DISPLAYING

Tutorial

Displaying Geospatial Data

with

TNTmips®

TNTedit™

TNTview®

Before Getting Started

This tutorial booklet introduces you to the TNT products from MicroImages, Inc. You may be a professional with years of experience, or you may be a student taking your first GIS or Image Processing course. Whatever your situation, this booklet will help you get started with the TNT products. We recommend that your next tutorial booklet be *Tutorial: Navigating*. Once you learn the basics of TNT with these first two booklets, you will be ready to branch off in any direction to explore the many powerful features TNT offers.

Sample Data The exercises presented in this booklet use sample data that is distributed with the TNT products. If you do not have access to a TNT products CD, you can download the data from MicroImages' web site. In particular, this booklet uses objects in the CB_DATA and BLACKBRN data collections. The installation process makes read-write copies of these files on your hard drive: you may encounter problems if you work directly with the read-only files on the CD-ROM.

More Documentation This booklet is designed as the first in the tutorial series. Further general system information is provided in the *Navigating* tutorial, which covers the X Server and many TNT interface conventions. After you complete the exercises in these two booklets, you will have the basic skills you need to pick up any of the other tutorial booklets. Refer also to the TNT reference manual (see page 31), which contains over 300 pages on the display and visualization of geospatial data.

TNTmips® and TNTlite® TNTmips (The Map and Image Processing System) comes in two versions: The professional version of TNTmips, and the free TNTlite version. Both versions run exactly the same code from the TNT products CD-ROMs and have exactly the same features. If you did not purchase the professional version (which requires a software license key), then TNTmips operates in TNTlite mode, which limits the size of your project materials and enables data sharing only with other copies of TNTlite.

This booklet refers to TNTmips, TNTedit, TNTlite, and TNTview as "TNT." Since the display features in all four products are essentially the same, you will be able to follow these exercises no matter which product you have.

Keith Ghormley, 3 June 2002

It may be difficult to identify the important points in some illustrations without a color copy of this booklet. You can print or read this booklet in color from MicroImages' web site. The web site is also your source for the newest tutorial and application booklets on other topics. You can download an installation guide, sample data, and the latest version of TNTlite:

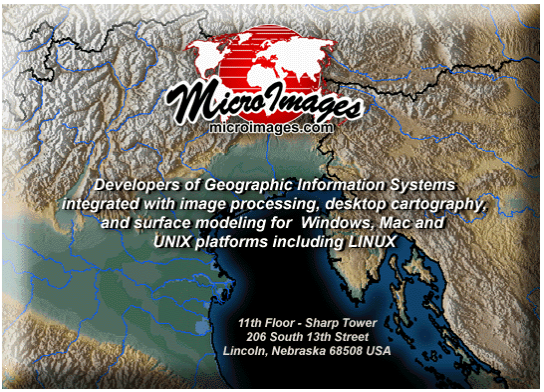
http://www.microimages.com

Install TNT

Install the TNT products from the CD-ROMs. An *Installation and Setup Guide* for each computer platform in Adobe PDF format is provided in the \getstart directory of the TNT Products A CD-ROM. Use the free Adobe Acrobat Reader and refer to the booklet for your platform: Windows (wininst.pdf), Macintosh (macinst.pdf), or UNIX (unixinst.pdf).

Sample Data The exercises in this booklet use the sample data distributed with the TNT Products. Use the option in the install process to copy the sample data to your hard drive (do not use it from the CD). You can also download the sample data from MicroImages' Web site. The Web site has TNT product information, tutorial and application booklets, a directory of authorized dealers for the TNT products, and instructions for downloading the newest version of TNTlite.

Windows computers begin each TNT session with the splash screen for MI/X, the MicroImages X Server.



The geospatial data display process is common to TNTmips, TNTedit, and TNTview. It also is at the core of the free TNTatlas product.

- TNTview contains the display process, the Spatial Manipulation Language and the import process.
- TNTedit is TNTview plus the geodata editor, georeferencing, and full export capability.
- TNTmips is the complete suite of TNT display, editing, processing, and support processes.

The exercises in this book describe the display process as it appears in the TNTmips / TNTlite product. Only slight differences in the way you launch the process appear in the TNTedit and TNTview products.

The exercises in this booklet on pages 4 - 9 introduce basic object and display concepts. Pages 10 - 20 introduce each type of spatial data object. More complex visualization and output features are covered on pages 21-31.

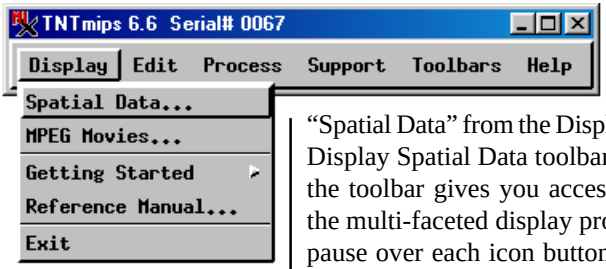
Start TNTmips

TNTmips 6.7

TNTmips uses cascading menus. The tutorial booklets refer to menu choices with a **menu path** notation. For example, choosing "Spatial Data" from the "Display" menu is indicated with the menu path "Display / Spatial Data."

Launch TNT for Windows and Mac computers by double-clicking on the TNT program icon created by the installation process. The system starts the MicroImages X Server, which provides the operating environment for TNT. (On UNIX computers, X should already be running.)

TNT displays its main menu with the items Display, Edit, Process, Support, Toolbars, Custom, and Help. This booklet uses the Display Spatial Data process to introduce the main types of geospatial **objects** used in the TNT products: rasters, vectors, CAD, TIN, and database. The exercises show you how to display both simple and multi-object / multi-layer views.



Launch the display process by selecting "Spatial Data" from the Display menu. TNT posts a Display Spatial Data toolbar. Each icon button on the toolbar gives you access to another aspect of the multi-faceted display process. Let your cursor pause over each icon button in turn to expose the ToolTip for that icon button. For these introductory exercises, we will use the simplest form: a 2D display group. Click the New 2D Group icon button on the toolbar.

When you are finished with a TNT session, close each active TNT process. You exit Display Spatial Data by clicking the exit icon button on the process menu bar. You exit TNTmips by selecting Exit from the Display menu in the main menu bar.

STEPS

- ☑ launch TNT from the desktop
- ☑ select Display / Spatial Data
- ☑ expose the ToolTip for each icon button in turn on the Display Spatial Data toolbar
- ☑ click the New 2D Group icon button

You can always tell what an icon button does by exposing its **ToolTip**: hold your cursor over an icon button for a moment to see a description of the button's function.

Group View and Group Controls

The display process opens a Group View window and a Group Controls window as Group 1. (Both of these windows are empty for now.)

Examine the **Group View** window. It contains menus, icon tool buttons, a large canvas area, a LegendView pane, and other status and position readouts (blank for now). The View window displays the objects in a group and offers zoom, pan, and measurement tools.

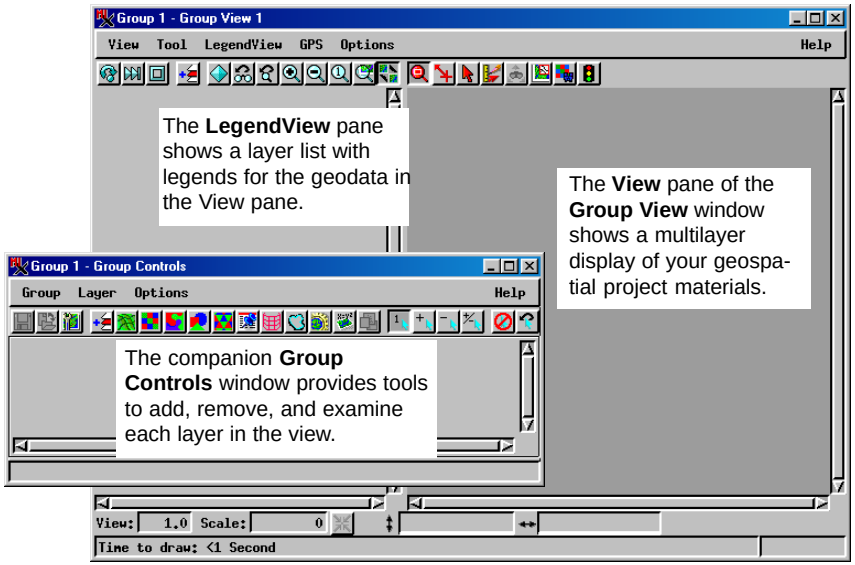
The companion **Group Controls** window adds and removes display layers, and lets you examine the attributes associated with each object. The Group Controls window contains menus, icon tool buttons, and an expandable list of objects in the group.

The display process lets you simultaneously open multiple View and Control windows, plus 3D groups, display layouts, and hardcopy layouts. This booklet introduces the 2D Group display. Other tutorial booklets treat 3D Perspective and Stereo visualization, and using hardcopy layout groups for map and poster design.

STEPS

- ☑ inspect the interface components of the View and Controls windows
- ☑ click on the main menus in each window to survey the drop-down selections
- ☑ close the group by selecting Close from the Group menu in the Controls window

The **LegendView** pane and the **Group Controls** window both show a layer list of the geodata in the display group. The LegendView in the View window offers commonly used functions where you can quickly associate them visually with the current view. The Group Controls window offers an exhaustive set of all display control features.



File and Object Selection

A **Project File** is the single TNT data structure for all raster, vector, CAD, TIN, database, and text materials, as well as associated subobjects that define attributes of the main objects (such as georeference control and display characteristics). Project Files all have an .RVC file extension.

Most processes open a standard Select Object window so you can navigate through drives, directories, and Project Files to locate the input and output project materials you want. In the exercises on this page and the next, you will select a predefined 2D group for the display process. For purposes of illustration, we assume your sample data is on drive C: in /TNTDATA/LITEDATA. (Sample data is copied to your computer by the installation process.)

First, select Open / Open Group from the main icon menu. TNT opens the Select Object window so you can select a 2D display group.

