GPS

Tutorial

Operating with a GPS Unit

in

TNTmips®

TNTedit™

TNTview®

Before Getting Started

This booklet introduces techniques for using input from Global Positioning System (GPS) receivers in TNTmips®, TNTedit®, and TNTview®. Single GPS coordinates can be used to locate discrete features and as control points to georeference project materials. Streaming GPS coordinates can be used to trace routes and boundaries. The TNT products let you use direct input from GPS devices, or use GPS log files that contain GPS output collected previously.

Prerequisite Skills This booklet assumes that you have completed the exercises in *Getting Started: Displaying Geospatial Data* and *Getting Started: Navigation*. The exercises in those booklets present basic skills and techniques that are not covered again here. Please consult those booklets for any review you need. You should also be familiar with the concepts of map coordinates and georeference control, which are part of the study in the booklet *Getting Started: Georeferencing.*

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 GPS data collection. The TNT products installation process makes a read-write copy of these files on your hard drive; you may encounter problems if you work directly with the read-only sample data on the CD-ROM.

More Documentation This booklet is intended only as an introduction to using GPS. Consult the TNT Reference Manual for more information.

TNTmips and TNTlite™ TNTmips comes in two versions: the professional version and the free TNTlite version. This booklet refers to both versions as "TNTmips." If you did not purchase the professional version (which requires a software authorization key), TNTmips operates in TNTlite mode, which limits its object size, and enables data sharing only with other copies of TNTlite.

Support for GPS input is available in TNTmips, TNTedit, and TNTview. All the exercises can be completed in TNTlite using the sample geodata.

Keith Ghormley, 7 March 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 Getting Started booklets on other topics. You can download an installation guide, sample data, and the latest version of TNTlite:

http://www.microimages.com

Using GPS

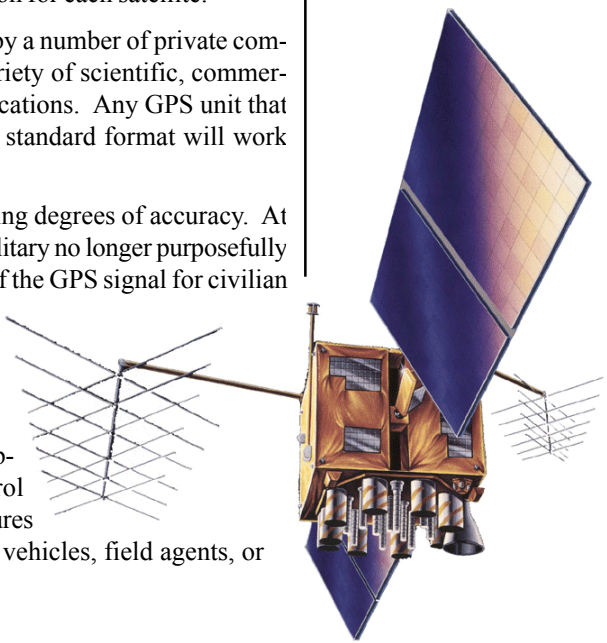
The Display Spatial Data process in the TNT products provides full support for input and positional display from Global Positioning System (GPS) receivers. A constellation of 24 satellites broadcasts continuous timing signals that GPS units are designed to receive. When a GPS receiver detects at least three of these satellites above its horizon, the unit can derive its position on the earth's surface by triangulation and provide map coordinates for the user. TNTmips can use input directly from a GPS receiver that is connected to one of the computer's ports. Most GPS receivers can collect a stream of map coordinates collected at intervals and save them as a file for later use. TNTmips can open such log files and use them as GPS sources.

The U.S. Department of Defense may scramble or degrade its GPS signals during times of international conflict in order to deny the GPS advantage to hostile forces or terrorist groups.

The GPS satellites are launched and maintained by the U. S. Department of Defense. A series of ground control stations are used to synchronize and correct the positional information for each satellite.

GPS receivers are sold by a number of private companies and used in a variety of scientific, commercial and industrial applications. Any GPS unit that provides its output in a standard format will work with TNTmips.

GPS units support varying degrees of accuracy. At this writing, the U. S. military no longer purposefully degrades the accuracy of the GPS signal for civilian receivers, so accuracy depends primarily on the quality and configuration of receiver.



GPS can be used to establish georeference control for geodata, to map features of interest, and to track vehicles, field agents, or other moving entities.

