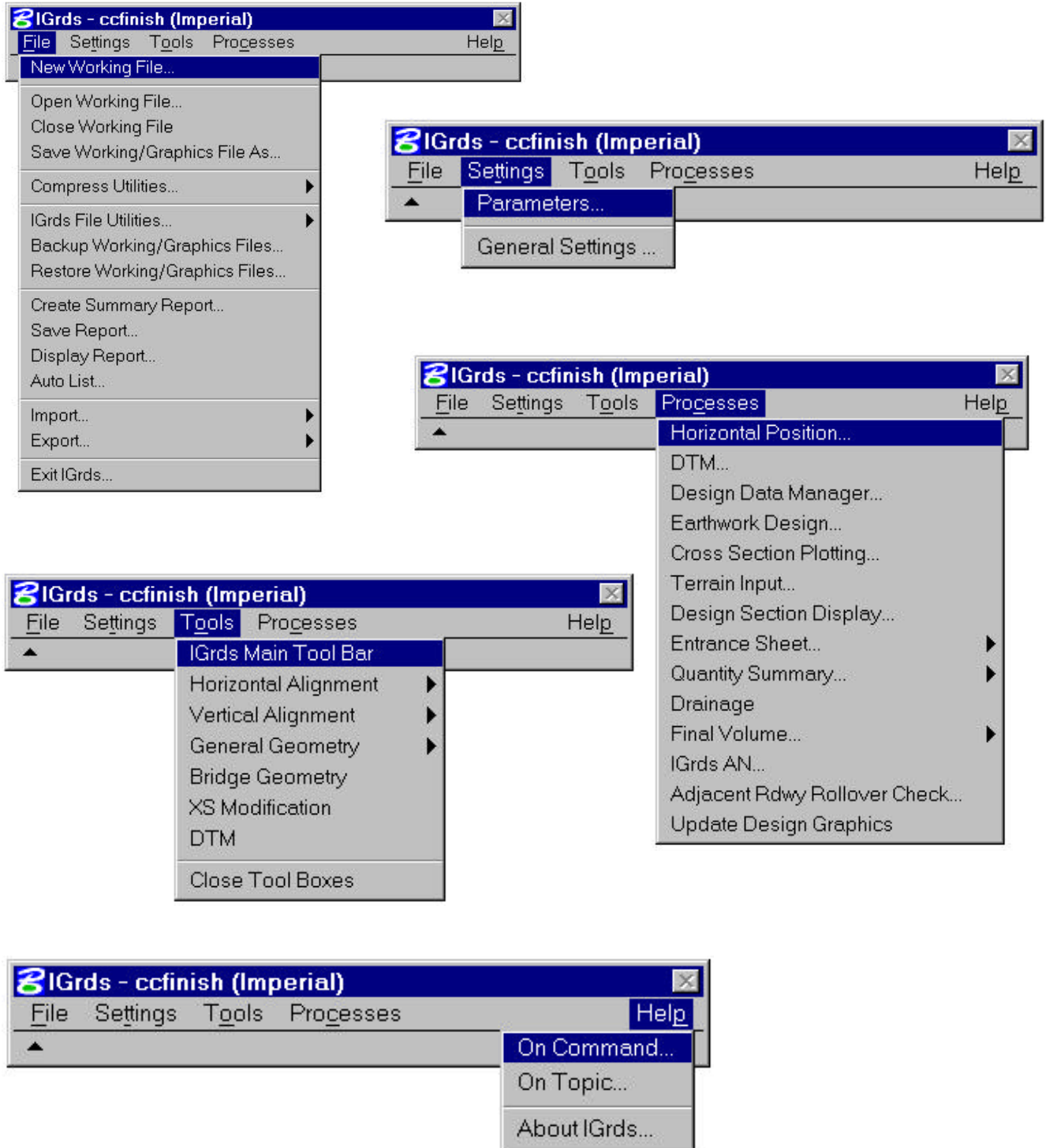


Figure 1-2
 IGrds Top Level Menu Bar and Menus

Pull Down Selection

Clicking on a Top Menu Bar item and pulling down, displays an option list. Releasing the button completes the selection except when there are three dots to the right of the selection, e.g.,

Open Working File...

the selection triggers another IGrds action such as a dialog box.

Horizontal Alignment >

Here you pull right to display more selection options and complete the selection.

Tool Palettes, Icons

The Tool Palette path may include menu selections as well as palette displays as shown. Palette displays consist of Icons, i.e., small pictures which are designed to depict IGrds functions. Selecting an Icon moves to the next step along the path which may be another tool palette or to the final step - a dialog box or tool which guides the user to select the desired options and to provide needed input to complete the IGrds function.

The user needs to recognize the Palettes and Icons to stay on the right path, but it is easy to get back on when a wrong selection is made.

Dialog and Tool Boxes are discussed next.

Dialog and Tool Boxes

Dialog and Tool Boxes are the primary means of facilitating user input when more than a selection is involved. Tool boxes are used primarily with Tool Palette Commands, and dialog boxes are used primarily with Processes. Both provide status information and provide for

- input text or values
- option selections
- default selections

They guide the user input and perform data validity checking. They also vary in format depending on selections to eliminate invalid data.

Dialog and Tool Boxes feature Standard Tools for recurring data types. For example, station ranges entry options are the same on every Box that requires station range. Standard Tools are discussed next.

Standard Tools

Dialog and Tool Boxes provide for data input and selections. Standard Tools are used for the data items and are repeated on many boxes. The following is a discussion of such standard tools. This means every time you see these items they look and work the same. Some examples are

- Roadway
- Station
- Point Locations
- Offsets
- Elevation
- VPI Data

The action buttons at the bottom of dialog and tool boxes (Apply, OK, Delete, Reset, Cancel, Close, Help, etc.) also look and work the same every time you see them.

