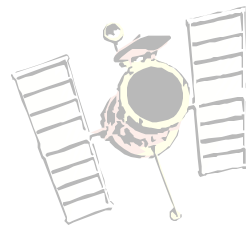


Introduction to Global Positioning Systems

(GPS) (Student)

What is a GPS?

GPS is an abbreviation for Global Positioning System. Have you ever spent an evening staring at the stars and saw something that was moving (so it wasn't a star), but moving too slow (so it wasn't a plane)? Well, it may have been a satellite. It turns out there are quite a number of satellites out there in space. They are used for a wide range of purposes; satellite TV, cellular phones, military purposes and etc. Satellites can also be used by GPS units.



Have you ever been shopping in a mall or a large department store and had a hard time finding your way? Maybe you were lucky enough to find one of those mall directory maps. Remember how handy it was to find that star labeled "you are here?"



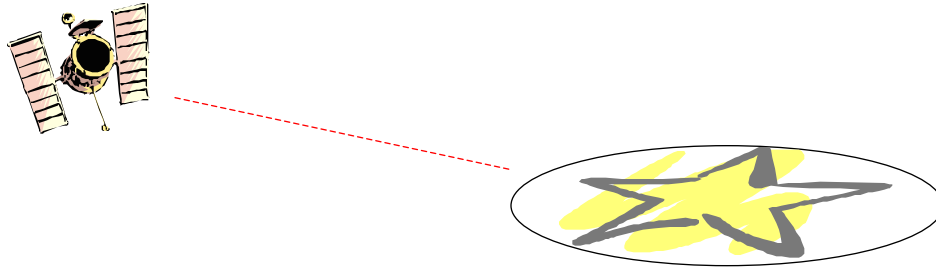
Then it was as if the whole layout made sense, and you didn't have to orient yourself anymore. Well, a GPS unit is a lot like that handy star, but on a much bigger scale.

GPS units are made to communicate with those moving satellites (which have a much better view of the Earth) to find out exactly where they are on the global scale of things. When you are holding a unit, it's as if the satellites are making a "you are here" star for you on a global map. The way they do it is neat.

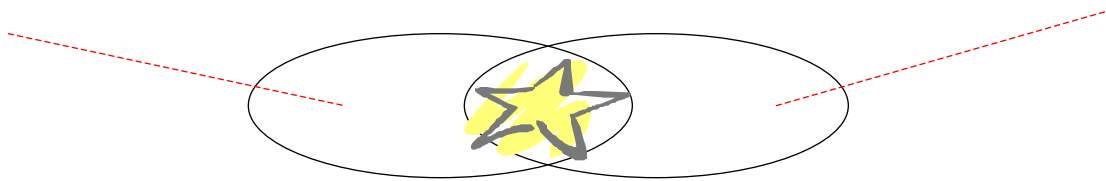


First of all, let's say a GPS unit communicates with one satellite. The satellite gives off a signal to a GPS, and because the satellites are in a locked (known) orbit, the GPS unit is able to calculate where it is in relation to the satellite. If it's only one satellite that the GPS is

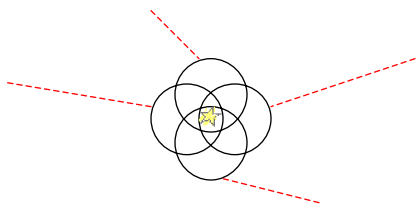
communicating with, then at best it can only make a very large “you are here” star (or circle as in our diagram).



However, if another satellite is locked on for communication, that would be two large circles we can draw, and we know that our “you are here” star fits in where those two circles overlap.



What if we could get three satellites to communicate with, or four? It turns out that the more circles we can draw, the more specific we can be at placing our star.



Do you see how small our star is? That means we’re pretty sure about its exact location.

So, the more satellites we have, the more sure we are about the placement of our star. It usually takes communication with *at least* four satellites for us to be confident about our star location. Even if we had every satellite in the sky communicating with us, though, we would still end up with a circle that surrounds our star with plus or minus five meters. Some GPS units are able to limit the size of their circles to one centimeter! The GeoExplorer 3 that we are using, however, is only able to do it to about five meters or so, which is just fine for all of our purposes.

Sometimes signals come in from satellites, and they're not following a crisp line. Have you ever put a pencil in a clear glass of water? Did you notice that where the pencil touched the water it seemed to be bent? Did you pull the pencil out just to reassure yourself that it wasn't messed up? You probably saw that it was straight as could be. So why did it bend when it was in the water? It turns out that when light hits the water, the light bends, which makes the pencil look like it is bent when, in fact, it is the same straight pencil.



