

Mission Planning

User's Guide

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Introduction

The Mission Planning for Windows (MPW) program allows you to plan a project that uses the Global Positioning System (GPS) and/or the Russian GLONASS system. It gives you the ability to view the visibility and availability of the satellite constellations, and to determine the dilution of precision using these constellations for any location in the world. All the tools are available for entering sites of interest, creating a list of sites, entering site-unique obstructions and determining the best time to make your measurements.

Ideally, you want to plan your project so you have a good window, meaning that there are enough satellites available and in good enough locations in the sky for you to obtain good results. Now that GPS is operational and GLONASS satellites are available, it is rare that you will find times when there are too few satellites to observe - a minimum of four is required for three dimensional positioning. However, especially in polar areas, and in locations with obstructions to the signals, such as modern urban environments, it can pay to do some careful planning. Also, considering the cost of field operations, a small amount of time spent planning your window can be paid back many times over when the best results are desired.

A major feature of the Mission Planning for Windows software is its ability to use both the GPS and GLONASS satellite systems. As a general rule, when there are more satellites available, you will obtain better results in a faster time. With two constellations, the number of visible satellites at any one time is practically doubled. Coupled with the Prism for Windows post-processing suite, Mission Planning for Windows gives you a complete set of software to plan and process data from both systems.

Overview

Examining some of the elements of Mission Planning will give you a clearer picture of what is available in the program and will help you use it more effectively.

The Mission Planning Project

The basic work unit of Mission Planning is the project. Mission Planning allows you to work on one project at a time. Each project is identified by a unique name, and is stored on your computer's hard disk as a Project File, with the extension *.prj. You may regard a project as a container for a number of sites. You should check the availability of satellites for each site in your project, since this will change with geographical location.

Mission Planning is supplied with USASITES.PRJ, which contains typical United States cities as a sample project.

You may create projects, open existing projects, and edit projects. When creating or opening a project your first task will be to select an appropriate site to begin planning.

Sites

In order to use Mission Planning properly, you must have a rough idea of where you are going to collect GPS/GLONASS data. The location where you set up your receiver is termed a site. It is quite possible to have many sites in a project.

Dilution of Precision (DOP)

One of the main factors you want to take into account when planning a project is the dilution of precision, or DOP. This is a measure of the geometrical strength of the solution you could obtain using a certain satellite configuration. Since the satellite constellation above each site is constantly changing over time, the DOP will also change. You should look at the plots of DOP available in Mission Planning to determine when the best time to observe will be - this will be your “window”.

The DOP value is unitless and depends on the number satellites available and their relative locations in the sky. There are a number of varieties of DOP, including:

- PDOP—the dilution of precision of (3 Dimensional) position.
- TDOP—the dilution of precision of time.
- HDOP—the dilution of precision of horizontal positions.
- VDOP—the dilution of precision of vertical positions.
- GDOP—the geometric dilution of precision, a combination of the position and time dilution of precision.

You may choose the particular DOP that is closest to your needs, i.e., for three dimensional positioning, PDOP would be of interest, whereas if you are only interested in vertical positioning you should examine the variation in VDOP.

The Observation Window

The goal of Mission Planning for Windows software is to allow you to select the best time to set up your receivers so that you can obtain the best results. Having set up a project, selected a site, chosen the appropriate satellites and defined an appropriate almanac file, you should inspect the various views available to define the best time to observe. This is called the observation window, or more simply the “window”. As a rule of thumb, a good window has at least four satellites available, and a PDOP of less than five.

The Almanac

The satellite location data are stored in a file called an almanac. Mission Planning for Windows requires an almanac file in order to compute satellite positions. The Ashtech naming convention for such files is of the form ALMyy.ddd, where yy are

the last two digits of the year and ddd represents the day of year. The Mission Planning program reads this file and calculates the satellite orbits and locations. You can select the directory, where MPW will look for almanac files.

A current almanac is important for accurate planning. When an almanac is over 60 days from the planning date (earlier or later), you will see a warning message indicating this fact. You can continue to use Mission Planning, but you should be aware that the information displayed is not current. Mission Planning automatically uses the latest almanac available, unless you have chosen previously to use the last used almanac in the Options dialog.

You can obtain a current almanac from an Ashtech receiver by using the Transfer module in the Prism for Windows program, selecting the Download screen followed by the Almanac option.