A First Look at GPS

STEPS

- ☑ launch the Display Spatial Data process
- ☑ select Open / Open Group

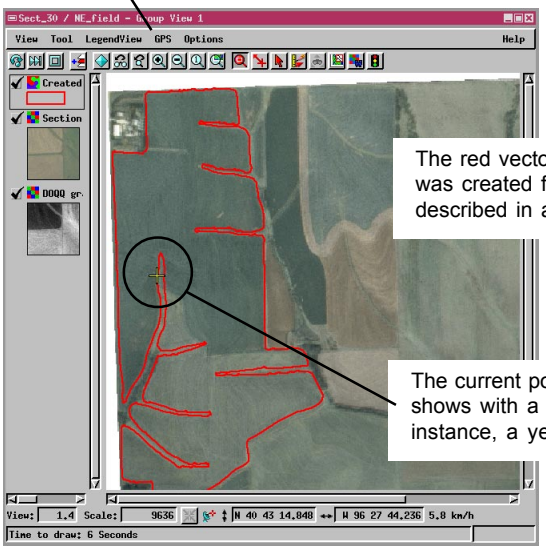
- ☑ select GPS / SECT_30.RVC / NE_FIELD from the TNT litedata
- ☑ select Open Log from the GPS menu in the View window
- ☑ select the RAYWEST1.GPS file in the GPS data collection

TNT accepts GPS input both from GPS receivers and from files that contain a formatted record of GPS data. For this exercise we will use a GPS log file that was recorded on a survey route that traced the boundary of an agricultural field. The TNT display process "plays back" the GPS log file and displays the result just as if it were direct input from a GPS receiver.

Open the NE_FIELD display group from the LITEDATA / GPS / SECT_30 Project File. That group contains two background airphotos and a vector object that represents the irregular boundary of an agricultural field.

To open the GPS log file, select Open Log from the GPS menu at the top of the View window. Select RAYWEST1.GPS as the input log file. The process opens the log file and displays a GPS cursor on the geodata. It also opens a GPS Status and Control window, showing the Status panel (illustrated on the next page). The process moves the GPS cursor around the boundary of the field according to the stream of GPS coordinates and the timing information in the log file.

The GPS menu gives you access to the GPS features in the display process.



The red vector object field boundary was created from the GPS source (as described in a later exercise).

The current position of the GPS source shows with a cursor symbol: in this instance, a yellow crosshair.

Configuring Your GPS Device

The TNT products can accept GPS input from GPS receivers and from log files. In the previous exercise, a GPS log file was used to trace the outline of an agricultural field. In this exercise, you will configure your receiver for use with the TNT products.

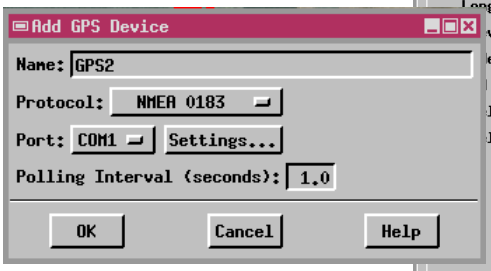
The first thing to do is to set up your GPS unit according to the manufacturer's instructions. Turn it on and make sure it is working correctly before you connect it to your computer.

After your receiver is on and working correctly, attach it to your computer. Commonly, this involves connecting a serial cable from the receiver to one of the computer's ports. Use your computer's system tools to verify which hardware port you have used (such as COM1).

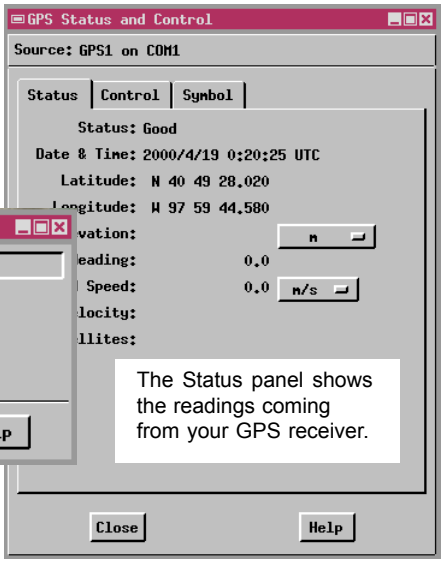
Finally, tell TNT to look for the GPS input. Select Add Device from the GPS menu. TNT opens an Add GPS Device dialog as illustrated. Choose the Protocol your device uses, the Port you used for the cable (modify the port settings if necessary), and select a Polling Interval (refresh frequency). When you close the dialog, TNT opens a GPS Status and Control window. The Status panel should now show the current values from your receiver.

STEPS

- ☑ set up your GPS receiver according to the manufacturer's instructions
- ☑ verify that your GPS receiver is working correctly
- ☑ connect the GPS receiver's serial cable to a serial port on your computer
- ☑ select Add Device from the GPS menu in the View window
- ☑ choose device settings in the Add GPS Device dialog
- ☑ compare the readout in the Status panel of the GPS Status and Control window to the display on your GPS receiver



The Add GPS Device dialog opens when you select Add Device from the GPS menu in a View window.