Signals from satellites can be like light. When they hit some interference (air patterns in the atmosphere, uneven geography, etc.) they sometimes bend a little, just like the light. And sometimes they bounce off things before they hit the units. All of this combines to make the signal less accurate, and gives it what we call a high "PDOP."

PDOP

So, high PDOP means less accurate, low PDOP means more accurate. We can set the GPS units to collect signals at a low PDOP, clear on up to a high PDOP. We just need to remember that the higher we go, the less accurate the signals are and the less sure we are on the placement of our star.


What is a GPS good for?

Now that you know what a GPS is, how it works, and how we can make it better, what exactly is it good for? Why do we care so much about the placing of a "you are here" star? It turns out that the possible uses for that kind of information are endless, and they get even more endless every day as we realize new ways to use this kind of information.

With GPS information, ambulances can drive quickly to the “you are here” star of the people making the call, without having to rely on old road maps.



Firefighters can GPS the sites of all of their hydrants so that when a fire happens in a building, they can see the best place to park that would give them the best access to a hydrant.

Better road maps, too, could be made with GPS technology because satellite communication is much better than just drawing out by hand the approximate locations of roads.



Pretty much anything you might need a map for, GPS technology can be used to make life a whole lot easier.

Why should you learn the GPS?



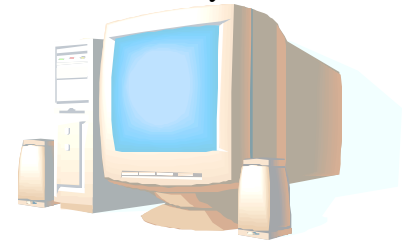
The best answer for that question is another question: why shouldn't you?



Although tons of uses for GPS data have been figured out already, we really haven't even scratched the surface of what could be done. This field opens up more every day, and people who know and are familiar with the GPS are snatched up just as quickly as they can learn. GPS technology can be as simple or as complicated as we want to make it. This tutorial was designed to help simplify Trimble's GeoExplorer 3 so that you, the reader, can hop on the bandwagon and join the exciting field of GPS.

Getting familiar with a Trimble GeoExplorer 3

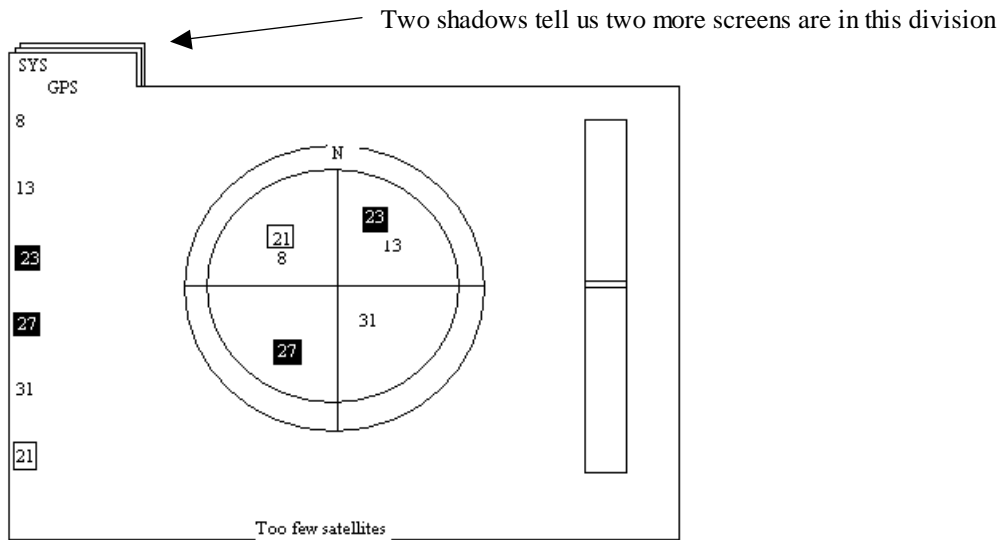
A GPS unit is very much like a small computer running on a simple Windows® program. The more windows you open, the more you can do. This tutorial is designed to take you through the running of these windows step by step. We'll start out with just the basics, and then work our way into stuff a little more complicated. Let's begin by getting to know the features of every unit.



To turn the GPS on, press the power button once. There is a small Trimble introduction, and then you are taken to the first of three “system” screens.