IGrds Files

The designer needs to understand the basic file structure. This is discussed in the section of this chapter on IG Option Files. Tools are available to help initiate and manage files. In addition to files generated by the designer, background mapping may also be transferred into graphics files for use for design reference and for incorporation into plotted output.

The Parameter File is a special file which sets defaults and standards which reduce user input requirements. This file also provides the opportunity to customize output. For more information, see the section of this chapter called "Parameter File".

How to Select the Right IGrds Function

SELECTING THE RIGHT IGrds FUNCTION IS THE PRIMARY USER RESPONSIBLE.

IGrds IS DESIGNED TO HELP YOU DO THIS.

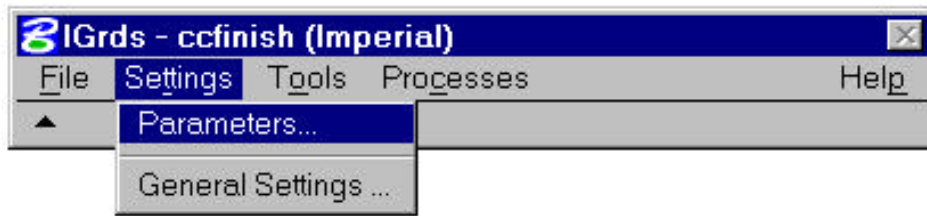
As a designer, you know what result you desire. You must be familiar with the IGrds functions and how to apply them to achieve the results.

This manual and the IGrds GUI provide extensive assistance including:

- Straight forward gateways to paths.
- Easy to follow pathways (and easy recovery if you stray). See Figures 1-4 through 1-12.
- Functionality grouped palettes.
- Pictorial Icons you can easily recognize - with a little study.
- Dynamic Display of function descriptions as you browse over the Icons.
- Help displays at the function level as well as other levels of IGrds. These Help displays provide descriptive information to make sure you are selecting the right function and also to guide you in using the function.
- The chapters of this manual that follow provide complete discussions of each IGrds function.

Chapter

- 2 General - File Operations, Settings, Help
- 3 Horizontal Alignment
- 4 General Geometry
- 5 Vertical Alignment and Geometry
- 6 Design Data
- 7 Terrain Processes
- 8 Earthwork and Quantity Calculation Processes
- 9 Cross Section Modification Processes
- 10 Auxiliary Processes
- 11 Plan Preparation and Construction Support Processes
- 12 Bridge Geometry