Printing

Mission Planning allows you to print the results of your planning. In the Project menu, are two printing options:

- Print Graph
- Print Table

Print Graph

This selection is only available if you have an open plot window. If you have more than one plot open, the graph plotted will be that of the selected plot window (this will be indicated by the window title bar being highlighted). To change the selected plot window simply click anywhere within the desired window. A plot of the graph shown on the screen will be sent to your printer.

Print Table

This selection is only available if you have an open plot window. If you have more than one plot open, the table printed will be that of the selected plot window (this will be indicated by the window title bar being highlighted). To change the selected plot window simply click anywhere within the desired window. A table of values of the selected plot window will be sent to your printer. For example, for the Satellite Availability window, a table of DOPs and the number of satellites against time is printed.

About Mission Planning

Selecting the About... option from the Help menu brings up the About dialog box.

Figure 1.1: About dialog

This gives you the version of Mission Planning you are using and copyright information.

Exiting Mission Planning

To exit Mission Planning for Windows, either:

Select Exit from the Project menu.

or

Double-click on the system menu button of the main window.

If you have made changes to the current project you will be prompted to save them if desired.

Tech Support

Project Management

Starting Mission Planning

When installed with Prism for Windows, Mission Planning appears as a separate icon in the Prism for Windows Program Group. Double clicking on it will execute the program. Alternatively, Mission Planning may be executed from within Prism for Windows by clicking on the Planning icon in the Main Menu screen. Once invoked, the main window of the program appears.

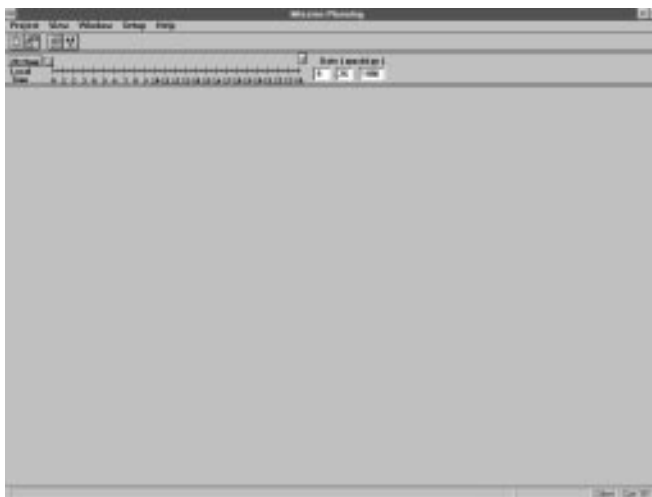


Figure 2.1: Mission Planning main window

Table 2.1 describes the various components of this window.

Table 2.1: Mission Planning main window

Component	Description
Title Bar	Displays the program name and the current open project.
Menu Bar	Displays the available function menus.
Tool Bar	Provides access to frequently used function. See the tool bar section for a list.
Time Control Bar	Defines date and time period of interest. Date fields are filled with the current date when Mission Planning is started.

Table 2.1: Mission Planning main window (continued)

Component	Description
Status Bar	Contains fields for the selected site names and location (if a site has been selected), the cut-off angle, and whether obstructions are on or off.

Creating a New Project

To create a new project, perform the following steps:

1. Select **Project** from the menu bar. The choices on this menu deal with project creation and maintenance.
2. Select **New...** from the Project menu. This brings up the Site Editor dialog box.

The project is initially named **PROJXXXX.PRJ**, with xxxx being a sequential number that is incremented every time a project is created. The project name appears in the Mission Planning main window title bar. This name can be changes using the Save as function in the Project menu.

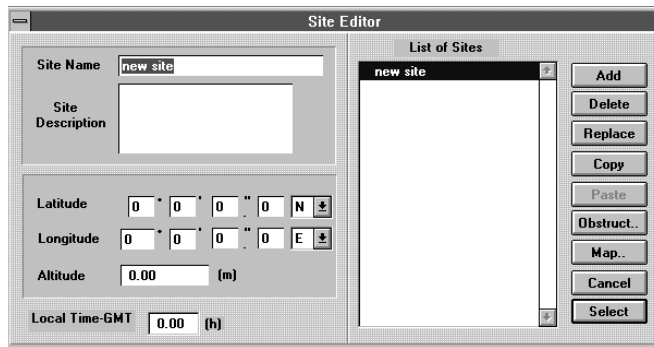


Figure 2.2: Site Editor window

Creating a New Site and Using the Site Editor

When you either create a new project or open an existing project, mission planning brings up the Site Editor. The Site Editor allows you to add or delete sites, or edit existing sites.