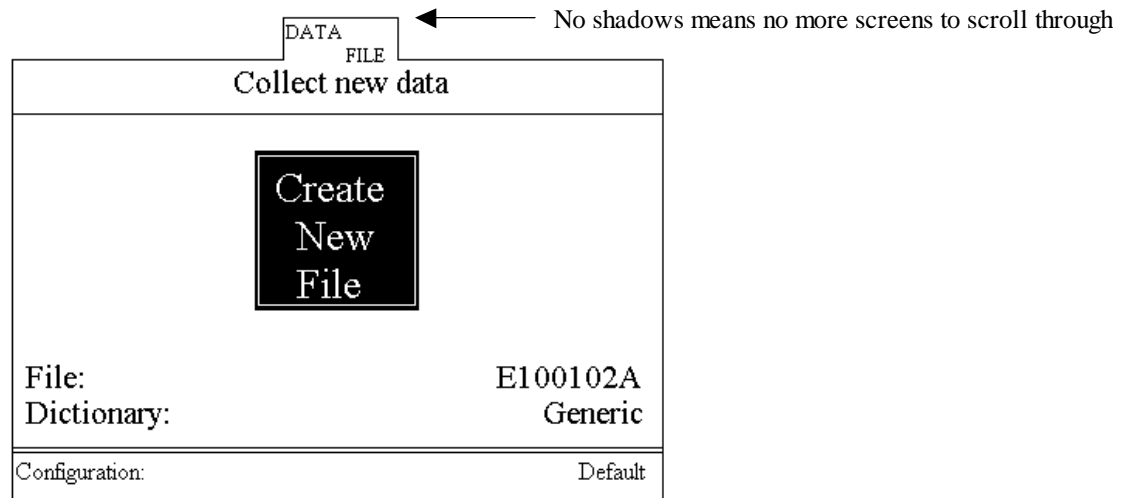
The three white buttons correspond to the three main divisions of the GPS unit. They are **System, Data and Navigation.**

System is a division of the GPS devoted to telling you how you have the GPS set up. There are three screens in the system division, and each one looks like a recipe card with the tab in the left corner.



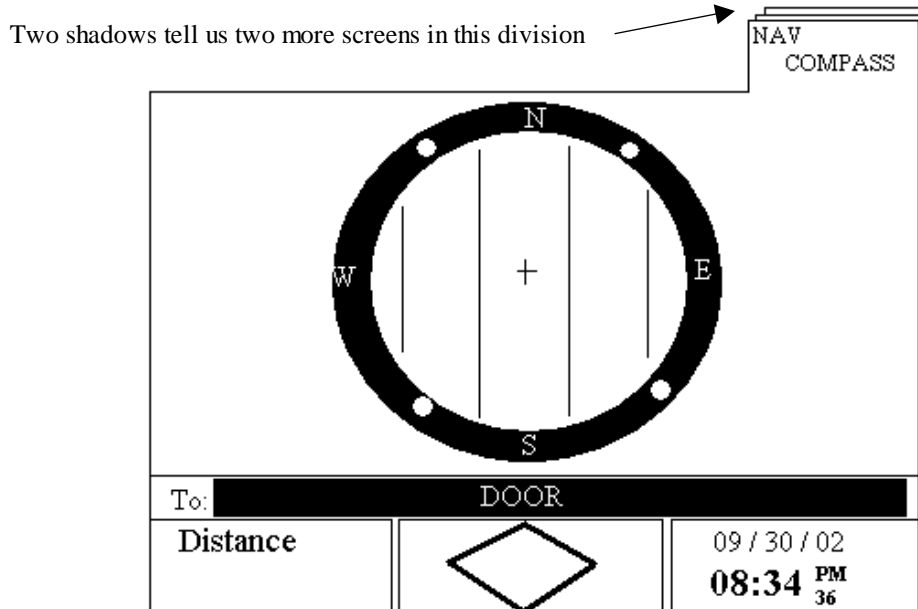
Under the **System** screens, we can see how many satellites we are locked onto with communication, we can check the level of memory and batter power left on the unit, and we can change the settings to how it collects data.

The **Data** division is the section where any data collected is stored. There is one main screen for **Data**, and it looks like a recipe card with the tab in the center.



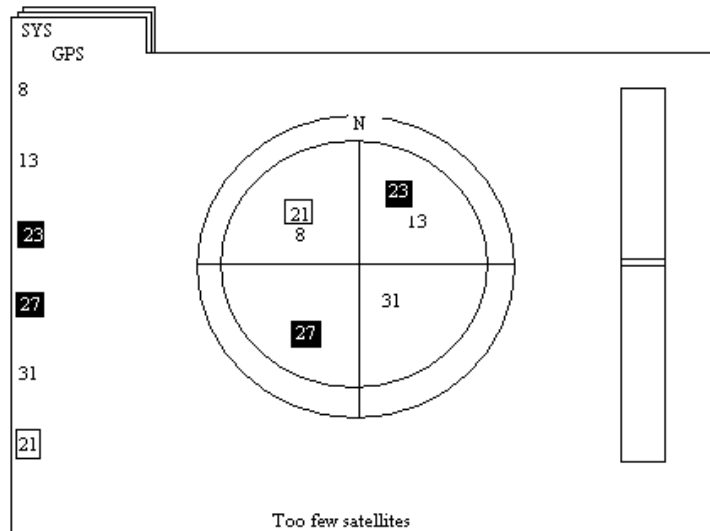
When a file is in use and data is being collected, then and only then will two more shadows appear behind the data recipe card tab which tells us there are now two more screens we can scroll through. We'll have more to say about these later.