Prerequisite Georeference

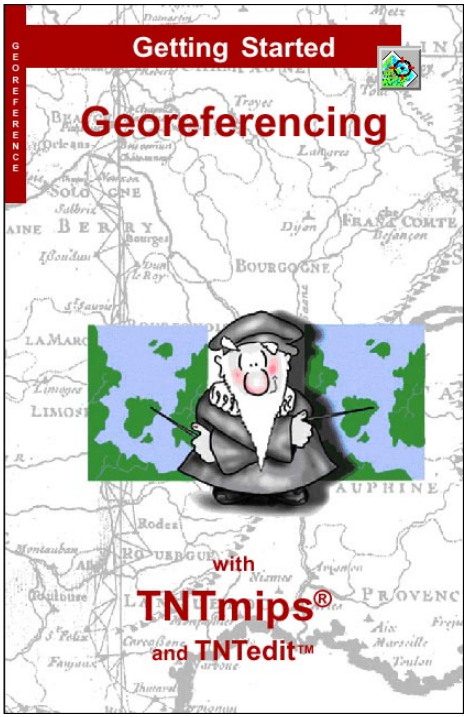
Refer to *Getting Started: Georeferencing* and establish georeference control for all of your project materials. All Getting Started booklets are included on the TNT products release CD, and can be downloaded from www.microimages.com.

See page 13 for instructions on using GPS input to establish control points in the Georeference process.

For your GPS input to display correctly with your other project materials, those materials must be georeferenced. TNT automatically reconciles differing map projections, coordinate systems and datums, so you can use a variety of georeference control. Refer to the booklet *Getting Started: Georeferencing.*

Three factors affect the accuracy you will get from using GPS receivers. First, the accuracy of your GPS receiver. If your GPS input is accurate to 30 meters, then you will notice some mis-registration if your reference materials have 3 meter accuracy.

The second factor is the accuracy of your georeference control. The cell size of your reference imagery may be 3 meters, but if your georeference control is taken from reference sources that have only 70-meter accuracy, then your GPS mis-registration difficulties will compound.



The third factor is the accuracy of your project materials. You may have 1 meter GPS accuracy, but if your reference imagery is 30-meter satellite data, then the GPS accuracy will not show in the display.

In sum, a casual approach to georeferencing can result in unwanted difficulties and reduced usefulness of GPS input. Be sure that the use you intend to make of your project materials is supported by the accuracy of your georeference control.

The georeference process (Edit / Georeference) is available only in TNTmips, TNTedit and TNTlite.

GPS Cursor Modes

The GPS cursor in the View window automatically switches between three cursor modes: Moving, Stopped, and Out-of-View.

The Out-of-View cursor (illustrated below) always appears along the edge of a View closest to the GPS location and points towards the source. If the GPS source moves into the extents of the view, then the cursor automatically changes to the Moving cursor symbol. The Out-of-View cursor symbol cannot be changed.

The Moving and Stopped cursor symbols can be selected from any existing point symbol or created with the symbol editor. Refer to the companion booklet *Getting Started: Creating and Using Styles*.

For this exercise, change the Moving symbol. Select the Symbol panel in the GPS Status and Control window. Click the Styles button and open the SECT_30 / GPSSTYLES object. Select Moving from the Symbol For option button. Select Point Type: option button. Select the plane symbol and choose a color and size for it.

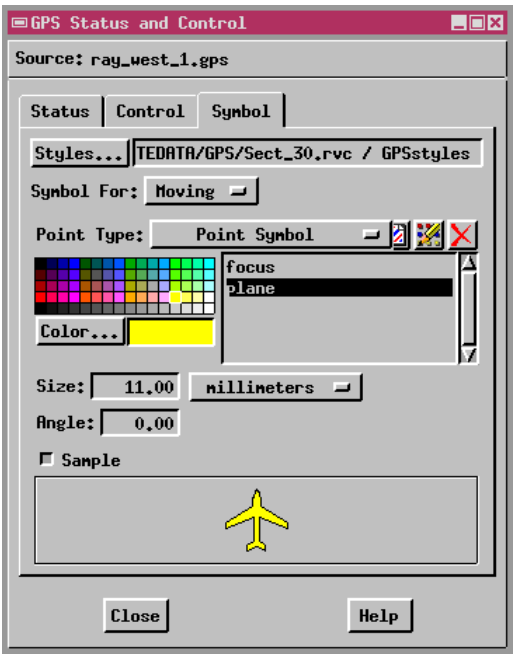
As soon as you choose a symbol, it appears in the View window. Since the GPS Status and Control window stays open while the GPS source is active, you do not close the window to apply style changes.

The out-of-view cursor appears whenever the GPS source is beyond the extents of the geodata in the group.

STEPS

- ☑ keep the RAYWEST1.GPS log file open and playing (see page 4)
- ☑ select the Symbol tab in the GPS Status and Control window
- ☑ click the Styles... button and select the GPS / SECT_30 / GPSSTYLES object
- ☑ select Moving from the Symbol For option button and choose the PLANE point symbol

The Symbol panel lets you choose separate point symbols for Moving and Stopped cursor modes.