Current Active Parameter File

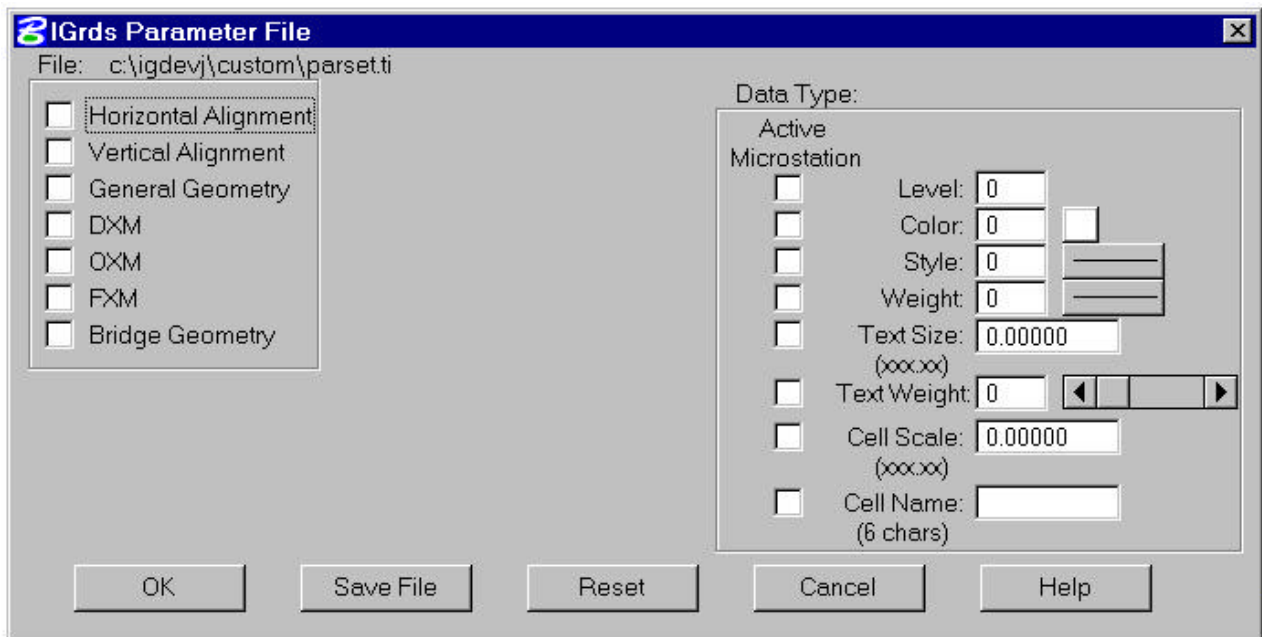


Figure 1-3
Modifying IGrds Parameters

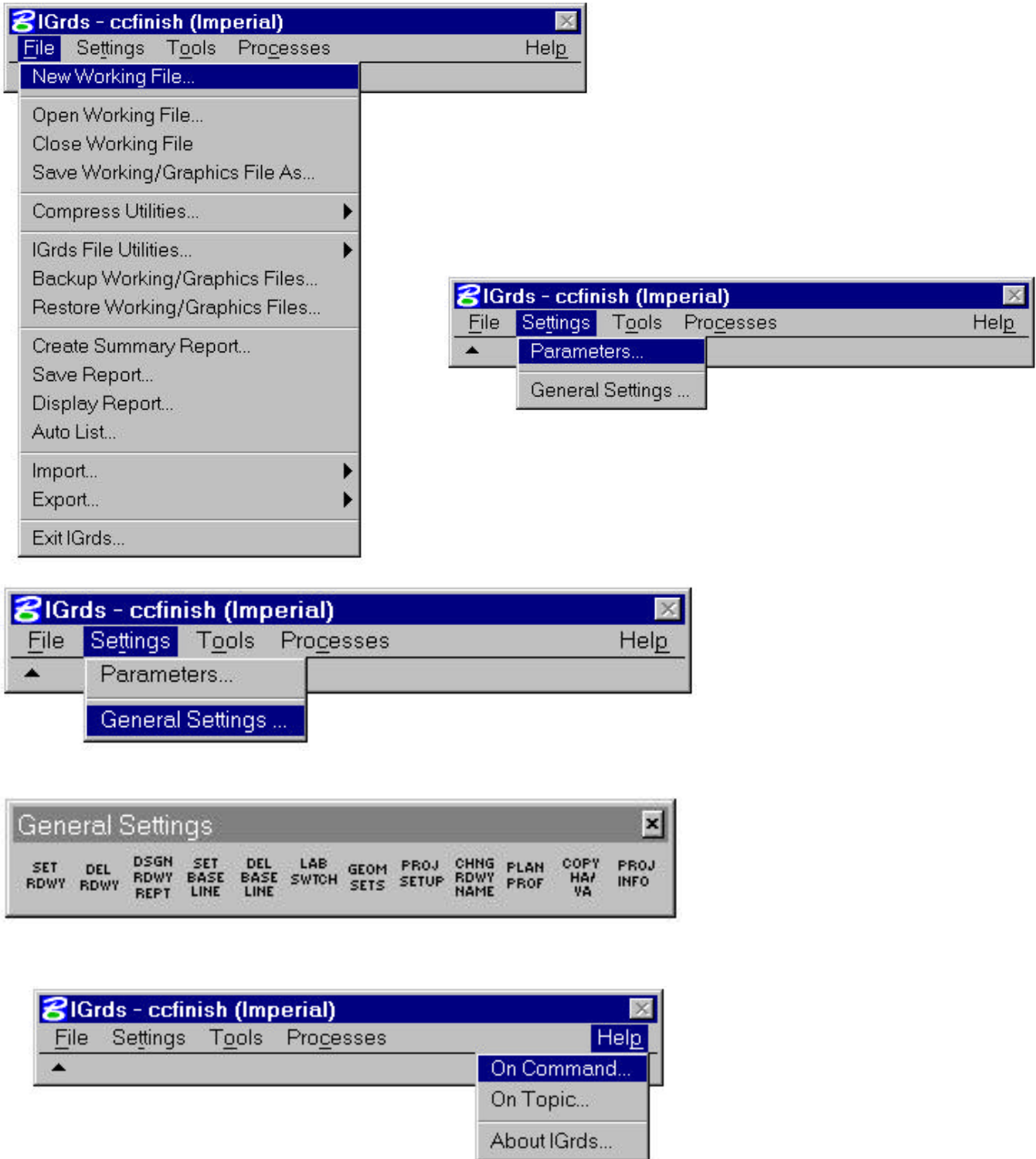


Figure 1-4
General File Operations, Settings, and Help

HORIZONTAL ALIGNMENT (HA)