The third division is **Navigation**. This division has many neat features useful when you are trying to navigate to a particular point or place. Some of these features are: maps to show where you are in relation to the place you're trying to get to, how fast you are walking or driving (velocity), how far you've gone since you started (distance), the time and date, and etc. There are three screens for **Navigation**. Each one shows you something different, and each one looks like a recipe card with the tab in the right corner.



Collecting Data

Let's get started. As was stated before, the first screen we come to when we turn the unit on is in the **SYS (System)** division. More specifically, it is the **GPS** screen. The large circle in the center of the screen represents the horizon, with the "N" representing north. Imagine yourself standing outside somewhere. If you were to look out as far as you could, and turn slowly all the way around as you did so, your horizon would look like a big circle as well. (Unless you had a tree or a building in your way, but we're talking about the big picture, bigger than the tree or building.)

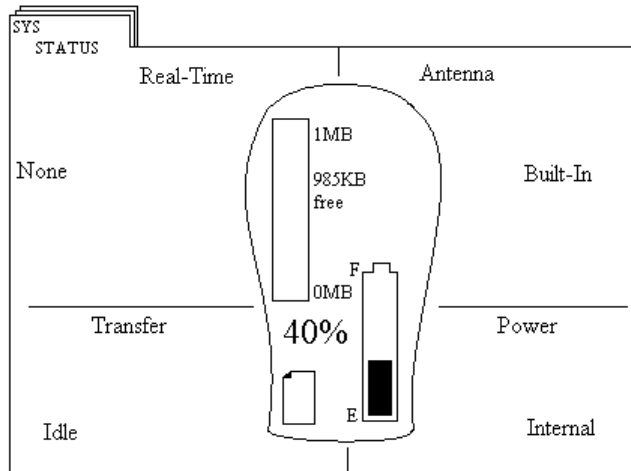


The numbers in the circle represent all of the satellites that overlap your piece of the world at that moment. If you only have six, maybe Russia or Australia have more over them at that particular time. The number of satellites directly above you varies for any given moment. Each number in the circle corresponds to a specific satellite. Those satellites that you are locked on with will have a filled-in black square around them. Those with an open square aren't quite locked on yet, and those with no square aren't communicating with you hardly at all.

If you only have a couple of satellites locked on, that is not enough and the bottom of the screen will say "too few satellites." (Remember, we think four is the minimum number we should have.) There are a few factors that go into our getting communication with too few satellites. One could be just a bad time of day. Certain time periods are better than others, and often there will be a small window of time when we won't have hardly any satellites above our horizon. There is a way for you to predict when the worst times are. This is further discussed in **Appendix 1** under Pathfinder PDOP prediction.

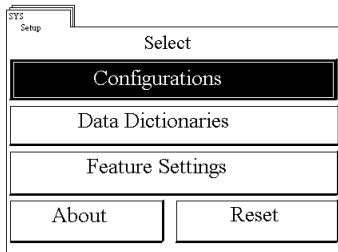
PDOP

Another factor could be that your PDOP is set too high. Let's run through the **Systems** screens now to see what configurations your unit has set. We want to get to the third **SYS** screen, but to do this we must first go through the second screen. Hit the **SYS** button once, and this will bring us to the **SYS status** (or second) screen.

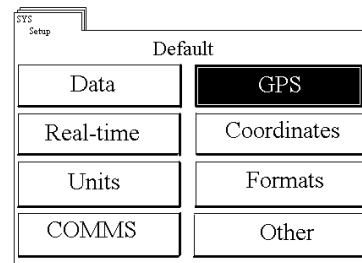


This screen is devoted to telling us about the unit. It lets us know how much memory and battery life we have left.

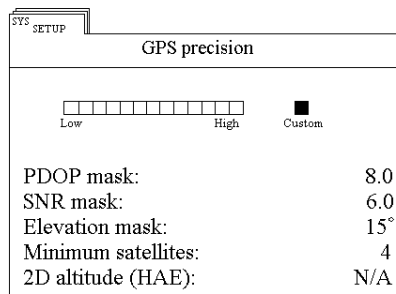
Hitting the **SYS** button again brings us to the third system screen, which is the setup screen. At this point in time, we're only interested in the box labeled **Configurations**.