STEPS

- ☑ click Open on the toolbar menu and select Open Group from the drop down menu
- ☑ examine the Select Object window that opens

The Select Object window shows Project Files and the objects they contain. Double-click on items in the list to open them (folders and Project Files) or to select them (objects).

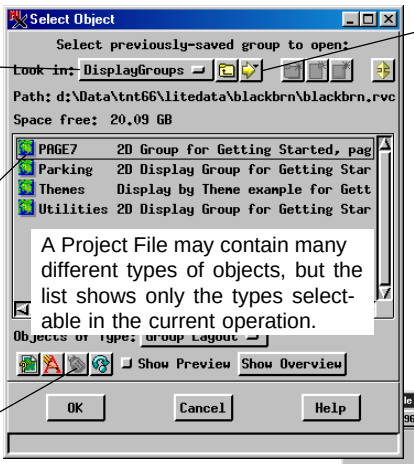
(The exercise on the following page helps you complete the process of selecting a 2D display group.)

Select folders, files, and objects from the object list.

Jump to a directory, Project File, or Folder by clicking on the Look In: option button.

An icon shows the type of each item in the list.

Grayed-out interface elements are not active in the current context.



Select your DRIVE or other storage device by clicking on the Go To icon button.

(The Project File Overview window is described later in this booklet)

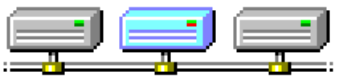
Select a Display Group

- ☑ Select drive C: from the Go To icon button above the object list; the object list will show you the directories in drive C.
- ☑ Select the /TNTDATA/LITEDATA/BLACKBRN directory from the object list; TNT shows you the Project Files (file extension .RVC) in that directory.
- ☑ Select the BLACKBRN Project File from the object list; TNT shows you a list of folders inside the Project File.
- ☑ Select the DISPLAYGROUPS folder; TNT shows you a list of objects in the folder.
- ☑ Select the PAGE7 display group.
- ☑ Click the [OK] button to complete your selection and close the Select Object window. TNT automatically displays the selected group in the View window.

When you complete these steps, your View and Controls windows should look like those illustrated on pages 8 and 9.

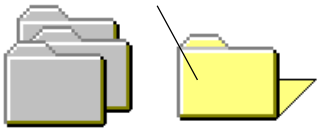
Keep the PAGE7 display group on the screen for the next exercise.

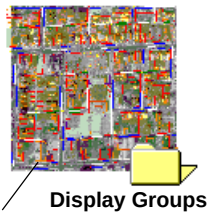
If you do not find the sample data on your computer, go back and run the TNT products installation process, specifying the option to install the sample data (see page 2).



1 Click the Go To icon button to select the **DRIVE** or other storage device; in this example, drive C**.**

2 Once you have selected the */*TNTDATA/LITEDATA/BLACKBRN directory, select a **Project File** from the object list; in this example, BLACKBRN**.**

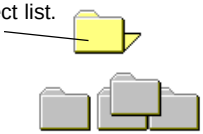




Display Groups

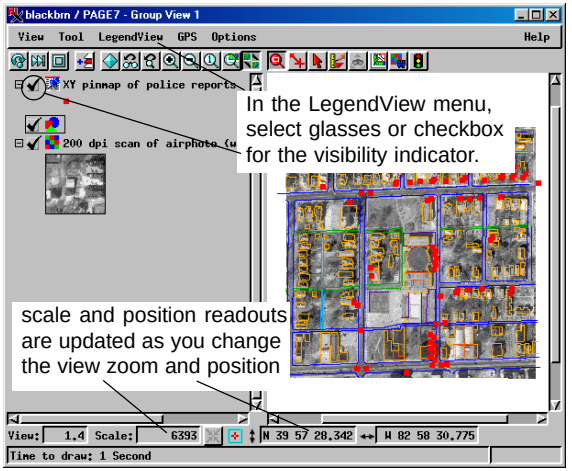
4 A Project File or a Folder may contain several **objects**. For this exercise, select the PAGE7 display group from the object list.

3 A Project File may be logically organized to include one or more **Folders**. For this exercise, choose the DISPLAYGROUPS folder from the object list.



The TNT system always LOCKS a Project File while you are using it so that only one user or process can access it at a time. If your computer shuts down abnormally while a Project File is locked, you can unlock it by deleting the .LOK file (such as BLACKBRN.LOK) located in the same directory.

Using the View Window



In the previous exercises, you selected PAGE7 from the DISPLAYGROUPS folder in the BLACKBRN Project File. The PAGE7 group contains three layers: AERIAL (a raster object airphoto), FOOTPRINT (CAD outlines of buildings), and CRIME (a database pinmap).

When you completed the selection process, TNT closed the Select Object window, returned to the display process, updated the layer list in the Controls window, and displayed the PAGE7 group in the View window.

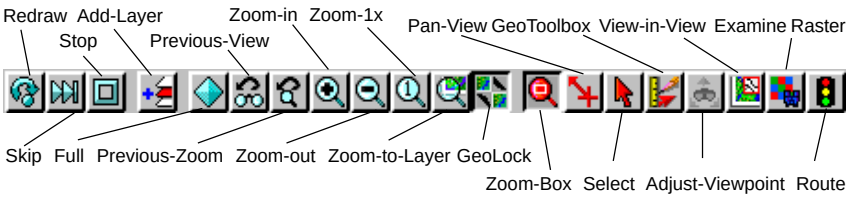
Icon buttons across the top of the View window present many display control features. Click the Zoom In icon to enlarge the view. Click Zoom Out to reduce the view. Select the Zoom Box and draw an elastic box on the display image. When you finish drawing the box by releasing the mouse button, the display zooms to the extents of the box. Click the 1x icon to return to a "1x" view (1:1 raster cell to display pixel). Click Full View to fit the whole group as nearly as possible to the current window size.

Notice that the scale and position readouts at the bottom of the window update each time you change the zoom level.

STEPS

- ☑ click **Zoom In** to magnify the display 
- ☑ click **Zoom Out** to return to 1x 
- ☑ click the **Zoom Box** and draw an elastic zoom box 
- ☑ return to **1x** with the 1x icon button 
- ☑ click **Full View** to fit the whole group to the window 

if the behavior of the zoom box has been redefined on your computer (see p. 30), you may need to click the right mouse button after drawing a zoom box to trigger the redraw.



Using the Controls Window

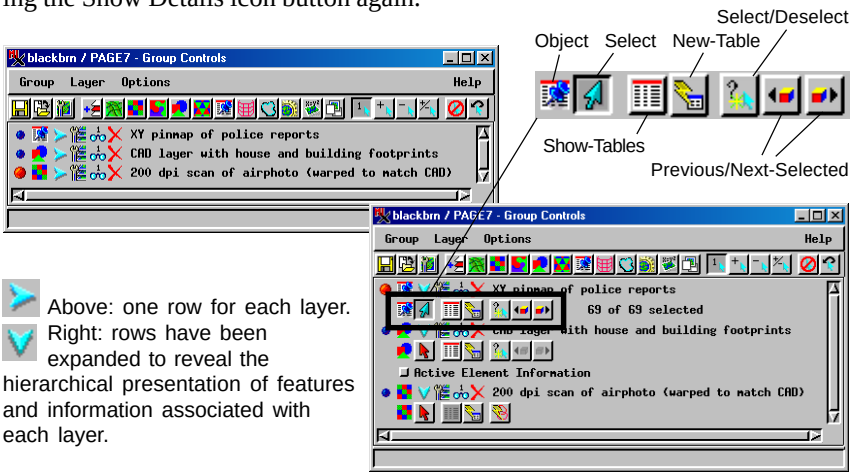
The Controls window for 2D groups gives you access to several features related to the display objects. Each row in the Controls window corresponds to one layer in the View window.

You can access subordinate information and controls for a layer by clicking the Show Details icon button to expose subordinate rows of table / selection controls. The table / selection controls vary slightly according to the type of parent object, but the differences are easily understood. For the CRIME database pinmap, click the Select icon button (it changes from red to blue), which *makes the pinmap symbols in the View window selectable*. Next, click the Show Tables icon button, which exposes a row for each database associated with the object (for the CRIME pinmap, one table).

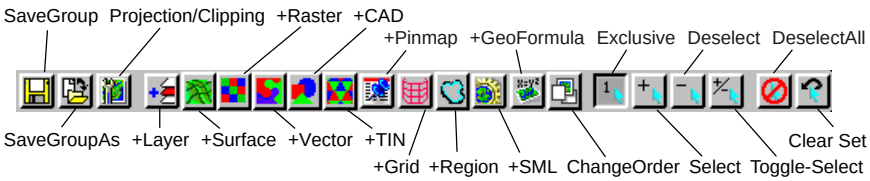
Hide the table / selection controls for a layer by clicking the Show Details icon button again.

STEPS

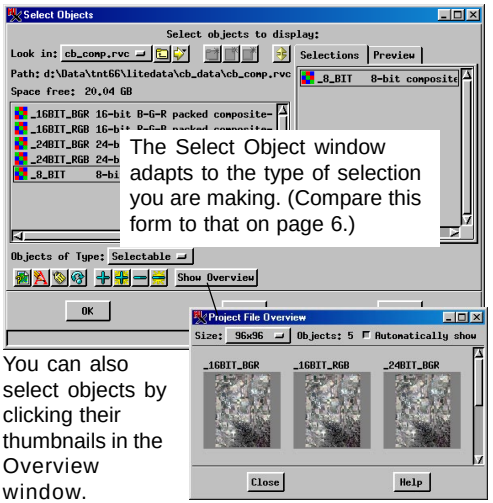
- ☑ click Show Details in the CRIME layer
- ☑ click Show Details in the FOOTPRINT layer
- ☑ click Select for the CRIME pinmap
- ☑ click Show Tables for the CRIME pinmap
- ☑ click Show Details for FOOTPRINT to close its table / selection controls
- ☑ click the Remove icon button for each layer to clear the Group for the next exercise



Above: one row for each layer. Right: rows have been expanded to reveal the hierarchical presentation of features and information associated with each layer.