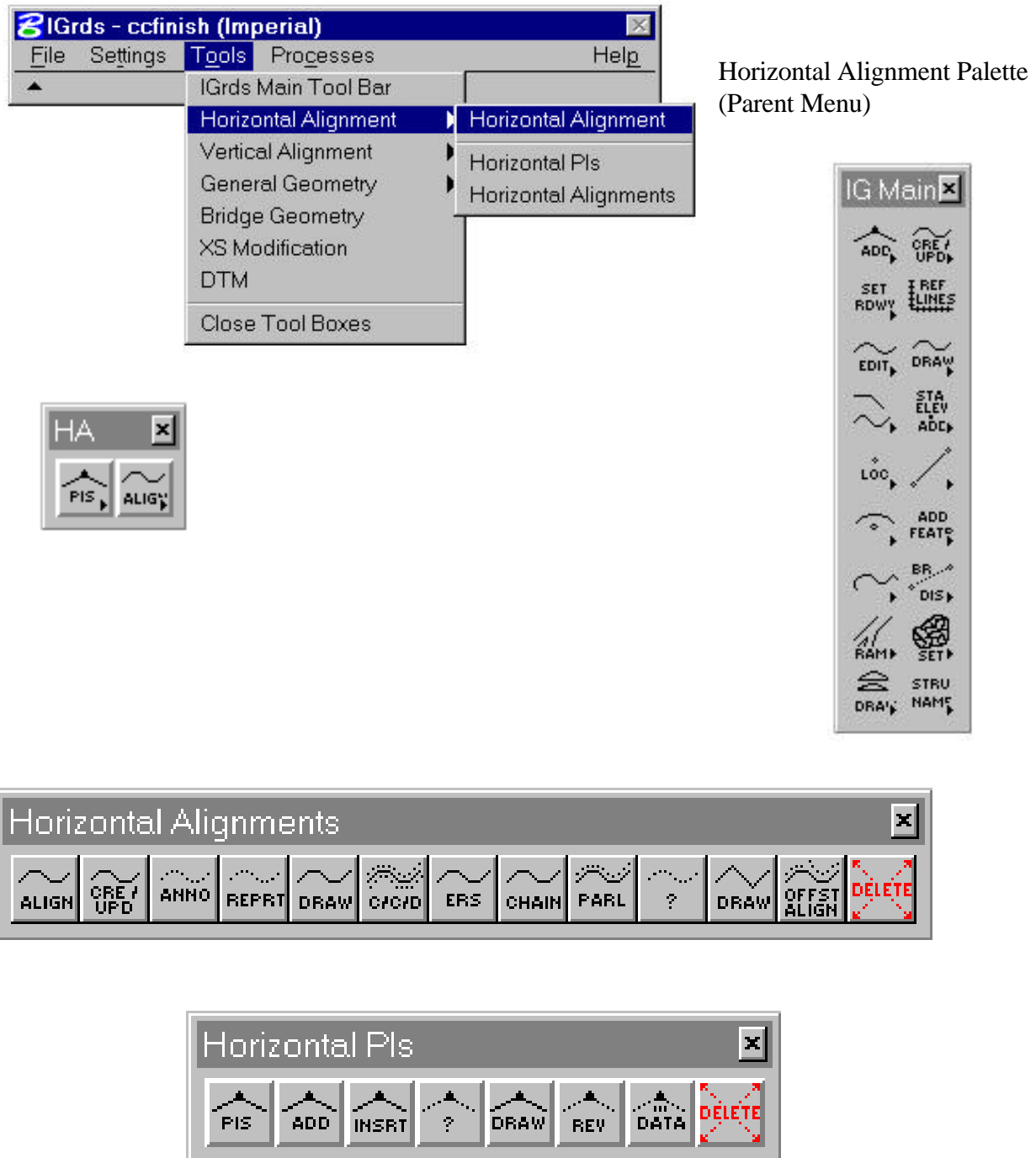


Figure 1-5
 Horizontal Alignment Tool Boxes

GENERAL GEOMETRY (GEOM)

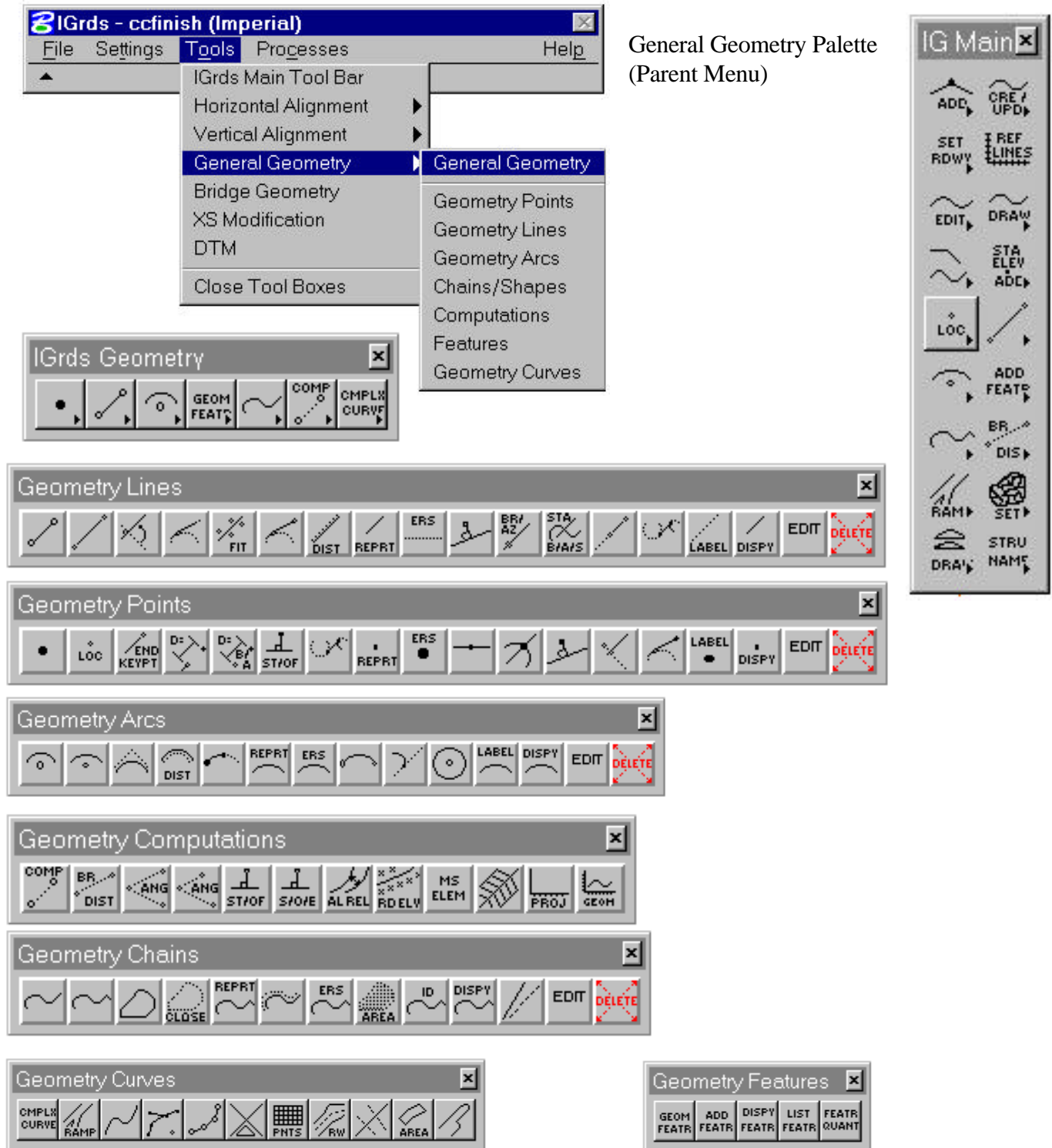


Figure 1-6
General Geometry Tool Boxes

VERTICAL ALIGNMENT (VA)