To create a new site:

1. Enter the site name (up to 20 characters).
2. Enter the optional site description.
3. Enter the site coordinates. This can be done one of two ways:
 - a. If you know the approximate coordinates of the site, type them into the latitude, longitude, and altitude fields.
 - b. If you do not know the approximate coordinated of the site, you can locate the site on a map and mission planning will devise the coordinates for you. Click on the map button located on the right hand side of the Site Editor. Use the mouse to click on the approximate site location. Click on the OK button.
4. Enter the difference between your local time system and GMT in the LOCAL TIME-GMT field. This will allow mission planning to display satellite visibility information in local time.
5. If you wish to add obstructions to your site, click on the obstruct button.
6. Once all the Site information is entered, click on the ADD button. This will add the new site to the List of Sites.



Sites that contain obstruction information will have a green # sign next to the site.

To edit a site:

1. Click on the desired site from the List of Sites.
2. Make any necessary changes in Site name, description, coordinates, obstructions, or local TIM-GMT time.
3. Once all changes have been entered, click on the replace button. The site will be updated with the new information.

Selecting a Site

Before any satellite visibility information can be displayed, mission planning must have a site location.

To select a site:

1. From the project menu, open a project file that contains a list of sites. This can either be a project file you have created or the Ashtech supplied USASITES.PRJ.
2. Click on the desired site from those available in the List of Sites.
3. Click on the Select button.

4. The Site Editor automatically disappears and you are now in the main screen. The Site name chosen along with the Site coordinates we displayed in the status bar at the bottom of the screen.

Time, Sats, & Almanacs

Principles

Having opened a project and selected a site, you are now ready to proceed with planning your mission. There are a number of steps to follow:

Select the day which you plan to observe (see Planning Date and Time below).

Select the system and satellites you wish to use (see Setup, Satellite Configuration).

Select the most up-to-date almanac.

Select options available such as cut-off angles, and position mode (See Setup/Options).

Examine the appropriate plot(s) to determine the best window.

You may zoom in on a smaller time period by adjusting the arrows on the time bar (see Planning Date and Time). You will have an idea of how long you need observe, based on the needs of your project. You need to select a good window which is as long as your observation period, or better still, longer, since many unforeseen problems can occur in the field.

The Sky Plot shows a polar plot of the satellite locations and tracks over time.

Planning Date and Time

Once you have selected the site of interest, you should enter the date which you expect to observe on in the date entry field of the Time Control bar. When you first execute the Mission Planning program the date is the current date as reported by your computer.

When you start Mission Planning, the time bar is set for a 24-hour time interval. There are two buttons with arrows on them, one pointing right (indicating the beginning time) and one pointing left (indicating the end time). The red section of the time bar is the current time slot for the mission.

You can adjust the time span to be viewed by sliding the arrow buttons in and out along the 24 hour time scale. To accept the time change you have selected, click outside the time bar region. This will update any plots that are present.

You have the capability to change the display to any planning date. However, since the satellite almanac data changes from time to time, planning more than 60 days beyond the

almanac data may produce inaccurate information. If you select a planning day which is out of range in relation to your selected almanac data you'll see the message:

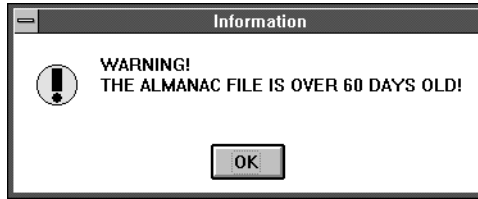


Figure 3.1: Information dialog

The time slot applies to all sites in the project - it will not change if you select a different site in the project.

To change the starting time

Perform the following steps:

1. Click and hold down the left mouse button on the right facing arrow.
2. Drag the arrow button to the left or right on the scale until the point of the arrow is at the correct time.
3. Release the mouse button. The selected time slot will change.

To change the ending time

Perform the following steps:

1. Click and hold down the right mouse button on the left facing arrow.
2. Drag the arrow button to the left or right on the scale until the point of the arrow is at the correct time.
3. Release the mouse button. The selected time slot will change.