Auto-Scroll Display

STEPS

- ☑ keep the NE_FIELD display group open with the RAYWEST1 log file playing
- ☑ zoom the display by typing the value 4000 in the Scale field at the bottom of the View window
- ☑ observe the Auto-Scroll effect when the GPS cursor comes to the edge of the view
- ☑ toggle off the Auto-Scroll feature in the GPS / AUTO-SCROLL menu and observe the Out-Of-View cursor

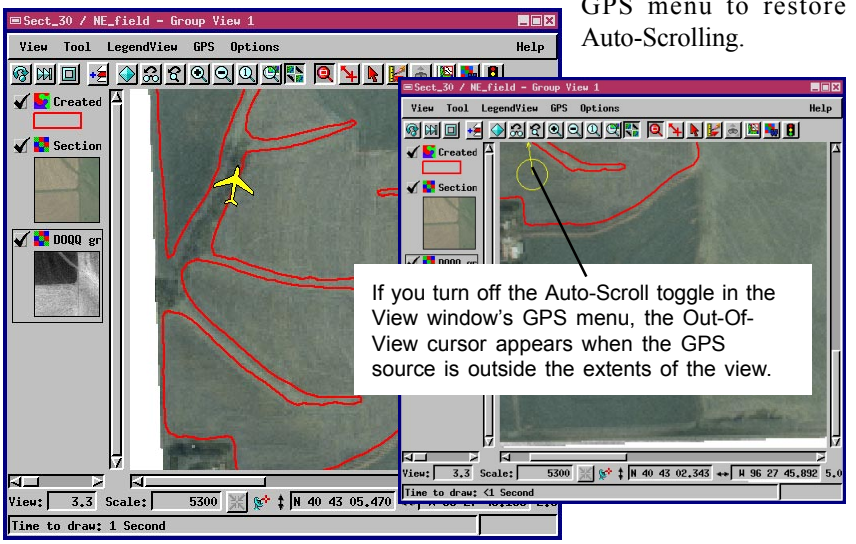
The display in the View window automatically scrolls to follow a moving GPS cursor when it comes to the edge of the view.

When a moving GPS cursor comes to the edge of a view window, it automatically scrolls the display in the direction of its travel if it can. Thus if your View is displayed at a zoom level such that only a portion of the geodata extent fits in the view, then the view will recenter automatically in order to follow the moving GPS cursor.

The Auto-Scroll feature is enabled by a toggle button in the GPS menu. You can turn it off with the GPS / Auto-Scroll menu toggle in the View window

Open the NE_FIELD group and zoom in to a scale of 1:4000 or larger as illustrated (so that not all of the field boundary fits in the view). Play the RAYWEST1.GPS log file and observe the auto-scroll effect when the GPS cursor comes to the edge of the view.

Open the GPS menu in the View window, and turn off the Auto-Scroll toggle. When the cursor comes to the edge of the View, observe the Out-Of-View cursor. Turn the Auto-Scroll toggle on again in the GPS menu to restore Auto-Scrolling.



Directional Cursor Symbols

The GPS cursor can be chosen from symbols that show travel direction. Thus, A vehicle, airplane, or arrow symbol can be selected for the moving cursor mode, and the symbol dynamically orients itself to point in the direction of travel. The plane symbol you selected on page 7 shows travel direction.

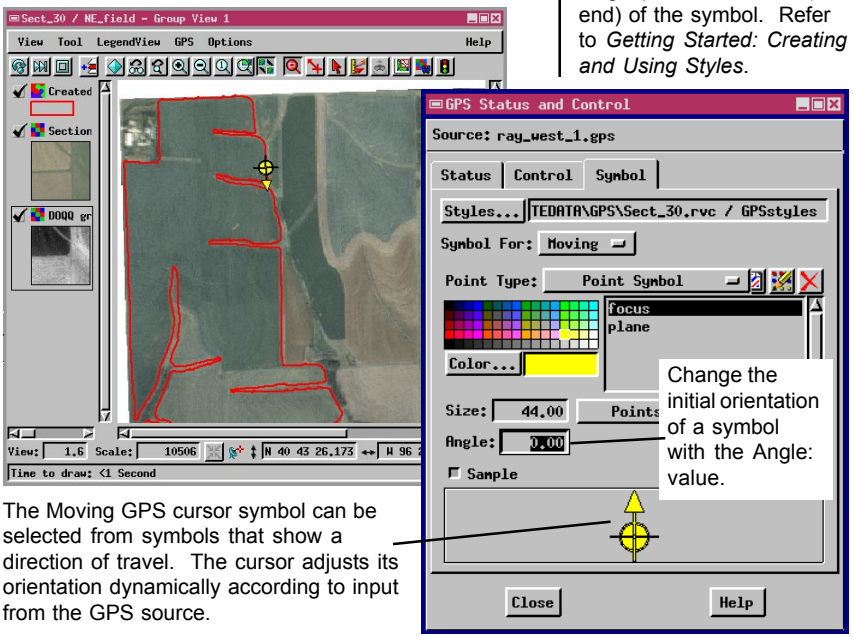
TNT interpolates the travel direction from the stream of recent points. If the recent points are very close together, the cursor may occasionally show erratic orientation.

Your style object may contain a symbol imported from TrueType character whose orientation is incorrect. That is, TNT sets the orientation of a directional cursor symbol in reference to the symbol's *base point* defined in the TNT Symbol Editor. If you need to establish or change the orientation of a directional cursor symbol, edit the symbol in the TNT Symbol Editor (Edit / Styles).