Highlight the **Configurations** box and press **ENTER**. Eight more boxed choices will appear. Highlight the **GPS** box and press **ENTER**.

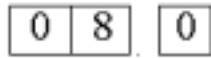


We are interested only in the first and fourth items in the list.



First highlight **PDOP mask** and press **ENTER**.

A numeric box will pop up.



The side to side arrow keys allow us to move among boxes, and the up and down arrow keys allow us to raise or lower the PDOP. (The box on the far right is for decimal places so we don't need to worry about that.) For now let's set the PDOP at **8.0**. Remember, the higher we go, the less accurate we are so only raise the PDOP if you have to, and lower it whenever you have plenty of satellites. When you're finished, hit **CLOSE**.

Next, highlight and select **Minimum satellites**. A choice box will pop up.

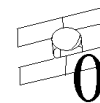


Select **4** and press enter. Now we're done with setting our configurations. Press **CLOSE** twice and **SYS** once. Hopefully you now have more than four satellites locked on.



Note GPS work must be done outside, as buildings create too much interference to get a signal.

You may have noticed by now that no matter what division of the GPS you're in, two small objects always appear on the right side. These are the satellite number on the top, and a small battery on the bottom. If the number below the satellite is blinking, it means you don't have enough satellites. These objects are really convenient, because regardless of where we are in the GPS, we can always check our number of satellites and our battery level. Neat, huh?

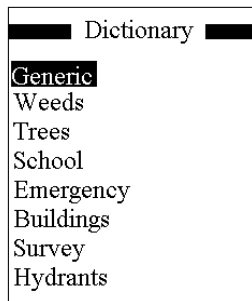
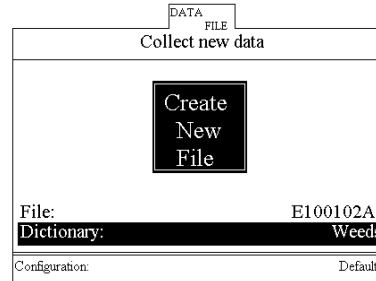


This has just been a very brief introduction to the basics of GPS technology. We are of the opinion that it is easiest to learn more by doing, rather than just reading. Following this section are a few activities for you to do which will take you step by step through the act of collecting data.

Collecting Data (GPS Activity 1)

Now that we (hopefully) have enough satellites, we're ready to collect data.

Press the **DATA** button once, to get into the **Data** division. Now use your arrow keys to scroll down and highlight the **Dictionary** option.



After pressing **ENTER**, a list of all the available data dictionaries pops up.

What exactly is a data dictionary?

A data dictionary is a means by which we collect specific information. GPS units allow us to collect data in points, in lines, and in areas. Let's say you used the GPS to find the locations of all of your town's road signs. How are you going to tell one road sign apart from any other? The GPS will record each sign as a point, but what if you want it to record things more specifically? What if you want to be able to tell a speed limit sign from a stop sign, or a detour from a one-way?



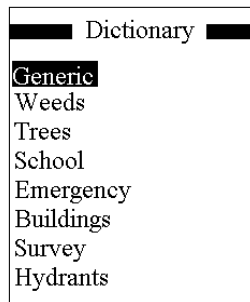
That's where the data dictionary comes in. It enables you to ask a series of questions that would help you tell one point (or sign) from the next. Each of the questions in your data dictionary is there to help you collect as much information as you can about that particular project.

What happens if you want to switch to “GPSing” your town’s fire hydrants instead of road signs? Now does it make sense to have to tell the GPS whether each point is a stop or speed limit, or detour sign? No, because there’s no such thing as a stop, or speed limit, or detour fire hydrant. Instead we might want to know how near a building the hydrant is, or how well it is working. This would require a new set of questions and, therefore, a whole new data dictionary.



Lesson 1

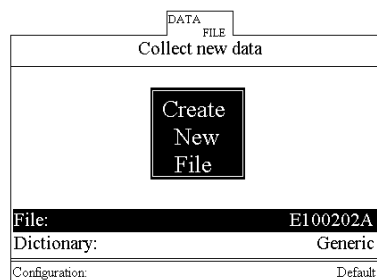
We’re now ready to begin delving into lesson one. You just learned that every project needs its own data dictionary, and we’re ready to start a new project so we need to select the correct data dictionary. In this lesson, we will be working with Macro Art (big art), and the **Generic** data dictionary is the one we’ll need.