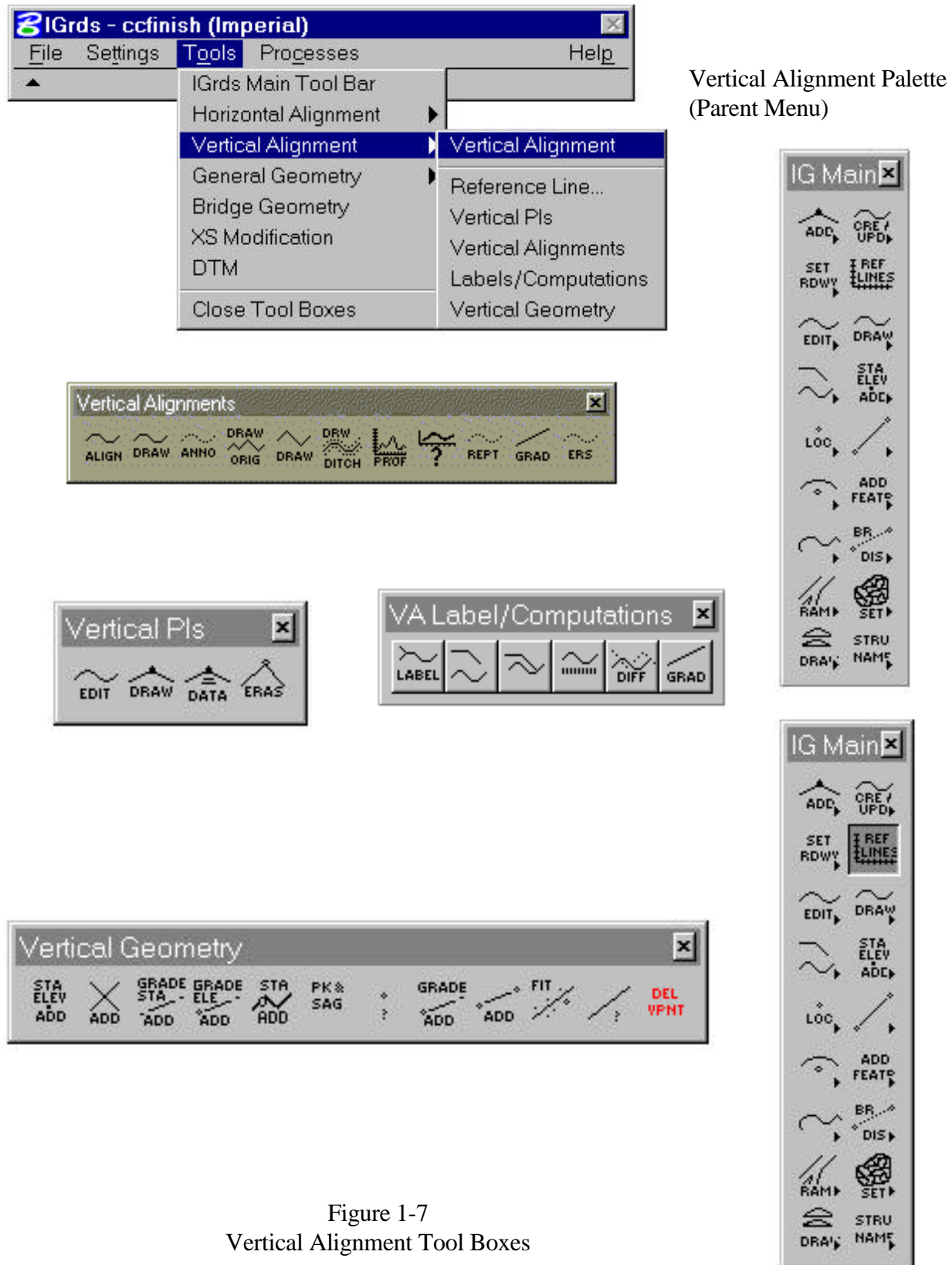
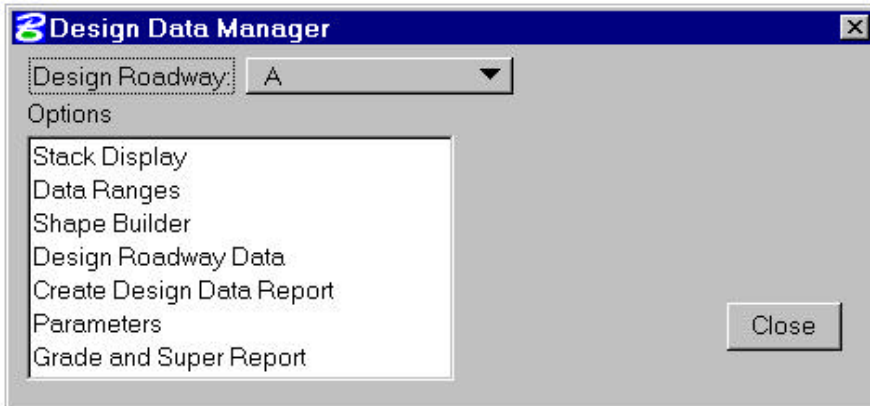
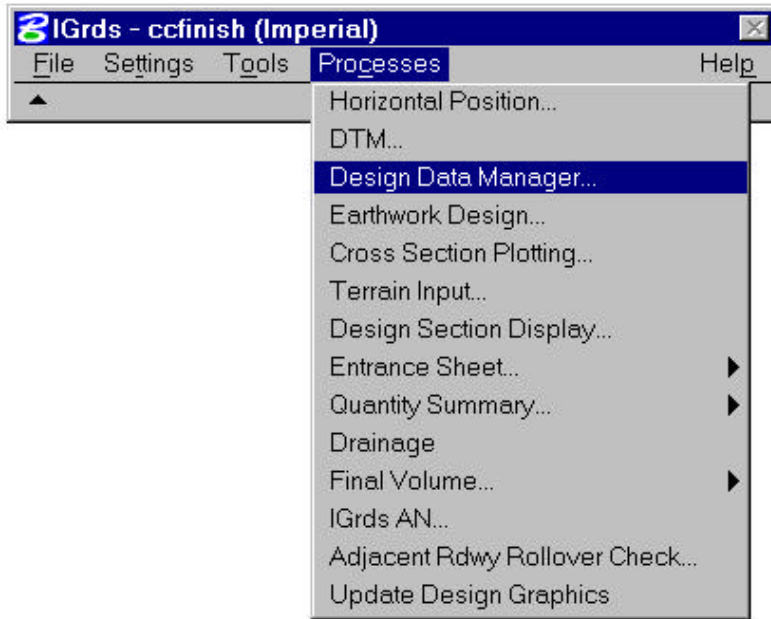