STEPS

- ☑ use the NE_FIELD group and the RAYWEST1.GPS source
- ☑ click the Styles... button in the Symbol panel of the GPS Status and Control window
- ☑ select the SECT_30.RVC / GPSSTYLES style object
- ☑ select Moving from the Symbol For option button
- ☑ change Point Type: to Point Symbol
- ☑ select the FOCUS symbol

You define the orientation of a symbol in the TNT Symbol Editor by placing the Origin point at the base (tail end) of the symbol. Refer to *Getting Started: Creating and Using Styles*.



The Moving GPS cursor symbol can be selected from symbols that show a direction of travel. The cursor adjusts its orientation dynamically according to input from the GPS source.

GPS in the GeoToolbox

STEPS

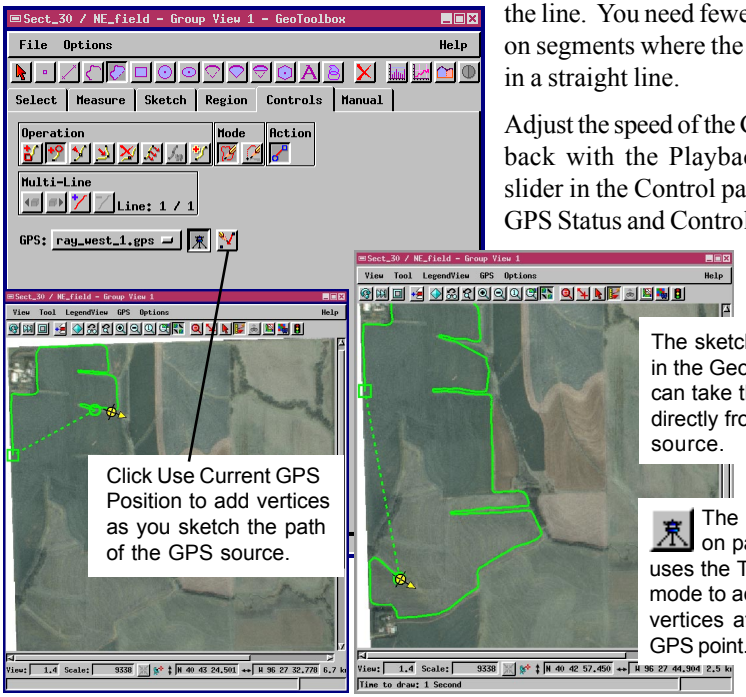
- ☑ use the NE_FIELD group but remove its NE_FIELD vector layer 
- ☑ open the GeoToolbox, add a new sketch layer, and select the polygon drawing tool 
- ☑ in the Controls panel of the GeoToolbox, select RAYWEST1.GPS as a GPS source
- ☑ as the GPS cursor moves, click the Use Current GPS Position button to draw vertices 

NOTE: You should be familiar with the sketching tools in the GeoToolbox before doing the exercise on this page. Refer to *Getting Started: Sketching and Measuring*.

One of the most useful features of GPS support in the TNT products is the ability to create line and polygon elements directly from GPS input. Thus you could trace hiking trails from a GPS log file carried by hikers, or have a team drive the boundaries of a field to define its usable area.

In this exercise, you will use the RAYWEST1.GPS log file as a source to create a sketch layer. When you open the log file with a polygon sketching tool in the GeoToolbox, the GPS cursor begins to trace the boundaries of the field. As the cursor moves, click the Use Current GPS Position button to place vertices along its path. Place more vertices where the path twists and turns in order to record the detail of the line. You need fewer vertices on segments where the path runs in a straight line.

Adjust the speed of the GPS playback with the Playback Speed slider in the Control panel of the GPS Status and Control window.



Recording and Using Log Files

When you connect a GPS receiver to your computer (refer to page 5), TNTmips can record a log file of the data from it. To record a log file from your GPS input, select Source Manager from the View window's GPS menu. In the GPS Source Manager window that opens, select your GPS source and click the Controls... button. In the GPS Status and Control window that opens, select the Control tab and click the Start Recording... button. Use the standard Select File process to specify a new output log file. TNT writes an entry to the log file automatically according to the Polling Interval you specified in the Add GPS Device dialog (see page 5).