Add a Raster from the LegendView



The Select Object window adapts to the type of selection you are making. (Compare this form to that on page 6.)

You can also select objects by clicking their thumbnails in the Overview window.

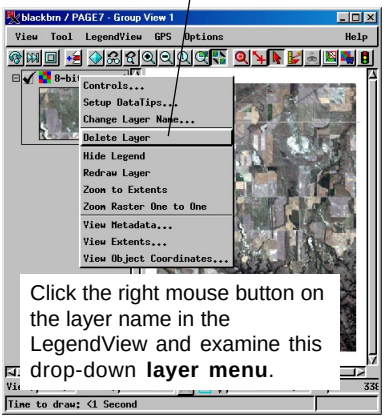
A **raster** is a geospatial data object that may contain an image, such as a digital photo, a satellite image, or a scanned map. A raster is logically a two-dimensional array of cells, like a spreadsheet. If you have ever used paint or photo-editing software, you may be familiar with common raster formats like TIFF, BMP, and GIF.

A composite color raster uses a color table to map each raster cell value to a discrete display color. Click on the Add Layer icon button in the View window, and select Quick Add from its menu. In the Select Object window, open the CB_DATA directory, the CB_COMP Project File, and the _8_BIT raster object. When you complete the selection, the View window shows the composite color raster, and the LegendView shows a single layer. Right-click on the layer name in the LegendView and examine the drop-down menu that opens. The selections on that menu apply to the _8_BIT raster layer. In later exercises, you will see multiple-layer views, and each layer will have its own drop-down menu in the LegendView.

STEPS

- ☑ click Add Layer / Quick Add in the View window 
- ☑ select CB_DATA / CB_COMP / _8_BIT
- ☑ right-click the layer name in the LegendView to see the layer menu for _8_BIT
- ☑ select Delete Layer from _8_BIT's LegendView layer menu

Survey the selections on the drop-down layer menu. When you are finished, remove the _8_BIT raster object from the group by selecting Delete Layer from the layer's drop down menu in the LegendView.

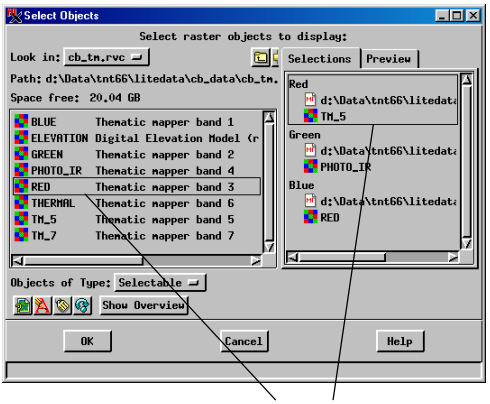


Click the right mouse button on the layer name in the LegendView and examine this drop-down **layer menu**.

_8_BIT is a composite color TM (Thematic Mapper) satellite image of the Crow Butte map quadrangle in Nebraska.

Select a Three-Raster RGB Set

A color image can be created from three separate raster objects when each raster object is used to control one color component: one raster object provides the red component, one the green, and one blue. Use component color raster display for viewing selected bands from multispectral image sources, such as 7-band TM satellite images. By assigning various bands to the RGB components, you can view and analyze false-color images. (Other multiple-component raster display modes use input rasters for hue, intensity, and saturation (HIS), or as hue, brightness, and saturation (HBS) components.)



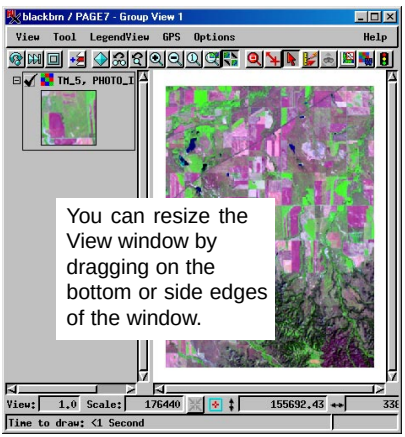
To select RGB rasters, click a raster on the left to add it in the current position on the right.

STEPS

- ☑ select Raster / Quick-Add RGB from the Add Raster icon button menu 
- ☑ select TM_5, PHOTO_IR, and RED from CB_DATA / CB_TM
- ☑ select Delete Layer from the layer menu in the View window

Click the Add Layer icon button in the View window, and select Raster / Quick-Add RGB from its menu cascade. In the Select Object window, select the CB_TM Project File, which contains 7 co-registered raster objects of the 7 bands of TM imagery for Crow Butte. Click on the TM_5 raster object to move it to the list on the right for the Red component. Then select PHOTO_IR for Green and RED for Blue. Click [OK] to complete the selection and look at the false-color image in the View window.

If your computer is in a 24-bit display mode, you will see a true 24-bit color image (each of the component raster objects provides 8 bits of information). If your computer is in a 16-bit or 8-bit display mode, the display process automatically reduces the 24-bit color information from the RGB raster objects into an optimally chosen palette with the appropriate number of colors.



Vector Display

A **vector** is a spatial data object containing point, line, and polygon data. Vector objects often contain features with associated database values, such as

- agricultural fields and crop information,
- political districts and population data,
- well locations and pumping capacity, and
- highway segments and paving type.

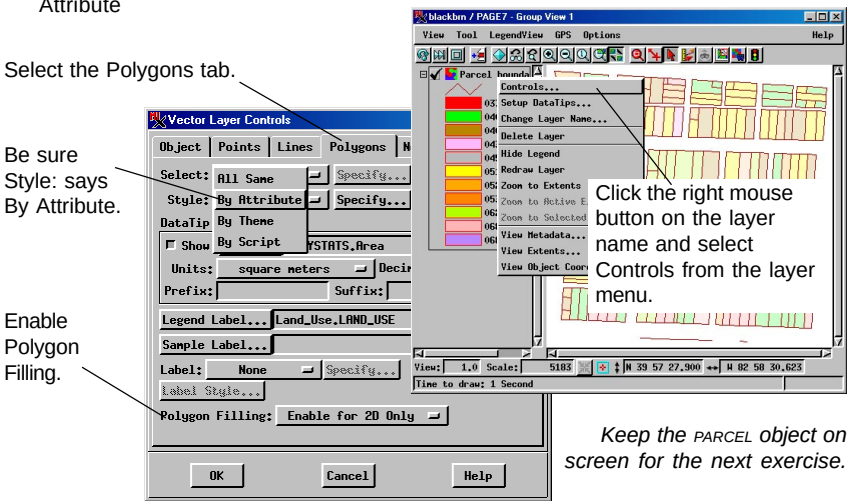
STEPS

- ☑ select Quick-Add from the Add Layer icon menu 
- ☑ select the /TNTDATA/LITEDATA/BLACKBRN directory, the BLACKBRN Project File, and the PARCEL vector object
- ☑ select Controls from PARCEL's right mouse button layer menu in the LegendView
- ☑ in the Polygons tab, select Style: By Attribute

This exercise introduces the second major type of geospatial data object: the **vector object**. Vector objects contain point, line, and polygon elements with associated database records. A sample vector object from the Blackburn neighborhood in Columbus Ohio shows property parcels and associated tabular data from the County Assessor.

Click the Add Layer icon button in the View window and select Quick-Add from its menu. In the Object Selection window, select the drive and directory where you have your sample data. Select the BLACKBRN Project File, and the PARCEL vector object in it. When you click [OK], TNT adds PARCEL to the layer list in the Control window and to the LegendView, and automatically redraws the display.

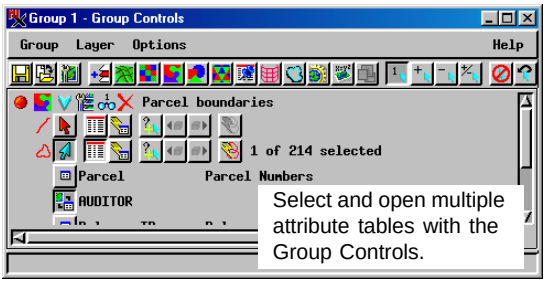
Open the Vector Layer Controls dialog by selecting Controls from the LegendView's right mouse button menu. Click the Polygons tab and be sure the Style: button says By Attribute and select one of the Enable options from the Polygon Filling option button. Visit the Object tab. When you click [OK], the PARCEL vector object should appear in the style illustrated here.



Keep the PARCEL object on screen for the next exercise.

Vector Attribute Display

You can select elements on the display to see database attributes of vector, CAD, TIN, and raster objects. Click on the Select Tool in the View window's tool bar. Then click on one of the parcel in the display, and TNT opens the default attribute database for the selected element

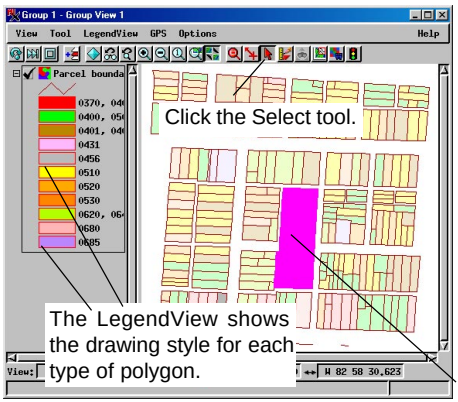


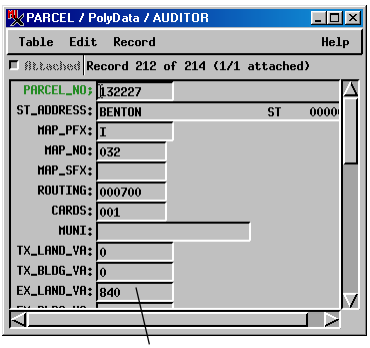
Vector elements may have any number of different attribute tables. To select other tables, click PARCEL's Show Details icon button in the Control window. The Controls window shows a table / selection row for each element type in the PARCELS vector object: lines, polygons, and points. Expose the tables for the polygon elements by clicking that row's Show Tables icon button. Then open a database window for AUDITOR by clicking its View Table icon.