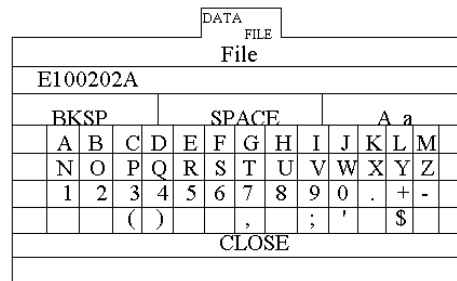
Every data dictionary is created by someone (using a program called pathfinder) except for the generic dictionary which comes with every unit. It is called generic because it doesn’t have any questions that allow us to collect specific information. It simply collects “generic” data. Highlight and select **Generic** from the list of data dictionaries.

With the correct dictionary chosen, we’re ready to start a new **roving file**. Before we open anything, though, it’s important that we name our file. Naming these roving files is crucial because it helps us tell them apart, it tells us what project we were working on, and which GPS unit we were using for all of that data. That’s a lot of information stored in just one little name.

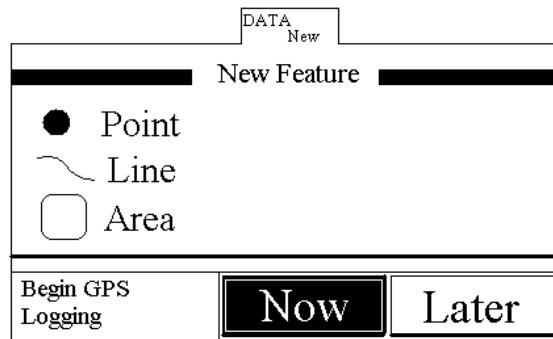
To name your roving file, highlight and select **File**.



A screen pops up that looks a little like a keyboard, in that it has numbers and letters on it. Use the **cursor** and **ENTER** keys to first delete all of the characters in the automatic name (by backspacing) except for the first letter. This first letter is the unit letter and lets us tell the data collected on this unit apart from data collected on any other unit. The next thing to type in is the project name. If you were working on hydrants you might type in EHYDRANT. If you were working on road signs you might type in ESIGNS. Because you will be working with Macro Art, go ahead and name your file EMACRO, replacing E with whatever unit letter you have. The last thing to type in is the project file number. If this were your unit's third time on Macro Art, you would name it EMACRO3. If it is your first, then name it EMACRO1. When you are finished, hit **CLOSE**.



Now that we've named our file, we can go ahead and create it. Highlight and select **Create new file**. A new screen entitle Data New will pop up.



On this screen are three features. These are generically named **Point**, **Line** and **Area**. The **Point** feature is used when you are collecting the information and location of a sign, a building, or weed patch for example. These are small things. The **Line** feature can be used to collect data along a roadway, river, or railroad. The **Area** feature is for larger things than points, and for things that often have shaped boundaries. You could use the **Area** feature for walking the perimeter of a huge weed patch for example, or the outline of a football field. For this lesson on Macro Art, we will only be using the **Area** features.

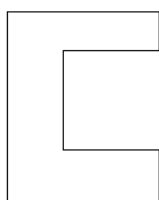


Figure 1



Figure 2



Figure 3

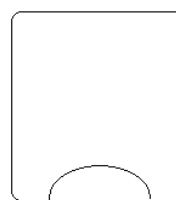


Figure 4

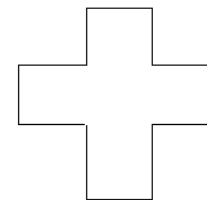
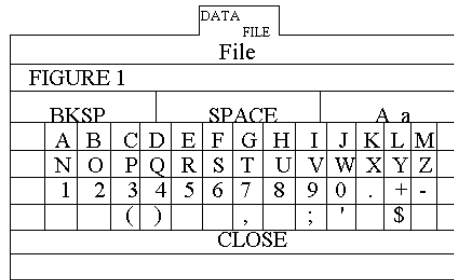
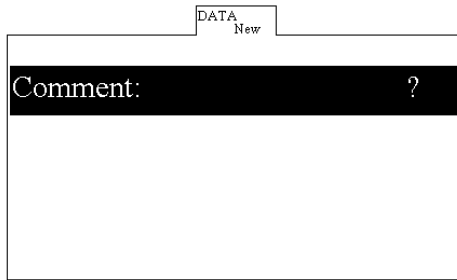