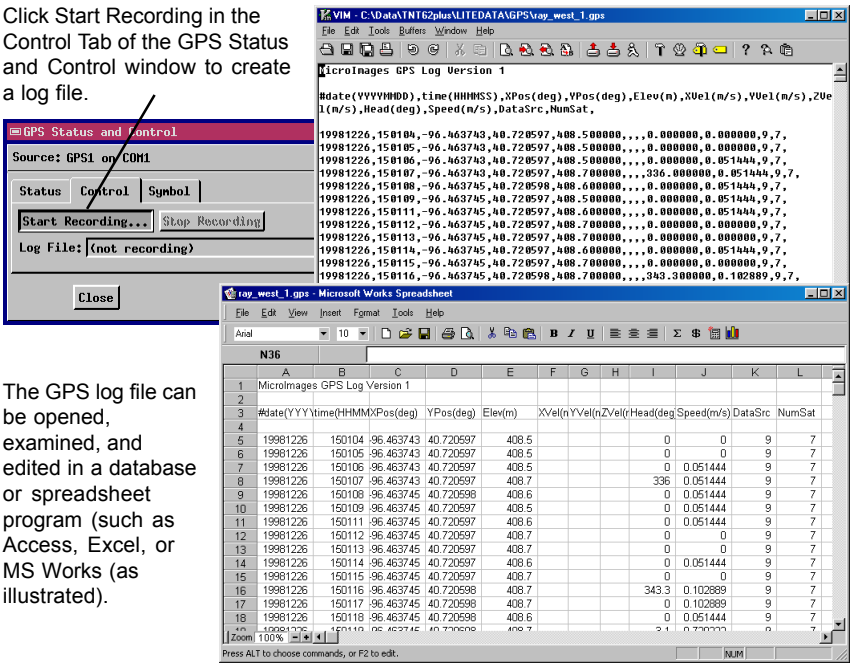
The GPS log file is a simple comma-delimited text format, so it can be opened, examined, modified, and processed in any number of editing, database, and spreadsheet programs.

STEPS

- ☑ connect a GPS receiver to your computer (see page 5)
- ☑ select GPS / Source Manager in the View window
- ☑ highlight your GPS device in the GPS Source Manager window and click Controls...
- ☑ select the Control tab in the GPS Status and Controls window and click Start Recording...

TNT creates a GPS log file in a simple comma-delimited text format.

Click Start Recording in the Control Tab of the GPS Status and Control window to create a log file.



	A	B	C	D	E	F	G	H	I	J	K	L
1	MicroImages GPS Log Version 1											
2												
3	#date(YYY	time(HHMM	XPos(deg)	YPos(deg)	Elev(m)	XVel(n	YVel(n	ZVel(r	Head(deg	Speed(m/s)	DataSrc	NumSat
4												
5	19981226	150104	-96.463743	40.720597	408.5				0	0	9	7
6	19981226	150105	-96.463743	40.720597	408.5				0	0	9	7
7	19981226	150106	-96.463743	40.720597	408.5				0	0.051444	9	7
8	19981226	150107	-96.463743	40.720597	408.7				336	0.051444	9	7
9	19981226	150108	-96.463745	40.720598	408.6				0	0.051444	9	7
10	19981226	150109	-96.463745	40.720597	408.5				0	0.051444	9	7
11	19981226	150111	-96.463745	40.720597	408.6				0	0.051444	9	7
12	19981226	150112	-96.463745	40.720597	408.7				0	0	9	7
13	19981226	150113	-96.463745	40.720597	408.7				0	0	9	7
14	19981226	150114	-96.463745	40.720597	408.6				0	0.051444	9	7
15	19981226	150115	-96.463745	40.720597	408.7				0	0	9	7
16	19981226	150116	-96.463745	40.720598	408.7				343.3	0.102889	9	7
17	19981226	150117	-96.463745	40.720598	408.7				0	0.102889	9	7
18	19981226	150118	-96.463745	40.720598	408.6				0	0.051444	9	7

The GPS log file can be opened, examined, and edited in a database or spreadsheet program (such as Access, Excel, or MS Works (as illustrated).

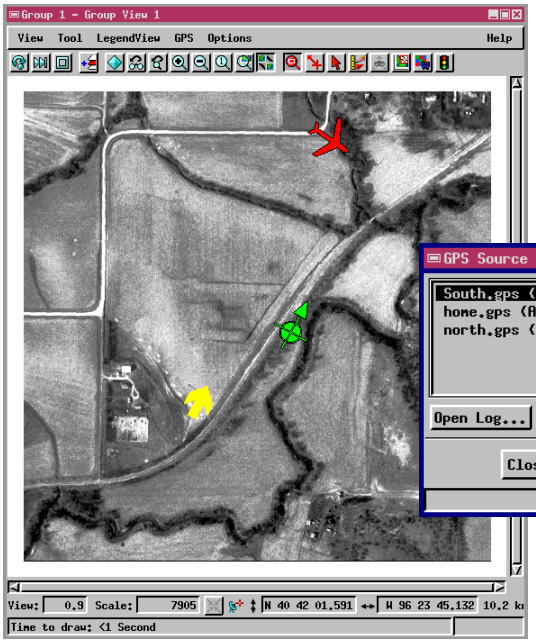
Multiple Inputs: The Source Manager

STEPS

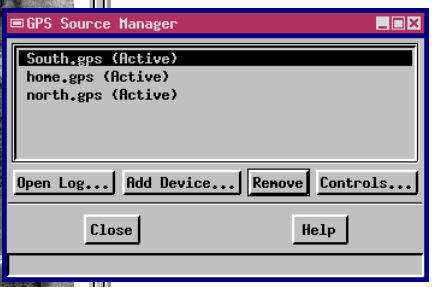
- ☑ open a view with the raster object GPS / OTOE.RVC / OTOE
- ☑ use the Open Log selection on the View window's GPS menu to add SOUTH.GPS, HOME.GPS, and NORTH.GPS in turn
- ☑ use the GPS Status and Control window for each log file to select different symbols and colors for each source

Since most desktop computers provide only a couple of serial ports that can be used for connecting GPS receivers, configuring your hardware for multiple simultaneous GPS inputs is not a trivial exercise. That is, you can easily watch a truck or two, but without a customized configuration, you won't see every vehicle in the fleet in real time. You are more likely to use the multiple-source capability of the TNT products to play back multiple log files. Properly synchronized, multiple inputs can offer a strong tool for visualization and analysis.