Now when you click on a parcel polygon in the View window, the database window shows the AUDITOR record for that polygon. You can switch from single-record view (illustrated here) to a tabular view by selecting Tabular View from the Table menu in the database window.

STEPS

- ☑ click Show Details in the Control window 
- ☑ turn on the Select arrow for polygons 
- ☑ click Show Tables for polygons 
- ☑ click the View Table icon for the AUDITOR table 
- ☑ click on a polygon in the View window
- ☑ examine the related database record in the database window





CAD Display

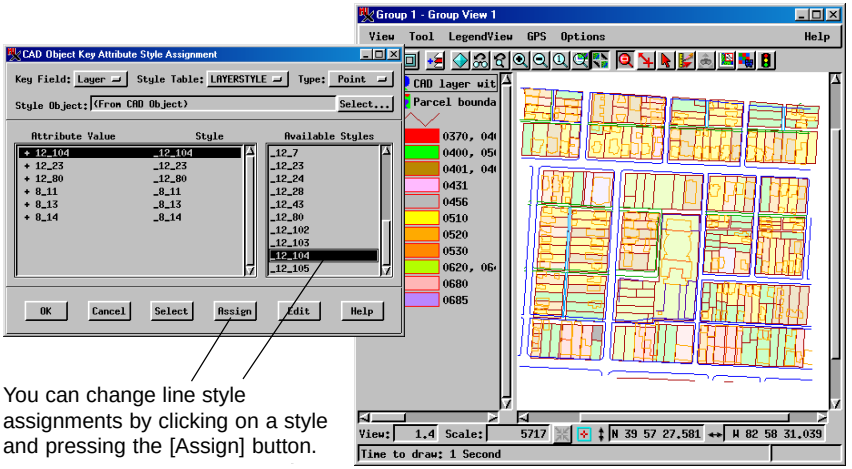
A **CAD** object contains point, line, polygon, shape, and block elements with their associated database records. CAD objects differ from vector objects in that CAD objects do not have the rigorous spatial **topology** of vector objects. A CAD object allows for overlapping elements in a layered drawing order, whereas in a vector object, all elements are always in one layer.

STEPS

- ☑ click the Add Layer(s) icon button  in the Group Controls window
- ☑ select the FOOTPRINT CAD object in the BLACKBRN Project File
- ☑ click the FOOTPRINT  layer icon in the layer list of the Group Controls window and change Style to By Attribute

This exercise introduces the third major type of object: the **CAD object**. CAD objects contain point, line, polygon, shape, and block elements with associated databases. CAD objects are used for interpretation and annotation layers, as well as for overlapping, layered spatial elements, such as lines that lie in front of or behind polygons.

The FOOTPRINT CAD object in the BLACKBRN Project File contains outlines of the buildings in the study site. Add a layer from the Control window by clicking the Add Layer(s) icon button, or from the View window by selecting Quick Add from the Add Layer icon menu. Select FOOTPRINT from the BLACKBRN Project File. The building footprints may display in a single line style. To use line styles, open the Layer Controls dialog (either click on the FOOTPRINT layer icon in the Controls window or select Controls from the layer drop-down menu in the LegendView), and then change the Style: option button from [All Same] to [By Attribute]. When TNT redraws the display, the lines show in colored styles. If you click on Specify... in the Layer Controls dialog, you can change the style assignments.



You can change line style assignments by clicking on a style and pressing the [Assign] button.

Database Pinmap Display

This exercise introduces the fourth major type of spatial data object: the **Database object**. Database objects contain records of numeric, text, and logical fields that may have some spatial quality. A database record may be related to a spatial coordinate system in two ways: (1) each record may contain explicit coordinate values, or (2) each record may contain attributes that act as key fields that are linked to other types of geospatial objects.

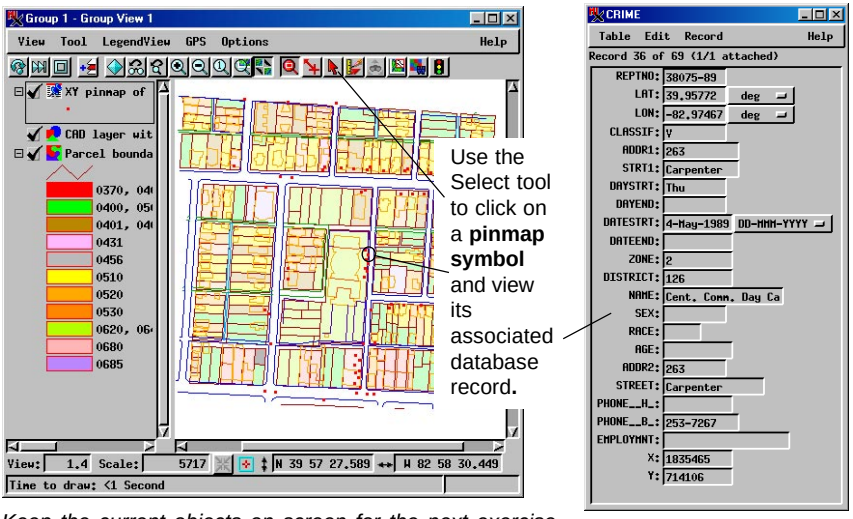
When database records contain map coordinate values, TNT can create a "pinmap" from the database records. The BLACKBRN Project File includes a database of police calls with such map coordinates.

Click the Add Database Pinmap icon button in the Controls window. Then select the CRIME database object from the BLACKBRN Project File. TNT opens a tabbed Pinmap Layer Controls window so you can change various pinmap symbols and control parameters. For this exercise, accept the default settings by clicking the [OK] button. TNT returns to the View window and automatically redraws the display.

TNT can link to external database files in several formats, or use its own internal database format.

STEPS

- ☑ click the Add Database Table Pinmap icon in the Controls window
- ☑ select the CRIME database object in the BLACKBRN Project File
- ☑ click [OK] to accept default display controls
- ☑ open the database for the CRIME layer by clicking Show Details, Show Tables, and View Table (refer to page 13)
- ☑ use the Select tool in the View window to click on a pinmap symbol



Keep the current objects on screen for the next exercise.

Theme Mapping

Theme Mapping applies selected values in a database to the drawing styles used for elements in vector and TIN objects.

STEPS

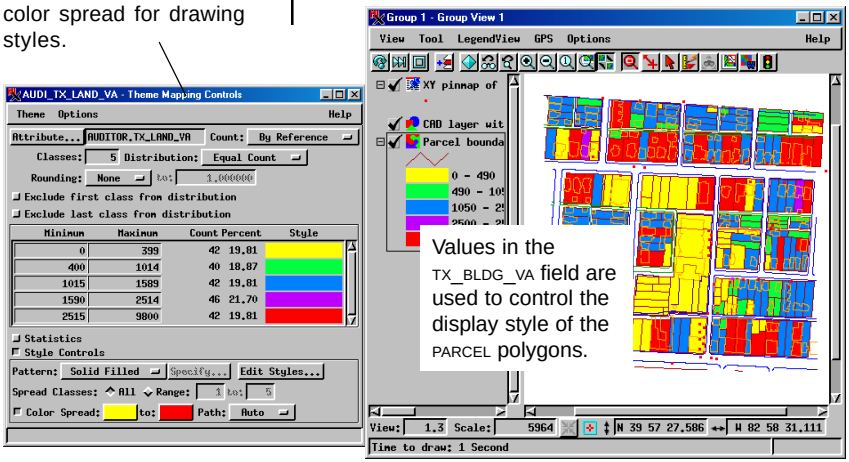
- ☑ click the PARCEL object icon to open the Vector Layer Controls dialog
- ☑ change Style: to [By Theme]
- ☑ click [OK] to initiate a redisplay
- ☑ close this display Group by selecting Group / Close in the Group Controls window

If you click [Specify...] next to Style: By Theme in the Vector Layer Controls window, TNT opens the Theme Mapping Controls window. You can select the database, theme field, number of themes, and color spread for drawing styles.

Vector and TIN objects can be displayed "By Theme" so that selected values in associated database tables control the display style of the elements. For example, a "Flow_Capacity" field associated with pipeline line elements could be used to determine the display color and style for all the pipeline elements in a vector object.

In this exercise the TX_BLDG_VA (building tax value) field from the county AUDITOR database is used to control the polygon display style of the PARCEL polygons. A color spread from yellow to red has been created so that churches, public buildings, and parcels with no buildings (zero tax value) display in yellow, and parcels with the highest tax values display in red. Intermediate tax values are green, blue, and purple.

The PARCEL vector object should already be on your display from the previous exercise. Click on the PARCEL object icon in the Group Controls window to open the Vector Layer Controls dialog. Select the Polygon tab and change the Style: to [By Theme]. When you click [OK] to complete the operation, TNT redisplays the PARCEL vectors in the style illustrated here.



TIN Display and DataTips

This exercise introduces the final major type of geodata: the **TIN** ("Triangulated Irregular Network") object. TIN objects consist of a network of *triangles* formed from a set of x,y,z coordinate *nodes* in 3-D space connected by *line* segments. TIN objects provide benefits of speed and efficiency for processes that deal with 3-D surfaces.

Select Open Group from the Open icon menu, and select the TINLITE Project File in SF_DATA. From the TINLITE Project File, select the TINGROUP object, which contains three layers: USGS_DEM, RIGHTLITE, and TINLITE. USGS_DEM was extracted from a full-quad elevation raster. RIGHTLITE is a reduced section of an airphoto. TINLITE was extracted from a stereo pair of airphotos in the Photogrammetric Modeling process, and represents the derived elevation surface.