Note that you can slide one arrow past the other. This provides a time slot that wraps over the midnight point. For example if you slide the right-facing arrow to the 20-hour point and the left-facing arrow to the 4-hour point, you schedule a time span from 20:00 to 04:00.

Time is always displayed as local time. The offset from GMT can be set in the Site Editor dialog. The offset is site specific.

Selecting Satellites and the Almanac

The setup menu allows you to change several parameters such as the satellite configuration, the almanac used. The satellite cut-off angle, and the display mode.

Satellite Configuration

To bring up the Satellite Configuration dialog, select Satellite Configuration... from the Setup menu. The following window will appear:

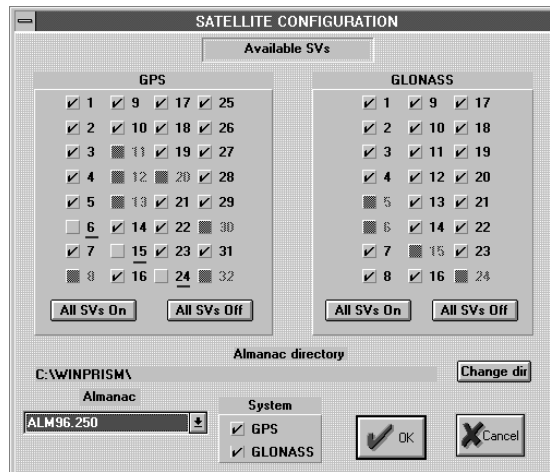


Figure 3.2: Satellite Configuration window

In this screen you can define the following:

- The satellite system to be used.
- The individual satellites to be used.
- The directory where Mission Planning will look for almanac files (default is the executable directory).
- The almanac file to be used in this project.

There are two panels of satellites, one each for GPS and GLONASS. In these panels, each satellite has a check box next to it. Additionally, there are two buttons at the bottom of each panel to switch on/off all the satellites in a particular system. These buttons are useful if you wish to quickly select or clear all the satellites in the panel.

There is also a “System” group of check boxes at the bottom of the screen to select the system to be used. To select which satellite system(s) you want to use perform the following:

1. Check the GPS box in the “System” group if you want use GPS.
2. Check the GLONASS box in the “System” group if you want use GLONASS.
3. If you have a receiver and software capable of using both systems, it is best to select both systems, since more satellites are always better.

To select individual satellites:

1. Click on the check box next the satellite. A checkmark indicates it is selected.
2. If a check does not appear it means that the system to which the satellite belongs has been deselected. Check the appropriate box in the “Systems” group.
3. If there is a red line underneath the satellite number, then that satellite is unhealthy according to the almanac. You may select unhealthy satellite, but be advised that your session will contain possibly bad date.
4. If the box is grayed out, there is no entry in the almanac for that satellite and it is not available.

The satellite selections you make in this dialog apply to all open windows. For example if you have the Sky Plot window open and deselect all GLONASS satellites, when you click OK, the Sky Plot will automatically be updated.

To select a different almanac:

1. If you need to change the path to the new almanac, click the Change Dir button. This will bring up a regular Windows Open File dialog in which you can change the drive and directory containing the new file.
2. Click OK to select the new path. If there are no almanac files in the directory you will not be able to click OK - in this case click Cancel.
3. Click on the arrow to the right of the Almanac drop down combo box. A list of available files will be presented.
4. Click on the almanac you wish to use.

The satellite panels will be updated to reflect the contents of the new file. For example if you change from an almanac containing only GPS satellites to one containing GPS and GLONASS you will see the GLONASS satellite check boxes become checked.

5. To accept changes, select OK.
6. To cancel changes, select Cancel.

Options

To bring up the Options dialog, select Options... from the Setup menu. The following dialog will appear:

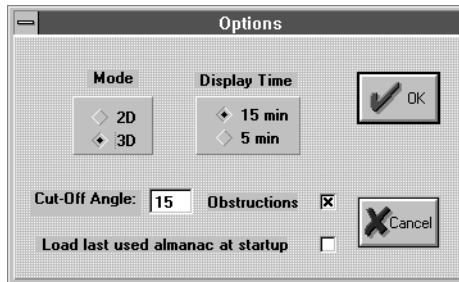


Figure 3.3: Options window

In this screen you can define

- Mode.
- The display time interval.
- The cut-off angle.
- Whether obstructions are on or off.
- To use the last used almanac automatically at start-up.