To synchronize GPS inputs from multiple log files, use their GPS Status and Control windows. Pause each GPS cursor at the starting point you want with the playback buttons in the Control tab. When you have each GPS input paused at the "starting point" you want for it, click the Play button in the Controls tab to start them.



Left: Three GPS log files play simultaneously in the View window. Each input has been assigned a different cursor symbol.



Use the GPS Source Manager to open and manage multiple log files and GPS devices simultaneously.

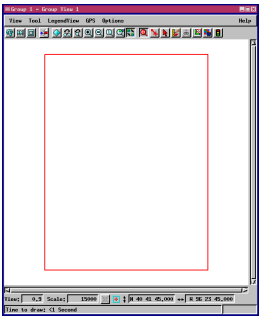
GPS in the Georeference Process

GPS receivers provide an excellent way to collect precise control points for georeferencing your project materials. Thus, if you have an airphoto to georeference, you could visit the site with a GPS unit, and record map coordinates for several well-distributed features that show in the image. In this scenario, you would simply make a list of features and their coordinates in a notebook, and enter the coordinates in the georeference process when you return to your desk.

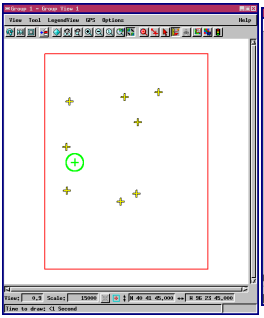
Another method would be to take a portable computer to the site and use your GPS device for direct input. Since GPS input is enabled only for views that have some existing georeference, you need some kind of initial reference object. One approach would be to draw a simple rectangle in TNT's Geospatial Editor, and assign its corners to map coordinates so that your airphoto site is contained within it. Then you can load that "frame" object in the field to establish your general geospatial location, and use your GPS input to drop vertices in a new sketch object. Back at your desk, you can use your sketch as a reference object in the georeference process.

The sketching tools in the GeoToolbox can take their input directly from a GPS source. Refer to page 10 for information about using GPS input to create a sketch object.

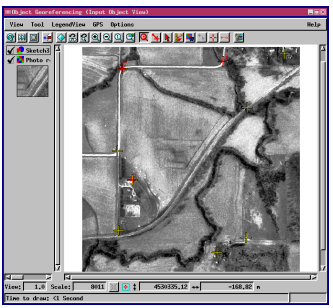
Refer to *Getting Started: Georeferencing* and establish georeference control for all of your project materials. All Getting Started booklets are included on the TNT products release CD, and can be downloaded from www.microimages.com.



Create a "frame" object and assign map coordinates to its corners such your airphoto is contained within it.



In the field, use GPS input over the frame to create a sketch object that contains features visible in the airphoto.



Use the sketch as your reference object in the TNT georeference process.

GPS in the Geospatial Editor

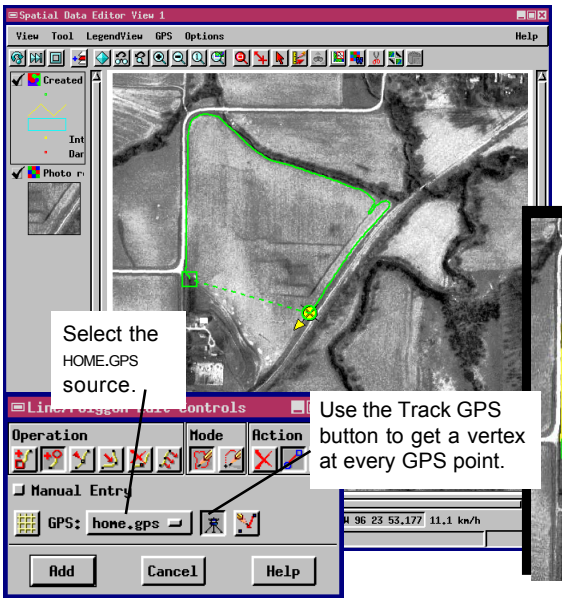
STEPS

- ☑ launch the Edit / Spatial Data process
- ☑ add a reference layer with the raster object GPS / OTOE.RVC / OTOE 
- ☑ create a new vector object 
- ☑ use the Open Log selection on the View window's GPS menu to add HOME.GPS
- ☑ select the editor's Add Polygon tool 
- ☑ select the HOME.GPS source and the Track GPS mode in the Line/Polygon Edit Controls 
- ☑ when the playback is complete, add the polygon

Using GPS input in the editor is similar to using GPS input for sketch objects in the display process (see page 10). You will choose to use the editor instead of the sketch tool when you want to work on more complex combinations of geodata. The editor lets you have several objects of different types open for editing simultaneously, and it provides features that the sketch tool does not.