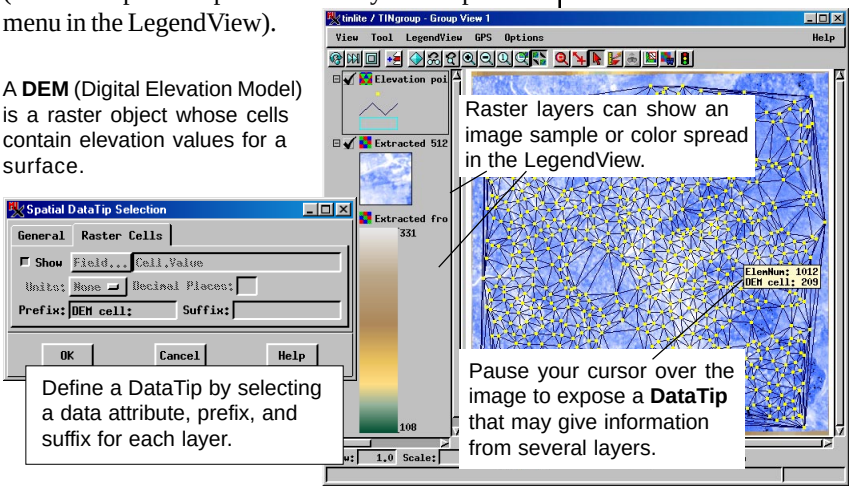
TINGROUP is defined so that a DataTip shows values from two of the three layers in the group. Compare the DataTip you see when your cursor pauses over the image with the DataTip definitions for each layer (select Setup DataTips from each layer's drop-down menu in the LegendView).

A **TIN** object defines a 3-D surface with a network of node, edge, and triangle elements.

STEPS

- ☑ select Open Group from the Open icon menu 
- ☑ select the SF_DATA data collection and the TINLITE Project File
- ☑ select the TINGROUP object
- ☑ select the View window's Options / DataTips menu and turn on the All Layers toggle
- ☑ pause your cursor over a TIN node to expose a DataTip
- ☑ select Setup DataTips from the layer menu in the LegendView

A **DEM** (Digital Elevation Model) is a raster object whose cells contain elevation values for a surface.



For information on the 3D display of TINs, see the tutorial booklet *3D Perspective Visualization*. To see how TINs are used in Stereo-to-DEM and surface modeling, see the booklets, *Making DEMs and Orthophotos* and *Surface Modeling*).

Multi-Layer Display

One of the most powerful visualization features of TNT is the way it so easily integrates geospatial data objects of all types and map projections.

STEPS

- ☑ in the View window, click Add Layers and Add Database Pinmap and select the objects listed 
- ☑ click on each layer's object icon in the Controls window and adjust its display controls

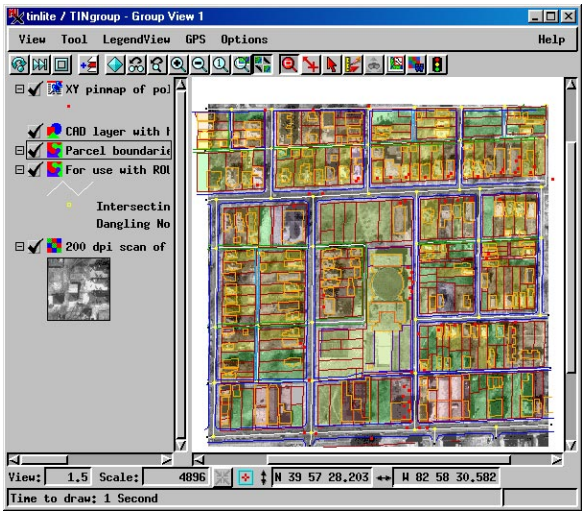
Several multi-object **layout objects** are included with the TNTlite sample data. Click Open / Open Layout on the main icon menu and browse through the LAYOUTS Project File in /BEREA, /BLACKBRN, / CB_DATA, and /SF_DATA.

This exercise builds a complex display from Raster, Vector, CAD, and Database objects. Create a new group and add these layers:

Raster:	BLACKBRN / AERIAL
Vector:	BLACKBRN / STREETS
Vector:	BLACKBRN / PARCEL
CAD:	BLACKBRN / FOOTPRINT
Database:	BLACKBRN / CRIME

First use the Add Layer(s) icon button in the Controls window to add the raster, vector, and CAD objects. Then use the Add Database Pinmap icon button to select the database object.

Whenever you select multiple objects for display, be sure each one is registered to some spatial coordinate system, as they are in this sample data. TNT automatically reconciles different map projections and coordinate systems, but if one object has no map registration, then you will get unpredictable display results. (To add map registration to an object that has none, refer to the tutorial *Georeferencing*.) Objects must also share a reasonable spatial proximity. A raster in Texas and a vector in Asia may be selected together, but a full display would zoom out so far that the objects would be too small to see.



The transparency effect for the polygons in the PARCEL layer is achieved in the Polygons tab of the Vector Layer Controls dialog. Set Style to By Attribute (the predefined styles for these polygons specify 90% transparency), and select one of the Enable options in the Polygon Filling option button.

SML Script Layers

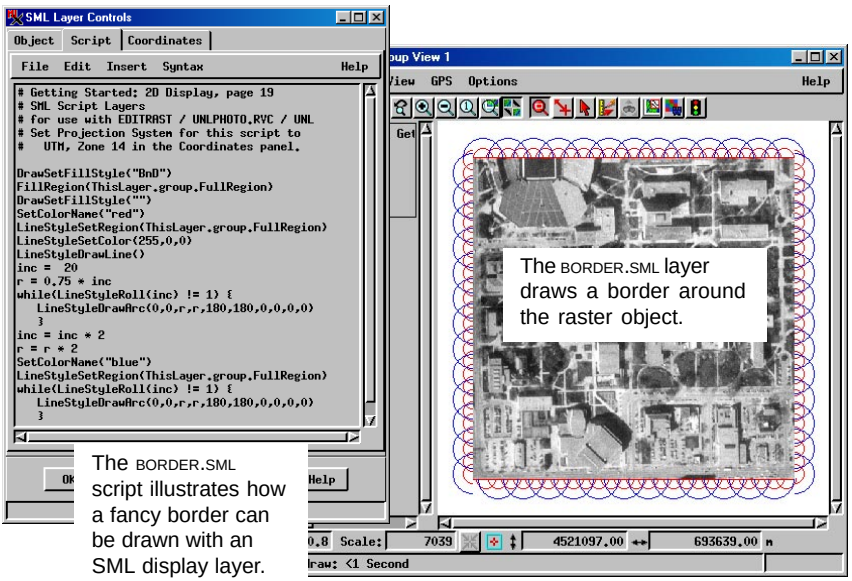
The Spatial Manipulation Language (SML) can be used to create a cartographic drawing layer for the display process. Each time the layer is redrawn, the SML script is executed and the output appears as a layer in the View window.

Please note that the separate SML process (Process / SML) offers a full-featured language for creating customized processes that manipulate and analyze geospatial objects. (Refer to the tutorial booklet *Spatial Manipulation Language*.) By contrast, this SML layer feature in the display process is designed with a much narrower purpose: to provide customizable cartographic drawing functions. (More complex SML display operations are possible with the GeoFormula feature, which is introduced on page 20.)

Add the UNLPHOTO / UNL raster object and the BORDER.SML script as instructed. The raster object must be added first because the script bases its drawing geometry on the raster's map coordinates.

STEPS

- ☑ click Add Layer and select UNLPHOTO / UNL from the EDITRAST data collection 
- ☑ click Add SML to open the SML Layer Controls window 
- ☑ select the Script tab and choose File / Open *.SML File
- ☑ select BORDER.SML from the EDITRAST data collection
- ☑ select the Coordinates tab and change the Projection System to Universal Transverse Mercator, Zone 14
- ☑ click [OK] to close the SML Layer Controls window
- ☑ click Change Order / Lower to move the SML layer behind UNL 



The BORDER.SML script illustrates how a fancy border can be drawn with an SML display layer.

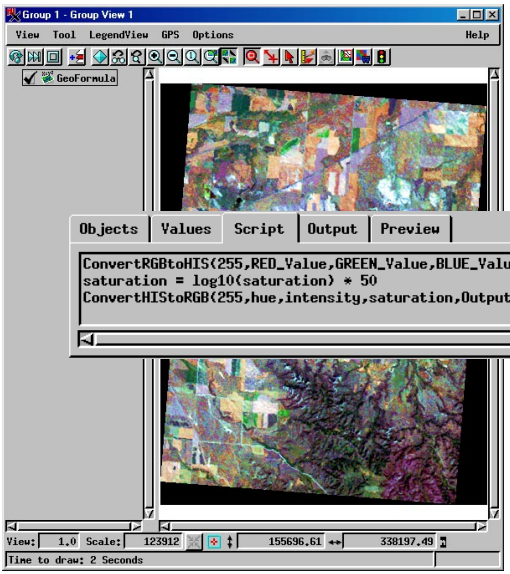
GeoFormula Layers

STEPS

- ☑ click GeoFormula / Add GeoFormula Layer in the Controls window
- ☑ in the GeoFormula Layer Controls dialog, select Formula / Open
- ☑ use the standard Select Object process to select GEOFRMLA / STRETCH2.GSF
- ☑ for input, select RED, GREEN, and BLUE from CB_DATA/ CB_TM as prompted
- ☑ click [OK] to close the GeoFormula Layer Controls dialog

A GeoFormula is a computed display layer that uses one or more input objects to derive a layer for display. It gives you a way to combine objects "on the fly" rather than preparing objects for display ahead of time with preliminary processing. A GeoFormula is a dynamic display layer that contains a "virtual object." The GeoFormula layer does not create an output object that is saved in a Project File. Instead, it creates a display layer that releases all its system resources (such as disk space and memory) when you are finished with it.

In the exercise on page 11, you used three raster objects for component color from CB_DATA / CB_TM. Create a new display group and follow the step list on this page. When you are prompted for input raster objects, select the same CB_TM Project File, this time adding the RED, GREEN, and BLUE rasters. If you are familiar with a programming language, such as C or BASIC, you should get a sense of how a GeoFormula works by examining the script illustrated below.



This GeoFormula applies a color transformation to increase color saturation. It translates the RGB components to Hue-Intensity-Saturation (HIS) equivalents and applies a saturation stretch.

Creating and applying GeoFormulas is an advanced skill in TNT. Begin by working through the tutorial booklets *Spatial Manipulation Language* and *Using Geospatial Formulas*.