Positioning Mode

You can choose between 2-D and 3-D positioning modes. If you are solely interested in horizontal positioning and are not concerned with height, you may choose 2-D. This option had more importance in the past when there were fewer satellites available and there were no receivers capable of simultaneous GPS and GLONASS data collection. Constraining the positioning mode to 2-D meant that you could work with only three satellites, a sometimes common occurrence. However, this should be much less of a consideration now that there are always more than four satellites in view. The recommended selection is 3-D.

Display time

You may also select the time interval at which the DOP and availability values are calculated. You have a choice between 5 and 15 minutes. The basic difference is that 15 minute intervals allow quicker calculation of the DOPs, while 5 minutes is slower but gives a better picture of how the satellite constellation changes over time when you are zoomed in on a small time span.

Cut-Off Angle

The cut off angle is the angle above the horizon below which you wish to ignore satellites. It is a good idea to have a value of at least 10 degrees here, since satellites at low angles are subject to high levels of atmospheric refraction and multipath.

Obstructions On/Off

There is a check box to apply or remove any obstructions you have defined for the current site. The obstructions are not destroyed if you deselect this box - they are merely ignored and can easily be restored by rechecking it.

Load Last Almanac

The final option in this dialog allows you to use the last used almanac the next time you start Mission Planning up. This overrides the default behavior of Mission Planning which is to load up the most recent almanac in the current directory.

Clicking OK will update all open windows with changes.

Clicking Cancel ignores changes.

Satellite Plots

Having selected a site and setting the desired options, you are now ready to view the Satellite plots to plan your mission.

Mission planning provides three different plots and graphs that you can examine. Each plot provides a different perspective on satellite visibility, location, and availability. All plots are accessed from the VIEW menu. The three plots that are available are:

- Satellite visibility plot that tells you when individual satellites are visible;
- The DOP plot that shows a graph of the total number of satellites available and the DOP values versus time, and;
- The SKY plot that display a polar plot of the satellite track as they cross the sky.

Which plot is most useful depends upon the individual. However, in general, the DOP plot is the most helpful as the availability and strength of the geometry are usually the most important factors in planning a mission.

Satellite Visibility

To activate the Satellite Visibility window, select Satellite Visibility from the View menu. This will bring up the following window:

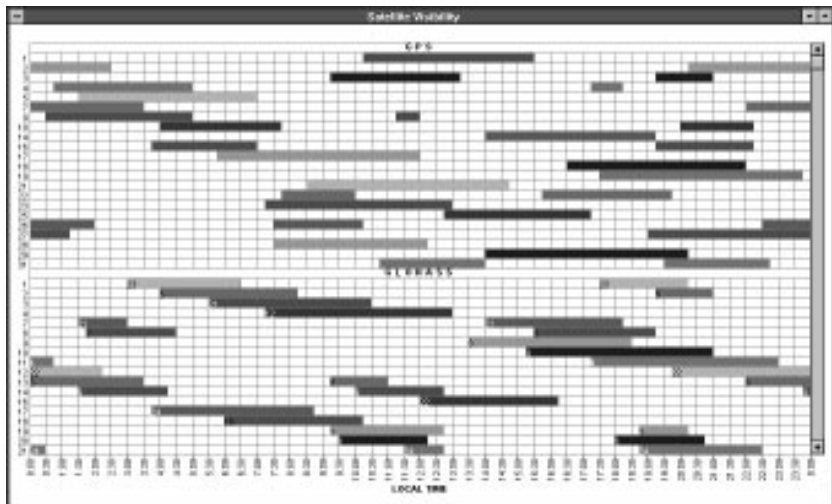


Figure 4.1: Satellite Visibility window

This window contains a graph of when satellites are available. The time scale on the horizontal axis corresponds to the selected time span in the Time Control bar. Down the vertical axis are the satellite PRN numbers for the satellites you have selected in the Satellite Configuration window. Since Mission Planning works with both GPS and GLONASS, the satellite constellation is also shown in the main client area of the window. If you have selected both systems, there may be too many satellites to fit in the window vertically. In this case a vertical scroll bar becomes active on the right side of the screen. Use this to move up and down the list.

A colored bar to the right of the satellite ID number indicates when it is visible at the selected site. The bar colors are highly contrasted to allow easier separation of the satellites.

You will want to select a time period when there are most satellites available for an extended period. For any particular time you can find the number of satellites available by counting the number of bars crossing that time.