Figure 1-7
 Vertical Alignment Tool Boxes

DESIGN DATA



- Stack Display
- Data Ranges
- Shape Builder
- Design Roadway Data
- Create Design Data Report
- Parameters
- Grade and Super Report

Figure 1-8
Design Data Processes

EARTHWORK PROCESSES

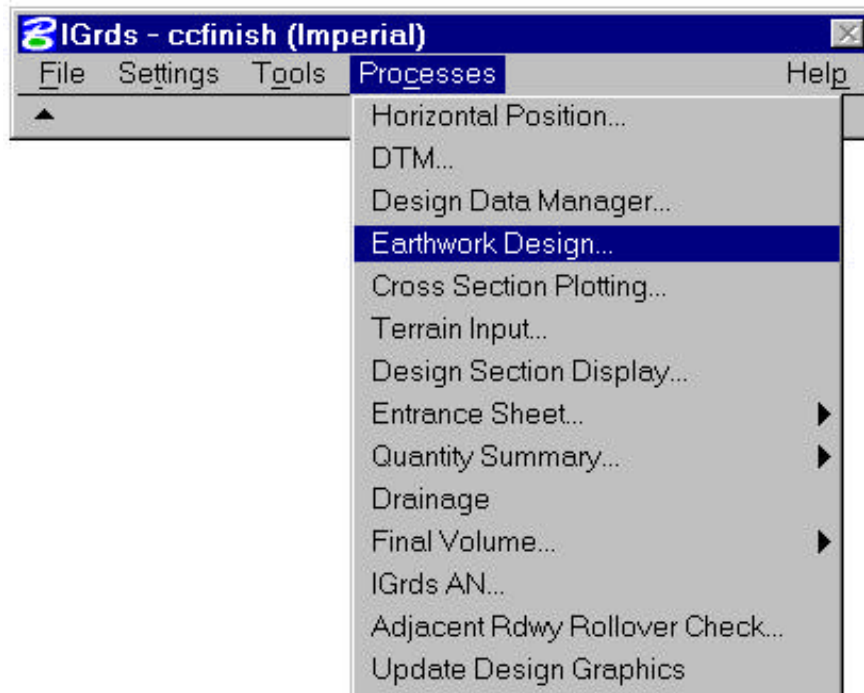
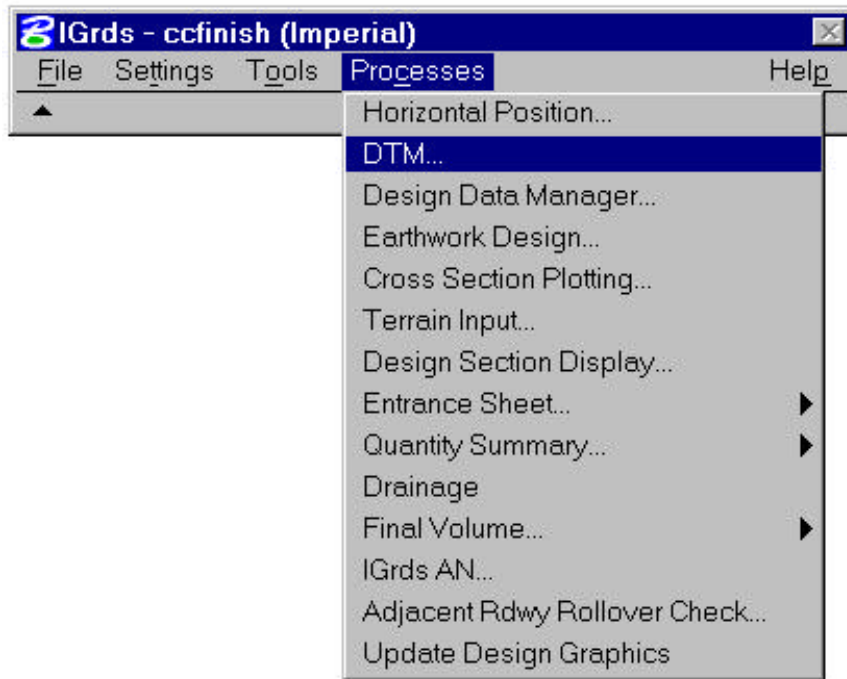
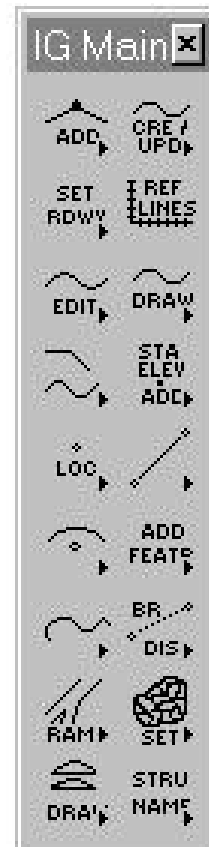