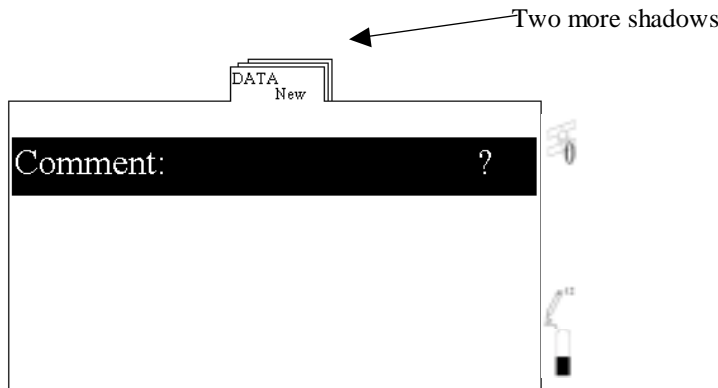
Figure 5

Look at the figures above. First get a good idea for the shape of **Figure 1**, and then select the **Area** feature. A comment option appears on the screen.



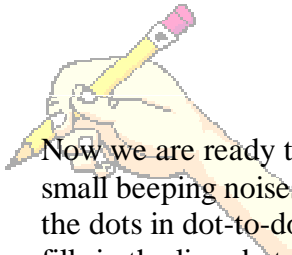
Hit **ENTER**, and when the keyboard screen pops up, type in **Figure 1**. Hit **CLOSE**, and you will be back at the comment screen.

It's time for a little observation. Do you remember when we first went through the GPS features, how the **Data** division only had one screen or recipe card? Now look at the tab in the center.

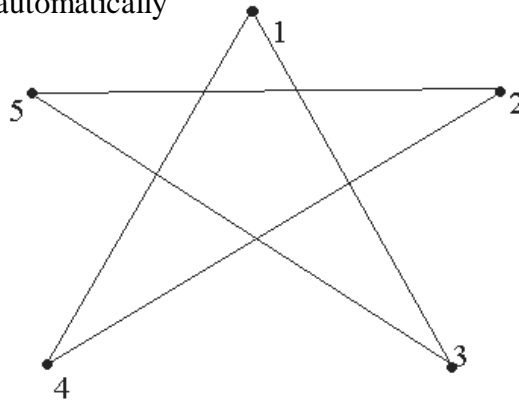


Do you see two more shadows? This means that while we are collecting data, we have two more **Data** screens available. (You'll see with time how handy these two screens are.) Also notice in the bottom right corner of the screen that a small pencil now appears with a trailing scribble of a line. When we are in the process of collecting data, this little pencil writes back and forth. The last new detail to notice is the small number above the pencil. This represents the number of times we've had a "hit" (or communication) from satellites. Hits come every five seconds and the more hits you get, the more accurate your data is.

Drawing the objects



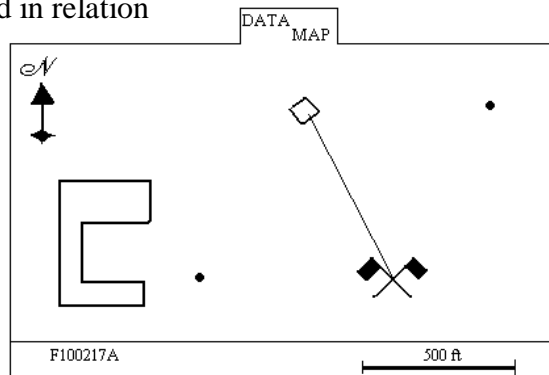
Now we are ready to draw figure one. Your unit should be actively getting hits, signified by small beeping noises every five seconds. These hits are like the dots in dot-to-dot art, where the GPS automatically fills in the lines between dots. It is your job to walk in the right pattern so that the dot-to-dot art your unit draws is the same as **Figure 1**. You can monitor your progress by using the third **Data** screen.



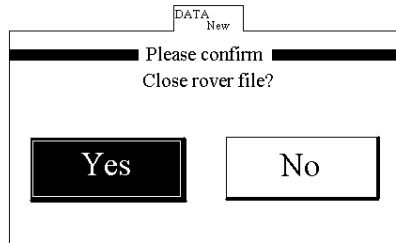
Pressing the **DATA** button once will take you to the second screen under the **Data** division. This screen is called Update, and it allows you to select features you collected previously and update or change them if you named them incorrectly. It also tells you how many features you've collected.

DATA New	
Update Feature	
1.	Area
2.	Point
3.	Line
4.	Area
?	
Current feature	N/A
Distance to start:	N/A
Area:	N/A

Pressing **DATA** again will take you to the third screen which is called Map. This shows you what your current feature looks like alone, and in relation to any other features you've collected. Pressing the **OPTION** button while in this screen allows you to zoom in or out to view your art more appropriately. Remember to make your Macro Art as big as the field or cleared area in front of you allows.