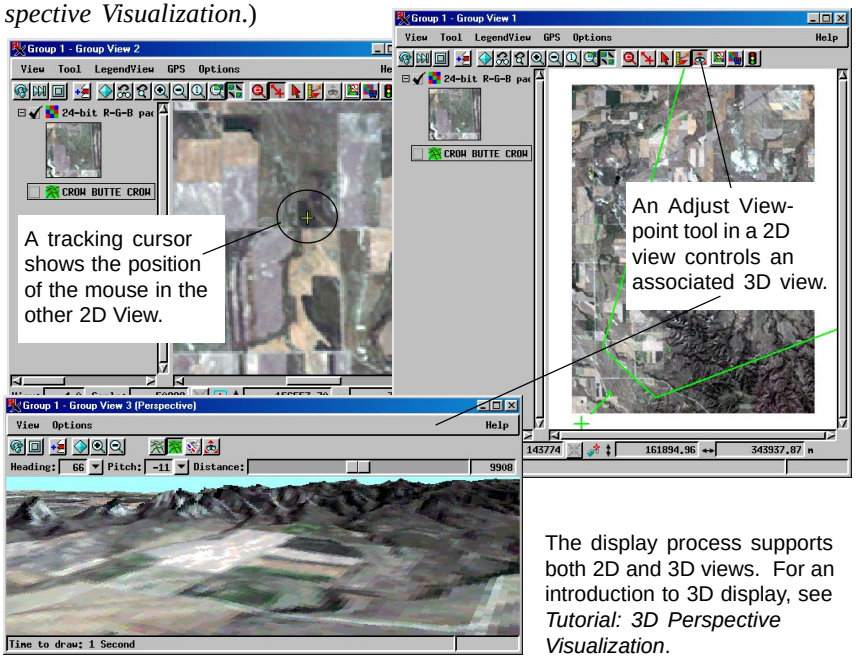
Multiple Views with GeoLocking

The Group menu in the Group Controls window offers two selections that let you open multiple View windows for one group. You can select Open 2D View and Open 3D View from the Group menu to open as many View windows as you need. The GeoLock feature automatically links the position and scale between multiple View windows so that scroll and zoom actions applied to one view automatically adjust the linked views. You can optionally turn off GeoLocking in one or more Views in order to adjust viewpoint and zoom levels independently. A tracking cursor echoes the position of your mouse cursor in all View windows that share some geospatial extent.

One or more of the views can contain a 3D perspective view that can be controlled by an Adjust Viewpoint tool in one of the 2D View windows. (The 3D tools are covered in another tutorial booklet: *3D Perspective Visualization*.)

STEPS

- ☑ start with an empty display group
- ☑ click Add Layer(s)  in the Controls window and select CB_DATA / CB_COMP / _8_BIT
- ☑ select Group / Open 2D View in the Controls window
- ☑ observe that the GeoLock tool  is active in both Views
- ☑ apply zoom and scroll operations and observe the linked view behavior
- ☑ turn off the GeoLock tool  and observe the effect on zoom and scroll operations



The display process supports both 2D and 3D views. For an introduction to 3D display, see *Tutorial: 3D Perspective Visualization*.

View-in-View

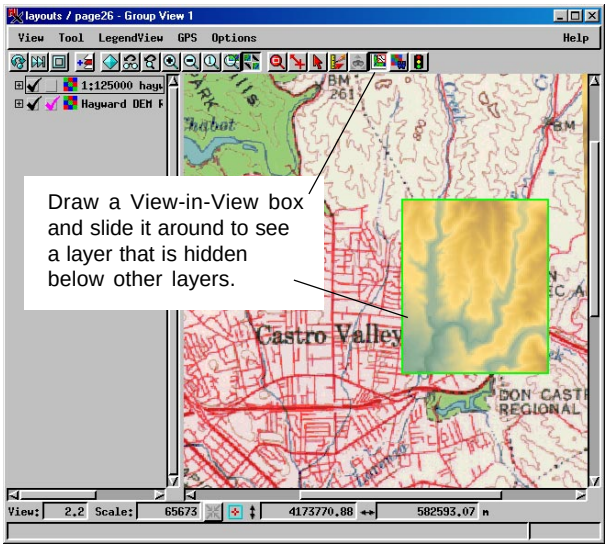
STEPS

- ☑ open the group LITEDATA / SF_DATA / LAYOUTS / PAGE22 
- ☑ select the View-in-View tool in the Group View window 
- ☑ draw a View-in-View box on the image
- ☑ slide the box to a different place and use the elastic box resizing tools
- ☑ notice the hide/show check marks in the legend layers 
- ☑ right-click anywhere on the image to reverse the inside/outside View-in-View rendering

When your display group contains several layers, the layers on top may sometimes completely hide the layers below. The View-in-View tool provides one way to hide one or more top layers in order to show the hidden layers. To use the tool, you draw a box on the display and click Hide/Show controls to choose which layers you want to see. The View-in-View tool displays the "show" layers inside the box, and the original view elsewhere. The View-in-View tool gives you an excellent visualization method for comparing two images.

The View-in-View tool is an elastic box that you can resize or move around as you compare different areas of the layers.

For this exercise, open the PAGE22 display group from the LITEDATA / SF_DATA / LAYOUTS Project File. The top layer is a scanned topo map of Castro Valley. The bottom layer is the Hayward DEM. Select the View-in-View tool and notice that the View-in-View layer selection check marks in the legend view indicate that the topo layer is to be hidden, and the DEM layer shown. Thus, when you draw a View-in-View box on the display, the box shows the DEM layer.



Hide the layers you don't want to see in the View-in-View box. 

Show the layers you do want to see. 

Zooming with Hotkeys

The display process provides a set of keyboard hotkeys for quick display manipulations. These hotkeys center zoom and pan operations on the location of the mouse cursor.

For example, to zoom in on a feature, you could select the Zoom Box tool (see page 8), and draw a zoom box around the feature. But with the hotkey alternative, you simply move the mouse cursor to the feature and press the "+" key on the keyboard.

The hotkeys all center the view at the mouse cursor:

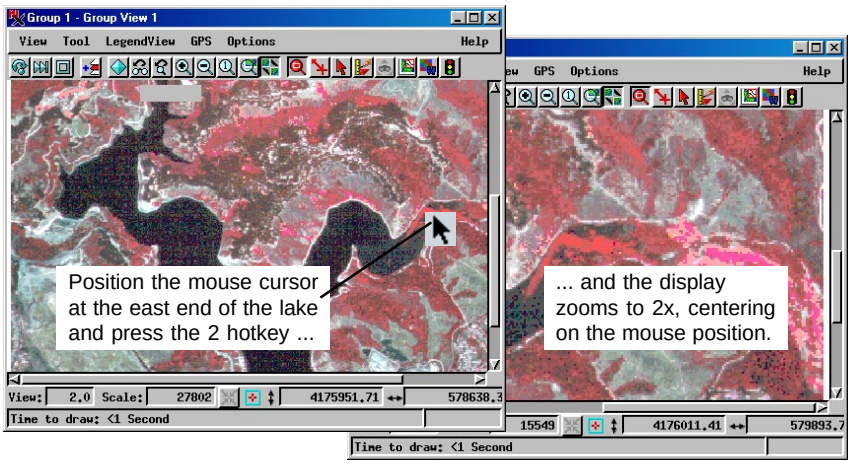
+	zoom in
-	zoom out
0	full view
1, 2, 3, 4	zoom 1x, 2x, 3x, 4x
spacebar	recenter (pan) at current zoom

Hotkeys save some steps when you would otherwise need to switch between several tools. For example, you can press the "-" hotkey to zoom out and center the view over a selected feature. The equivalent operation with the display tools would require clicking the Zoom Out icon tool button, selecting the Pan View tool, and drawing a line in the view to define the pan operation.

STEPS

- ☑ open a new view with LITEDATA / SF_DATA / AIRPHOTO / CIR146A
- ☑ position the mouse on a feature of interest and press the + hotkey
- ☑ position the mouse in the corner of the view and press the - hotkey
- ☑ experiment with the 0, 1, 2, 3, and 4 hotkeys
- ☑ recenter the view several times at the current zoom with the spacebar hotkey

The numeric hotkeys work at a set zoom level. For example, from any other zoom factor, the 4 hotkey jumps to a 4x zoom level. But if the view is already at a 4x zoom level, the 4 hotkey has the same effect as the spacebar hotkey: it recenters the view at the cursor position without changing the zoom level.



Complex Display Layouts

STEPS

- ☑ select Open Layout from the Open icon button menu 
- ☑ select the PAGE24 layout from the LAYOUTS Project File in the BLACKBRN data collection.
- ☑ click Show Layers in the Controls window to expose the layer lists 
- ☑ move the cursor between the groups and note the Position Report coordinates

Vocabulary

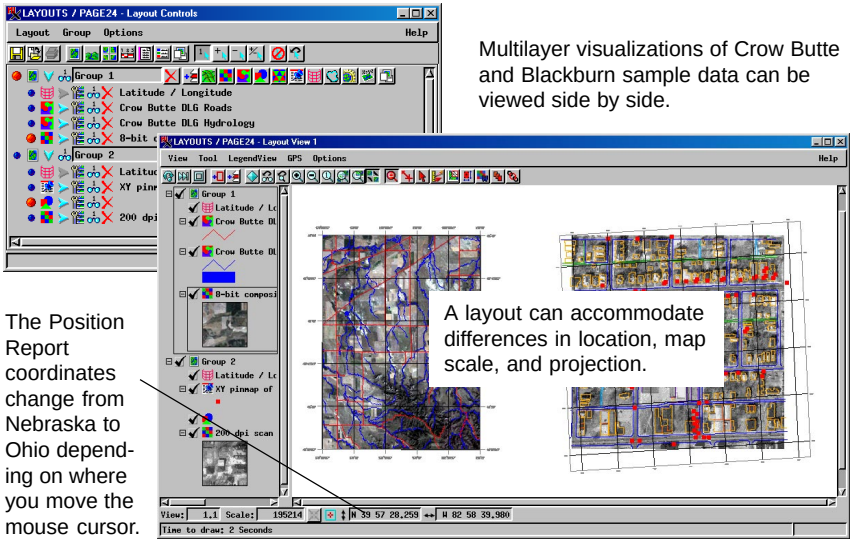
A Group can contain many layers and be presented in many View windows.