Figure 1-9
Earthwork Processes

IGrds DIGITAL TERRAIN MODEL (DTM) PROCESSING CAPABILITY



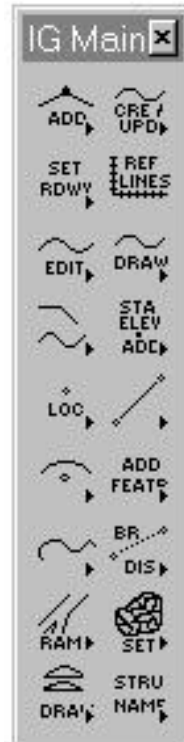
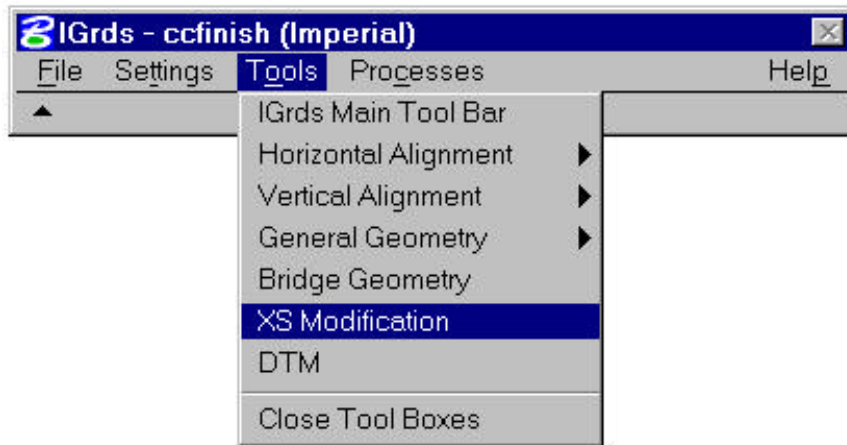
IGrds Digital Terrain Model (DTM) Processing Palette (Parent Menu)



Note: The DTM tool box can also be invoked from the Tools menu.

Figure 1-10
DTM Tool Box

CROSS SECTION MODIFICATION (XSM)



Cross

Section Modification (XSM) Palette (Parent Menu)



Figure 1-12
 DXM Tool Boxes

IG Option Files

The IG Option works with a number of internal files to store data and graphics and to perform computations and displays. While it helps to have an understanding of these files, you can begin operating the IG Option without a detailed understanding.

The files for a single project can reside in any directory. They should have the same name (1-8 characters) plus the extension which identifies the file (EXAMPLE: .dda). There are three ways to establish files for a project:

1. Start from scratch. IGrds will automatically create all necessary files.
2. Start a new project using existing Working files. (Such files could have been created by the AN Option or transferred from another computer system using ASCII Project File Utilities.)
3. Start a new project using working files created by the AN Option.

Many IGrds commands require special action to save input data into files. These actions are discussed under the applicable commands.

The IG Option files are shown in Figure 1-13. File description and instructions for retaining files are given in the following sections.

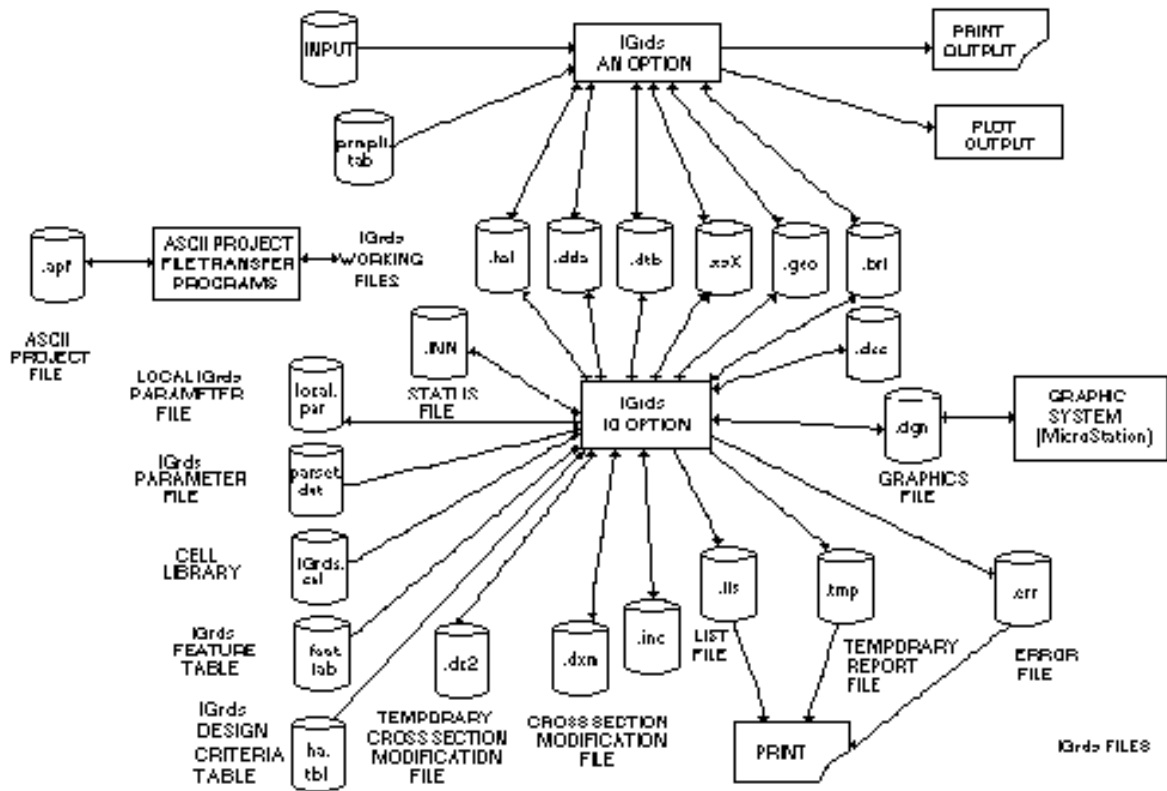


Figure 1-13
 IG Option Files

Parameter File

The IGrds Parameter file (named parset.dat) contains organizational and user defined values for the graphical representation of design data. Three classes of data are presently included in the Parameter file:

- System Setup Values - Units Label ("FT"), NE/XY, etc.
- Option Flag Settings (Initial) - Label (On/Off), Auto List (On/Off), etc.
- Graphical Data Representation - Alignment Level, Reference Line Color, etc.