When you think your feature looks just like **Figure 1**, press **CLOSE**. This brings you back to the New Feature screen where you can again select **Area**, and get to work on **Figure 2**. If you pressed **CLSOE** too many times, the unit will think you want to close your roving file as well as your feature.



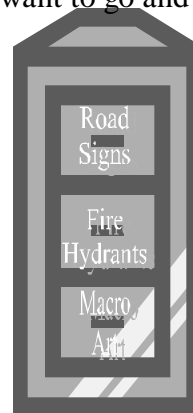
YOU DON'T WANT TO DO THIS!

The idea is to have as few roving files as possible for a day. You can create as many features (such as your Macro Art figures) as you'd like inside of a roving file, but you really only need one roving file.

What is the difference between a roving file and a feature?

A roving file is like a drawer of a filing cabinet. Say you want to go and look up a certain Macro Art in your friend's filing cabinet.

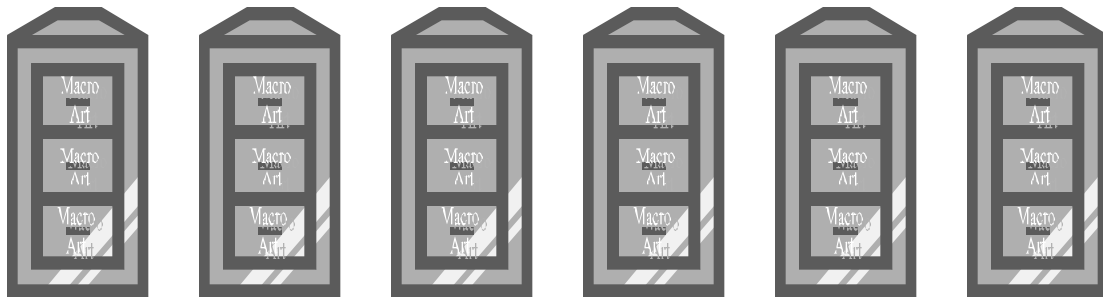
You would probably first go to the filing cabinet and read the labels on the outside. The first one might say Road Signs, and the second one might say Fire Hydrants, but the third one could say Macro Art. That's the drawer you want.



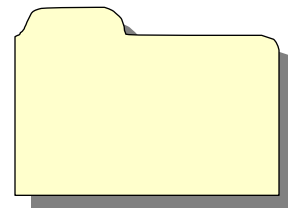
Upon opening the drawer you would see a whole bunch of folders (which are similar to our idea of features). The first one would be labeled **Figure 1**, the second **Figure 2**, and so on.

So a feature is something that fits inside a file, just like a hanging folder fits inside a drawer.

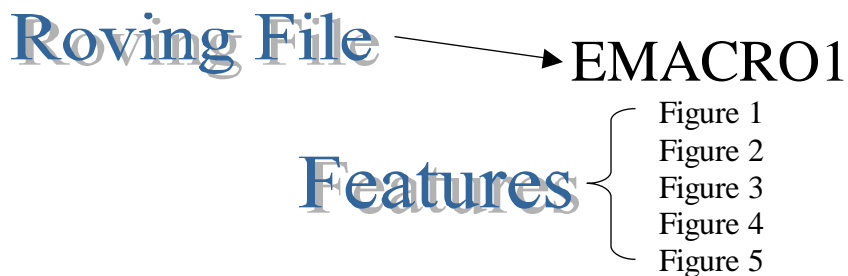
But what if your friend didn't understand the difference between a feature and a roving file? Then when you went to look up Macro Art, a whole new scene would await you.



Instead of one easy drawer being labeled Macro Art, you'd find drawer upon drawer with that label. When you open each drawer you might see that only one small folder is inside each. What a waste! Those filing cabinets take up so much room. When each one only contains a single folder, so much space is wasted. It's much better when all of your folders are in one easy-to-access drawer. The same is true of features and roving files.



When you are finished with your Macro Art lesson, your data should look like this:

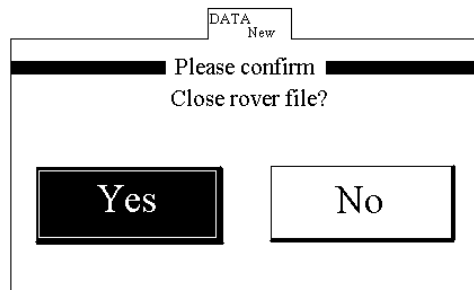


All of your figures should be tucked neatly inside your roving file.



NOTE: If you plan on using the GPS for more than one interval during the day, and these intervals are separated by at least one hour, it's okay to give the next interval a separate roving file.

Once your roving file is closed,



you may turn your unit off by pressing the **power** button down for three seconds.

You are now ready to download your data!