However, this window is most useful for detecting when individual satellites are visible. For example, if you are interested in GPS satellite 28 you can easily see it on this graph. A more useful view for seeing the total number of satellites available is the combined DOP/Satellite Availability plot, described next.

As you move the mouse over the window, you will see two fields in the status bar showing the time and the satellite ID number.

DOP Plot

To activate the DOP plot window select DOP Plot from the View menu. This will bring up the following window:

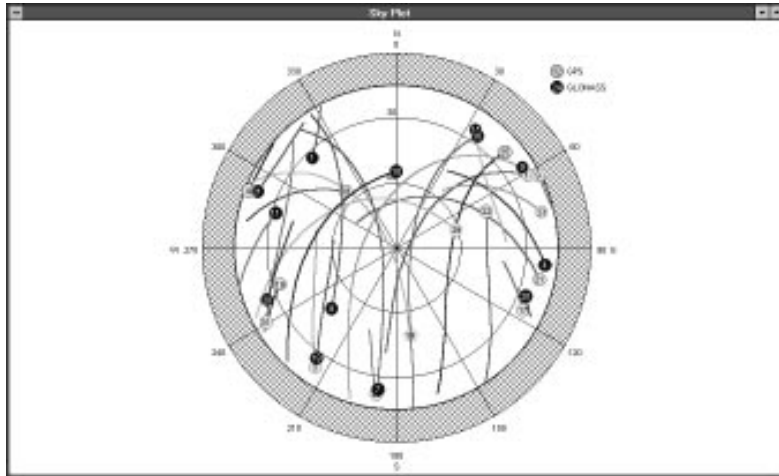


Figure 4.2: DOP Plot window

This shows a graph of the Dilution of Precision and the number of available satellites against time. The time scale on the horizontal axis is adjusted to correspond with the selected time span in the Time Control bar. There are a number of check boxes along the top of the window. PDOP and Satellite Availability are checked by default.

You will notice that the left vertical axis displays the DOP value, while the right axis displays the number of satellites available. Availability is always displayed in green, as indicated by the title on the availability axis scale. You may select to view any combination of DOP types by checking and unchecking the appropriate boxes. As a particular DOP is selected, a color key is added to the legend above the graph. Each DOP has a different color. For example, to display GDOP:

1. Move the mouse arrow to the GDOP box.
2. Click the GDOP box.

You will notice the graph is updated with GDOP, and the legend is updated above the graph. To remove GDOP, uncheck the box.

You should also notice that there is a general inverse correlation between the DOP value and the number of satellites available - the more satellites there are, the lower the value of DOP, and vice versa. To achieve the best results

you should be looking for an extended period where the DOP value is low and the number of satellites is high. You can adjust your observation schedule to fit in with the best time. Note that the time axis is in local time.

As you move the mouse over the window, you will see two fields in the status bar showing the time and DOP value.

The satellite availability graph actually provides a different view of the same information as the Satellite Availability window. Most users find this window the easiest to use to find the best time to observe.

Sky Plot

To activate the Sky Plot window, select Sky Plot from the View menu. This will bring up the following window:

Figure 4.3: Sky Plot window

This graph shows a polar plot of the satellite tracks as they cross the sky. As in the Obstruction Editor screen, north is at the top, east at the right, etc. The figures around the edge indicate the bearing from north in 30 degree increments. The concentric circles indicate elevation above the horizon, from 0 degrees at the edge to 90 degrees (directly above the site) in the center.

You will see the track of each satellite plotted in contrasting colors - the colors correspond to those used in the Satellite Visibility window. The PRN numbers are also attached to each track. GPS satellites are indicated by yellow disks, while GLONASS satellites are shown by blue disks.

If a cut off angle is specified, a portion of the polar plot will be shaded above the horizon up to the cut off angle. No satellite tracks appear below this angle. In addition, if you have defined an obstruction for the site, and have selected to use it, it will appear as a shaded region.

As you move the mouse over the window, you will see two fields in the status bar showing the azimuth and elevation.

Arranging Plot Windows

Mission Planning follows the standard Windows Multiple Document Interface definition. Each plot you open is a separate window with its own system menu and minimize/maximize buttons. You may arrange and tile these windows using the Window item on the main window menu bar - you use this in the same way that you use the Window menu in the Windows 3.1 Program Manager. It can be useful to open the plots and tile them so that you see them side by side.