As it draws a line or polygon, the editor can add vertices in two ways: it can add a vertex at every GPS point, or it can add a vertex only when you tell it to. In the sketch exercise on page 10, you used the Use Current GPS button to add vertices explicitly. For this exercise, use the Track GPS button so that every point in the GPS log is used as a vertex in the new polygon element.

If you are not familiar with the geospatial editor, refer to *Getting Started: Editing Vector Geodata* for more information.



Turn off the Auto-Repeat toggle in the Control panel of the GPS Status and Control window and wait for the GPS playback to finish. Then add the whole polygon at once.

GPS in SML and APPLIDATs

Support for GPS devices is found throughout all the processes of TNTmips. You can use the GPS techniques introduced in this booklet in any process that has a view window. For example, you can use GPS input or log files in the Feature Mapping process (Process / Raster / Interpret / Feature Map) to check the classifications you make against ground truth that is coordinated with GPS points.

GPS input can also be manipulated in custom processes that you develop with TNTsdk or with the Spatial Manipulation Process (SML). All the functions you need for polling and reading GPS inputs are found in the functions and libraries provided.

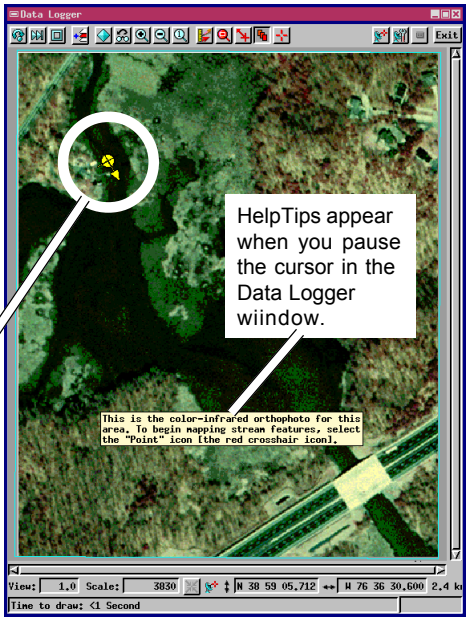
For this exercise, launch the Data Logger sample APPLIDAT, which is distributed with the TNT products (Custom / APPLIDAT / datalog (SML)). This APPLIDAT demonstrates several ways to develop customized, turnkey applications with TNT. The Data Logger is written in SML and bundled with geodata objects that are pre-selected for the user.

Follow the instructions in the series of HelpTips that appear when you pause your cursor over the image.

STEPS

- ☑ open the Data Logger sample APPLIDAT (Custom / APPLIDAT / datalog (sml))
- ☑ click the Data Logging icon on the menu bar 
- ☑ use the GPS Source Manager in the Data Logger window to open / CUSTOM / APPLIDAT / SOUTHRIV.GPS (in your TNT product directory) 
- ☑ let your cursor pause in the window and follow the instructions in the APPLIDAT's HelpTips

The Data Logger APPLIDAT demonstrates the customized use of GPS input. This turnkey application, written in SML, is designed to let a field team use GPS input to locate field observations and automatically record the coordinates as they make database entries.



Advanced Software for Geospatial Analysis

GPS

MicroImages, Inc. publishes a complete line of professional software for advanced geospatial data visualization, analysis, and publishing. Contact us or visit our web site for detailed product information.

TNTmips TNTmips is a professional system for fully integrated GIS, image analysis, CAD, TIN, desktop cartography, and geospatial database management.

TNTedit TNTedit provides interactive tools to create, georeference, and edit vector, image, CAD, TIN, and relational database project materials. TNTedit can access geospatial data in a wide variety of commercial and public formats.

TNTview TNTview has all the same powerful display features for complex visualization and interpretation of geospatial materials as TNTmips. TNTview is perfect for those who need flexible access to the TNT project materials but do not need the technical processing and preparation features of TNTmips.

TNTatlas TNTatlas lets you publish and distribute your spatial project materials on CD-ROM at low cost. TNTatlas CDs contain multiple versions of the TNTatlas software so that a single CD can be used on any popular computing platform.

TNTserver TNTserver lets you publish TNTatlases on the Internet or on your intranet. Navigate through massive geodata atlases with your web browser by using the free, open-source TNTclient Java applet (or any custom applet you create) to communicate with TNTserver.

TNTlite TNTlite is a free version of TNTmips, TNTedit, and TNTview for students and professionals with small projects. You can download TNTlite for your computer (about 100MB) from MicroImages' web site, or you can order TNTlite on CD-ROM (shipping charges apply).

MicroImages, Inc.

11th Floor - Sharp Tower
206 North 13th Street
Lincoln, Nebraska 68508-2010 USA

Voice: (402)477-9554
FAX: (402)477-9559

email: info@microimages.com
Internet: www.microimages.com