A Layout can contain multiple groups as well as legends, annotations, scale bars, and other complex layout elements.

The previous exercise introduced the capability of using several related View windows in a single group. Another level of visualization complexity is offered by the layout feature. The Display Layout process and the Hardcopy Layout process let you combine multiple objects and groups in views of higher complexity.

For this exercise, a sample Display Layout has been prepared. Click the Open icon on the Display Spatial Data menu bar and select Open Layout. Use the standard File / Object selection process to choose PAGE24 from the LAYOUTS Project File in the BLACKBRN data collection.

Two groups are listed in the Layout Controls window. Click the Show Layers icon button for each group to expose their layer lists. Each layer list is the same as the layer list that appears in the simple 2D Group process we have been using. The main row for each group offers analogous controls along with the same icon buttons that appear in the Group Controls window for adding and removing layers.



Multilayer visualizations of Crow Butte and Blackburn sample data can be viewed side by side.

Save Groups and Layouts

If you use the display process to view the same spatial data many times during the life of a project, you should take advantage of saved groups and layouts. Layout and group definitions can be saved as objects in Project Files. They contain a record of all your layers, objects, and display options, so that you can return quickly to a complex view rather than adding each component, object by object, every time you want to view the materials. The layout and group objects work even if your project materials have been modified: if your raster objects have been processed, or if your vector overlays have been edited, or if your database has been updated. Thus you can view dynamically changing project materials quickly and easily, as long as the object names remain the same and the Project Files remain in the same drive and directory.

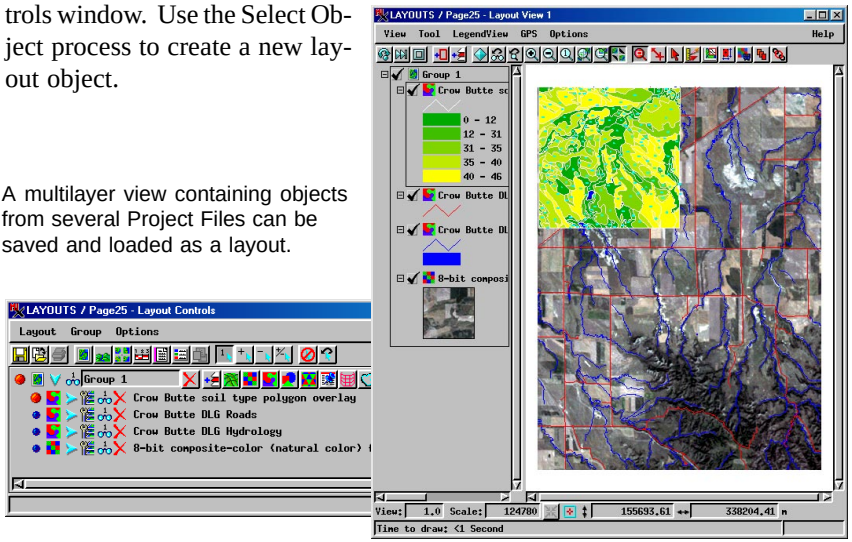
Select Open / Open Layout from the main icon menu. Choose CB_DATA / LAYOUTS / PAGE25, and then add several vector layers from the CB_DLG Project File. Adjust the zoom level and any other viewing options, and click Save Layout As in the Layout Controls window. Use the Select Object process to create a new layout object.

A **layout** is an object in a Project File that records the layout and display specifications for a selected group of objects. A layout may also include scale bar, map grid, legends, and other annotations.

STEPS

- ☑ select Open /Open Layout 
- ☑ choose CB_DATA / LAYOUTS / PAGE25
- ☑ click Add Layer(s) and select several layers from CB_DLG 
- ☑ adjust the scale, layer order, styles, and other view controls
- ☑ click Save Layout As and choose a new layout object 

A multilayer view containing objects from several Project Files can be saved and loaded as a layout.



Measuring with the GeoToolbox

STEPS

- ☑ retain the layout LITEDATA / CB_DATA / LAYOUTS / PAGE25

- ☑ select the GeoToobox tool in the Group View window

- ☑ click the Measure tab in the GeoToolbox window and select the Ruler tool

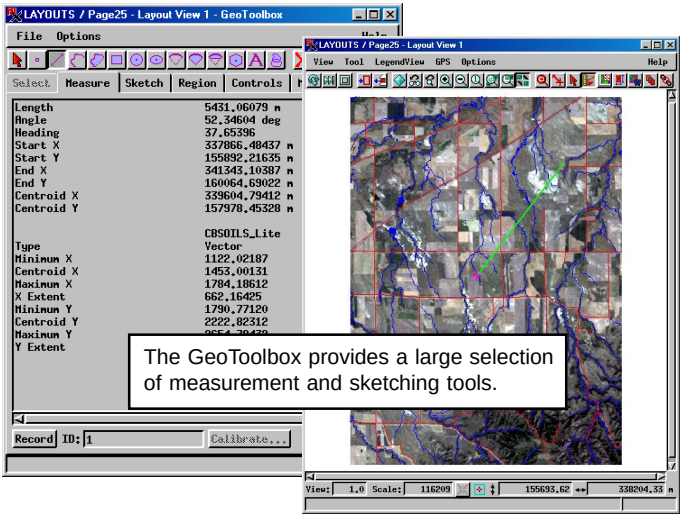
- ☑ draw an elastic measurement line on the image
- ☑ slide the line to a different place and use line resizing techniques to change its length
- ☑ inspect the measurement statistics in the Measure panel
- ☑ change the measurement units with the Options / Measure / Length menu cascade

This lesson introduces a powerful and richly featured tool in the display process: the GeoToolbox. In this exercise, you will draw a simple measurement line. A much more complete survey of the GeoToolbox is provided in the companion tutorial booklet *Sketching and Measuring*.

The GeoToolbox window offers a row of tools and several related tabbed panels. The measurement tools let you draw lines and shapes of all kinds and reports a complete set of statistics for each measurement.

Click on the Ruler tool and select the Measure tab. Draw an elastic measurement segment on the view. You can adjust its length and drag it to a new position. Each time you manipulate the measurement line, the statistics in the Measure panel update to show the new values. You can change the measurement units displayed in the Measure panel with the Options / Measure menu cascade.

You can record the measurement statistics to a text file by selecting Measurement Record from the File menu in the GeoToolbox window.



For a much more complete survey of the tools in the GeoToolbox, refer to the tutorial booklet *Sketching and Measuring.*

Selecting Elements with Regions

Region objects are composed of vector polygons and are used primarily for element selection operations. Your regions may represent things like property boundaries, or watersheds, or feature polygons. You can use regions to select point, line, or polygon elements that lie inside the region, outside the region, partially inside, or partially outside.

In this exercise, a region is used to find all the windmills within 100 yards of any stream. The region object is a 100-yard buffer zone around the Crow Butte hydrology. This buffer zone is applied in an element selection operation on the WELLS object from CB_WELLS, which contains point elements.

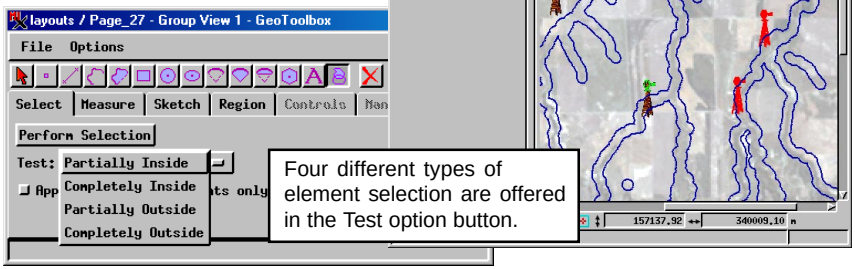
Follow the step list on this page to open the PAGE_27 group and select the HYDROBUFFER region object. In the Select tab of the GeoToolbox, apply a few different kinds of region selections and inspect the results. Since point elements have a location but no length or area, there is no possibility of a point element being partially inside or outside a selection region.

Notice that the controls for the WINDMILL layer in the Group Controls window make the WELLS point elements selectable. When you construct your own region selection operations, be sure to use the Group Controls to make the element types you want selectable.

STEPS

- ☑ select Open Group from the Open icon menu 
- ☑ select CB_DATA / LAYOUTS / PAGE_27
- ☑ select the GeoToolbox tool 
- ☑ click the Add button in the Region tab 
- ☑ select the CB_WELLS / HYDROBUFFER region object
- ☑ choose the Select tab in the GeoToolbox, and click Perform Selection
- ☑ change the Test option button to Completely Outside and click Perform Selection again

A buffer zone can serve as a region to select windmill point elements within 100 yards of any stream.



Printing

First, select your printer with Support / Setup / Printers on the TNTmips menu bar. Then the hardcopy layout process formats your layout for the selected printer and paper size automatically.

TNT offers two types of printing: *snapshot* and *layout*. **Snapshot** printing prints the contents of the View window without special annotation or layout control. You can print snapshots by selecting View / Print Snapshot in any View window. The contents of the View window are posted to a temporary raster, and TNT opens a printer dialog so you can choose a destination for the output.