The first two groups of parameters are established and saved during initialization of IGrds.

The third group of parameters (graphical data representation) are read from the file at the beginning of each IGrds session. These values define the graphical data depiction of design data (as per examples preceding). See Chapter 2 for how to modify parameters as well as the System Documentation.

Preferences File

The IGrds Preferences (.ini) file contains other organizational and user defined values for the operation of IGrds. These are completely described in the System Documentation.

User Customized Environment

Each installation of IGrds can be customized in various ways to reflect the standards of the user agency. The IGrds System Documentation and installation instructions provide for customization of:

- Cell Libraries
- Parameter Files
- MicroStation precision units
- Design Criteria Table

System managers should provide needed customization information to users and answers to user questions regarding installation specifics.

General IGrds GUI Conventions

The IGrds Graphic User Interface (GUI) uses MicroStation methodology as far as possible. This section gives a brief discussion of some of the terminology and procedures used in this manual. For a more complete coverage of these items, refer to the MicroStation User Guide.

- Mouse Button - The left button is used for most GUI operations while the right button is used for rejecting selections from the graphic screen.
- Click - A quick press and release of a button is used for operations such as change push buttons and focusing on fields.
- Drag - Pressing a button and holding it down while moving is used for operations such as displaying menu or option lists or tearing off palettes.
- Push - Push is used for buttons which have an on/off state. Click on the button to change the state.
- Enter - Enter is used for fields where a key board entry is required or is an alternate method of input.
- Select - Select is used when a selection with the cursor is needed for the following cases:
 - Option Boxes
Click on the box to show selection options, then click on the desired selections.
 - Graphic Selections
Click on the desired IGrds graphic element (such as Points, Lines, Arcs, Chains, PIs, VPoints, etc.).
- Digitize - Digitize is used when a point in the graphic area is required. It is not used when specific elements are being "Selected".
- Station - The same tool for defining stations is used in almost every instance. This tool provides for
 - Entering station value
 - Selecting Beginning or Ending Station
 - Digitizing a point
- Shape - Shapes may be designated by entering a number or selecting a shape from Graphic Shape Browse display.

- Prompt - Prompt is used when the system gives an instruction such as "Select VPI to be revised".
- Action Buttons - Dialog boxes have action buttons such as the following which are clicked to cause an action.
- OK

Executes the command or process with the data shown; dismisses the dialog.
 - Cancel

Dismisses the dialog without changing any data.
 - Apply

Executes the command or process with the data shown; leaves the dialog open.
 - Reset

Returns values to their state prior to current changes.
 - Close

Dismisses the dialog.
 - Help

Displays Help information for the dialog.
 - Delete

Deletes the specified object.
 - Prev

Moves to previous object.
 - Next

Moves to next value.
 - Toggle

Refers to a two state button where each click changes state.

- Highlight

Signifies that this item has the keyboard focus.

- Scroll

A technique for accessing information that is too large to fit within a list box.

- Accept/Reject

Accept with left mouse button; reject with right button.

- Focus

Indicates that this item will react to keyboard input.

- Tear Off

Drag a tool box menu off of master palette frame.

Important Data Considerations

There are a few data conventions and consideration that must be observed throughout IGrds. These are discussed in the following subsections.

Metric/Imperial Units

Most of the IGrds internal computations are dimensionless, but input or output units may be either metric or imperial. The selection of units is made at the project level by initially selecting the appropriate parameter file. Input units will be interpreted according to the select parameter file. A recent feature allows for the conversion of IGrds working files from one set of units to the other, from metric to imperial and vice versa. This process is discussed in detail in Chapter 10.

Roadway stations are expressed as 100 foot distances when imperial units are being used. When metric units are being used, stations may be expressed either as 100 meter distances or 1000 meter distances. Output stations are shown as illustrated here:

35+15.21	100 feet/station
35+15.21	100 meters/station
3+515.211	1000 meters/station

Roadway Considerations

Multiple roadways (Horizontal Alignments may be defined and may be referenced by many IGrds commands. Any roadway may be designated as a baseline (alignment for cross sections). You must always be specific as to which roadways and baselines are to be referenced by IGrds command or function. There are commands for establishing active roadway, active baseline, or sets of design roadways. You need to remember the following important considerations:

- Roadway names can be up to eight characters in length. Leading or trailing blank spaces are ignored, but spaces within the roadway name are considered part of the name. ROADWAY NAMES ARE CASE SENSITIVE.
- Any defined roadway may be a design roadway used to develop design cross sections.
- Any defined roadway may be a terrain baseline. See Multiple Baselines.
- Any defined roadway may be both a design roadway and a baseline.
- Multiple baselines (35 maximum) may be used in a single project with multiple design roadways (1-6) assigned to each baseline.
- When entering one or more sets of baselines in the AN option or IG option (via the Terrain Input facility); or requesting one or more sets or cross sections from a displayed DTM in the IG option, the baseline for each must be specified. See Multiple Baselines.
- When requesting a design, the baseline and design roadways must be specified.
- When requesting cross section or profile plots or similar earthwork functions related to a baseline, the baseline must be specified. See Multiple Baselines.
- Design can be done directly on the baseline roadway.

Multiple Baselines

IGrds supports the use of multiple baselines (up to 35) in a single project. The ability to define and use multiple baselines facilitates the design of interchanges within a single project, especially when used in conjunction with a displayed DTM.

The Create/Set Active Baseline command establishes the active baseline and design roadways. It is similar to setting the active roadway, but it indicates which set of design roadways to use.

Percent Grade

Percent grade is expressed as change in elevation per 100 units of distance (e.g., feet of rise per 100 feet or meters of rise per 100 meters).

MicroStation Precision

IGrds is designed to work only with .01 feet or meter, .001 feet or meter, or .0001 feet or meter (MU:SU:PU's of multiples of 10).