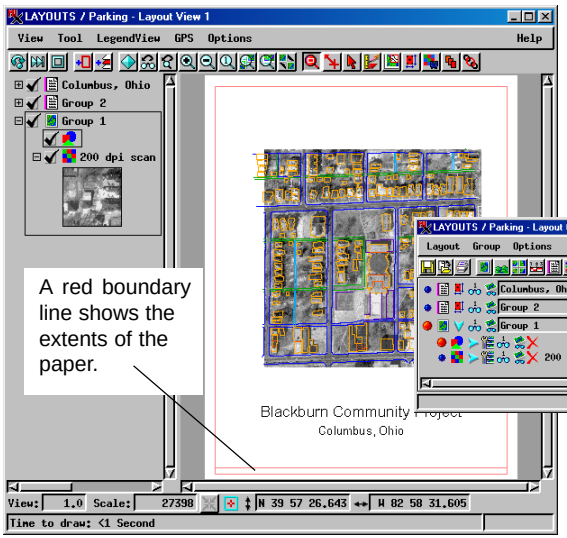
New Hardcopy Layout

To use the advanced composition tools of **layout** printing, select New Hardcopy Layout from the icon menu bar. The Layout Controls window offers the same tools and features as the Display Layout process (refer to pages 24-25). You can add map grids, scale bars, and annotations for color printers of any size and resolution.

STEPS

- ☑ setup your printer in Support / Setup / Printers
- ☑ select Open / Open Layout from the main menu bar 
- ☑ select BLACKBRN / LAYOUTS / PARKING
- ☑ select Layout / Print... in the Layout Controls window

For quick and simple printing tasks, you can use the clipboard feature of your computer's operating system to paste screen captures into other software programs. Many simple editing and composition programs are available in which you can crop, edit, and annotate complex screen displays captured from TNT. Of course printing screen shots limits your output to screen resolution and image size, but in some circumstances, that may be all you need.



You can load the layout illustrated here by selecting the PARKING layout from BLACKBRN / LAYOUTS.

Customizing the LegendView

You can customize many aspects of the LegendView, including the position and level of detail it shows. You can even turn off the LegendView in order to maximize the area on your screen for map and image display, especially when you are working with several view windows at the same time.

Open the PAGE25 group in the LITEDATA / CB_DATA / LAYOUTS Project File. The group opens with the LegendView on the left side of the View window, and legends for all four layers showing. Apply these customizations to the view:

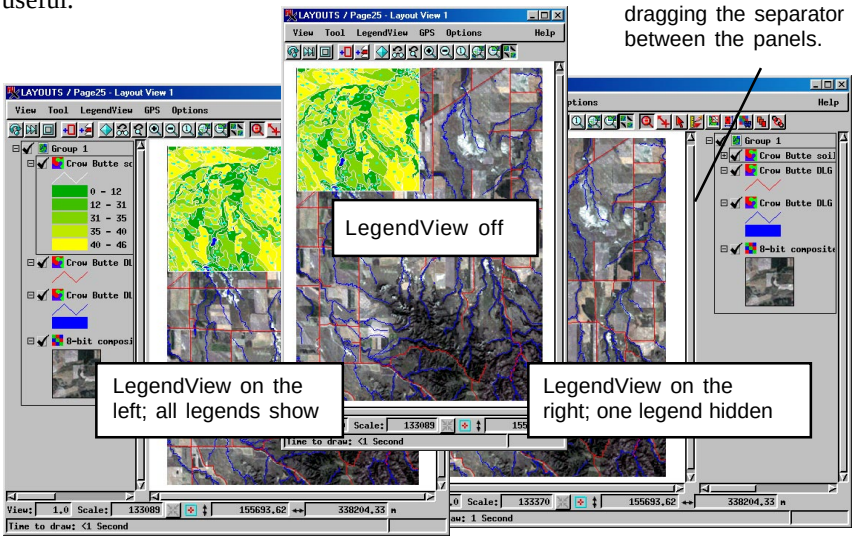
- Turn on the Right toggle in the LegendView / Show menu cascade.
- Drag the separator between the panes to adjust the width of the LegendView.
- Right-click on the soil layer and select Hide Legend from the drop-down menu.
- Turn on the None toggle in the LegendView / Show menu cascade.

STEPS

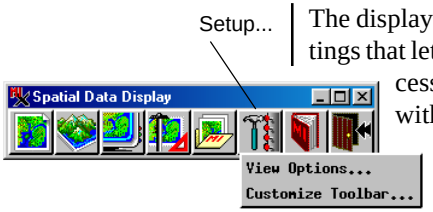
- ☑ open the layout LITEDATA / CB_DATA / LAYOUTS / PAGE25 
- ☑ move the LegendView to the right side with LegendView / Show / Right
- ☑ drag the separator between the panes to adjust the width of the LegendView
- ☑ select Hide Legend from the soil layer's right mouse button drop-down menu
- ☑ turn off the LegendView with LegendView / Show / None

Explore other options on the LegendView and drop-down layer menus, and consider how they might be useful.

Adjust the width of the LegendView by dragging the separator between the panels.



Select Display Options



The display process offers a number of control settings that let you customize the behavior of the process. Thus, if you share a TNT installation with others in your department, or if your TNT installation is controlled by a system administrator, some of the default behavior you experience may be different than that assumed in this booklet. In particular, the default behavior of the display process is to open with the menu toolbar only. However, if the default has been changed with the Options controls, you may wonder why your system automatically opens a new 2D group on startup.

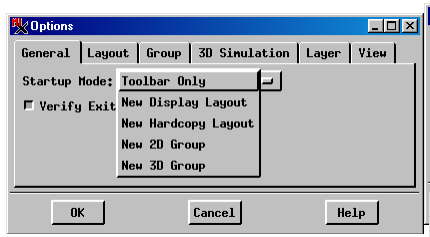
Select View Options from the Setup icon menu on the Display Spatial Data toolbar. TNT opens the Options dialog illustrated below. Each tabbed panel in the Options dialog offers controls that let you customize certain behaviors in the display process.

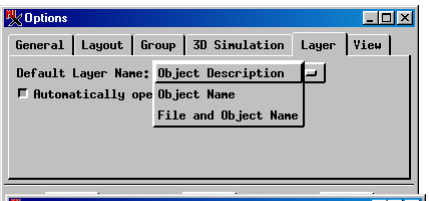
The General tab lets you choose the startup and exit behavior of the process. Select Toolbar Only in the Startup Mode option button to conform the behavior of your system to the default behavior used in these exercises.

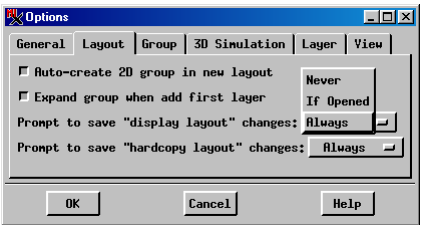
STEPS

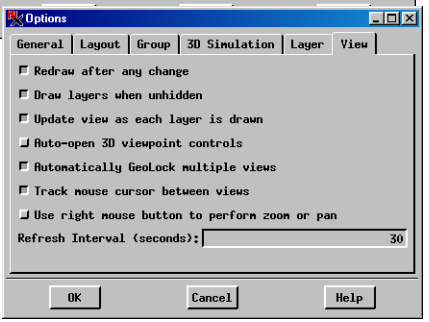
- ☑ select Setup / View Options on the Display Spatial Data toolbar
- ☑ select the General tab and choose Toolbar Only on the Startup Mode option button
- ☑ explore the other tabbed panels for other default program behaviors
- ☑ click [OK] to close the Options dialog

Tabbed panels in the Options dialog let you set default behaviors for the display process.









Online Reference and Help

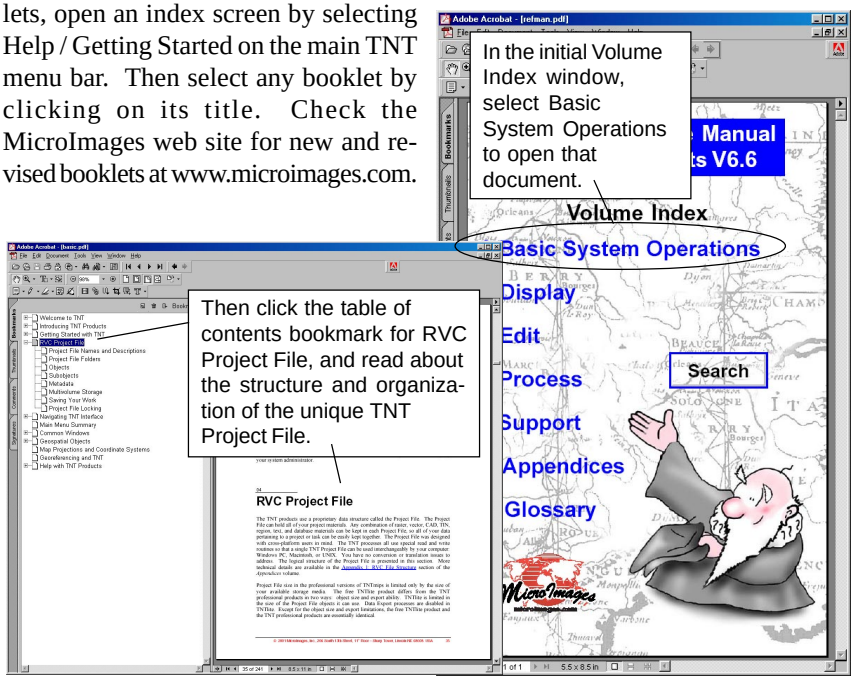
The TNT Products CD provides over 2900 pages of reference material in the Online Reference Manual, plus over 1700 pages of tutorial and application booklets. The Reference Manual can be installed to your hard drive with TNTmips as an option during the installation process. The TNT products CD also lets you install the free Acrobat Reader to view and print the documentation.

If you install the Reference Manual, you can launch the Reference Manual by selecting Display / Reference Manual from TNT's main menu bar. If you choose not to install the Reference Manual, then the Reference Manual selection on the Display menu is disabled, and you can browse the manual directly on the TNT Products CD by opening refman.pdf in the Reference Manual directory.

To access the series of tutorial and application booklets, open an index screen by selecting Help / Getting Started on the main TNT menu bar. Then select any booklet by clicking on its title. Check the MicroImages web site for new and revised booklets at www.microimages.com.

STEPS

- ☑ select Display / Reference Manual... from the main menu bar to open the Acrobat Reader
- ☑ click Basic System Operations in the initial Volume Index view
- ☑ select RVC Project File in the bookmark panel in the next view and read the description of the logical TNT Project File structure



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