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YoNav: Your Own Integrated Navigation System for DOS Platforms

by

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Abstract

YoNav is a real-time navigation and data acquisition program written in Microsoft C/C++ that provides navigation services on almost any DOS platform. The YoNav Graphical User Interface (GUI) supports virtually any VGA and most EGA graphics hardware. In its fullest configuration, YoNav will support up to 10 simultaneous serial RS232 channels, 4 channels of digital I/O, live video display and frame capture from 3 types of video input and graphic support for over 150 different printers. The same software will also operate on a notebook PC with only one or two serial inputs. YoNav is completely configurable by a small utility YoCfg that allows various pieces of optional hardware to be configured in or out of the system. Data can be logged in either or both a compact binary or standard USGS ascii format on any system disk. Post-plotting of binary format navigation data can occur while data is still being acquired through a multi-tasking time slice process.

Introduction

During the winter of 1991, the USGS Marine Facility began development of a portable PC based integrated navigation system that would replace the aging navigation RhoRho [2] system currently in use. One of the driving factors for a new navigation system was the completion of the GLORIA Exclusive Economic Zone (EEZ) work and the termination of the lease of the R/V Famella which had been the primary research vessel for marine operations since the late 1980's. The RhoRho system had been designed mainly to provide steering displays and navigation services to the GLORIA project on a ship that always had the same sensors, helmsmen and navigators. With the acquisition of a new vessel on the horizon, it became apparent that we needed a navigation system that could be portable, work with many different navigation sensors and have a modern graphical user interface that is both intuitive and easily learned by less experienced watchstanders. This paper describes and documents the operation and setup of this system known as **YoNav**.

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[2] Gann, John T., 1988, Integrated GPS, Range-range and Hyperbolic Loran C Marine Navigation System for Use on IBM AT or Compatible Microcomputers, USGS Open File Report 88-562, 39 pages
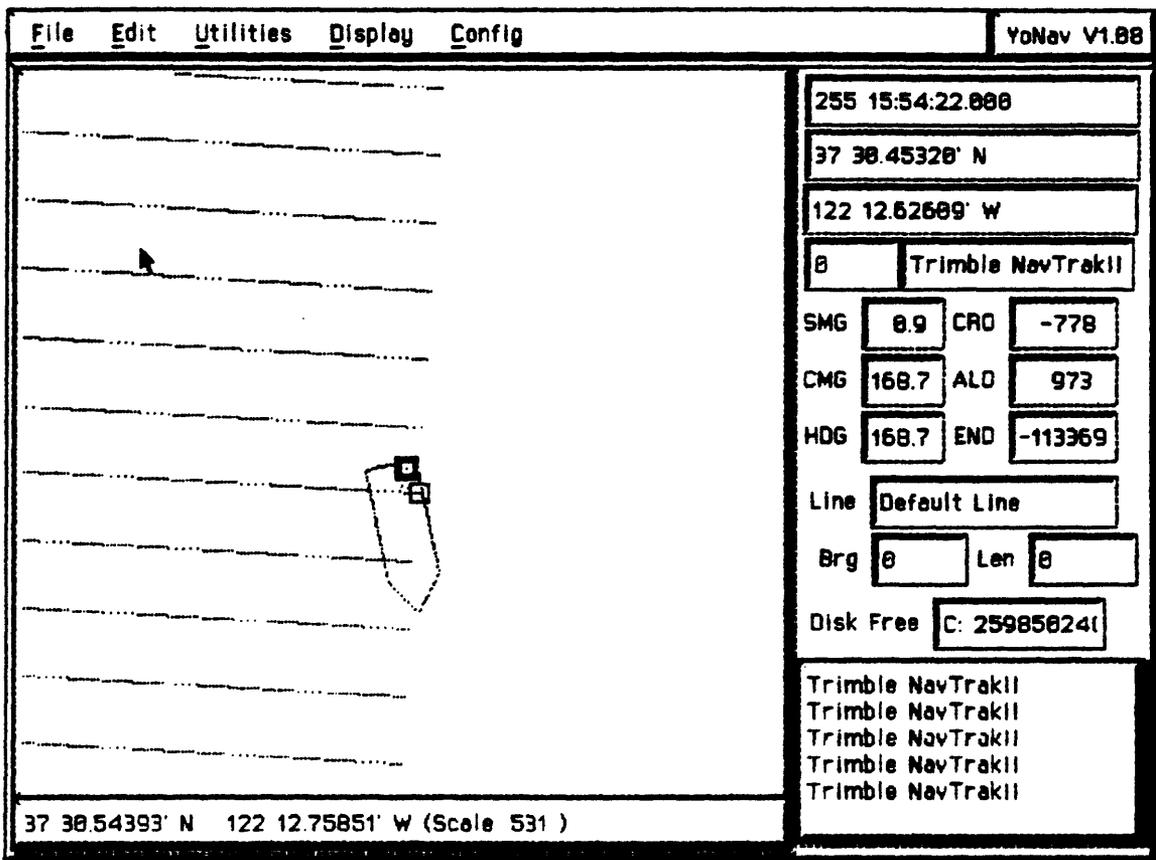
Figure 1. Anatomy of Main Navigation Display

Main Graphics Display

The main graphics display is comprised of 4 different windows: 1) the main drawing area, 2) the side panel display, 3) the scrolling message area in the lower right corner and 4) the status bar at the bottom of the main drawing area display. Each part of the display serves a discrete function. Please refer to Figure 1. while reading the next few sections.

Main Drawing Area

The main drawing area displays a plan view of the ship's location, survey lines, sampling sites and other symbology that the user can specify. See Figure 2.
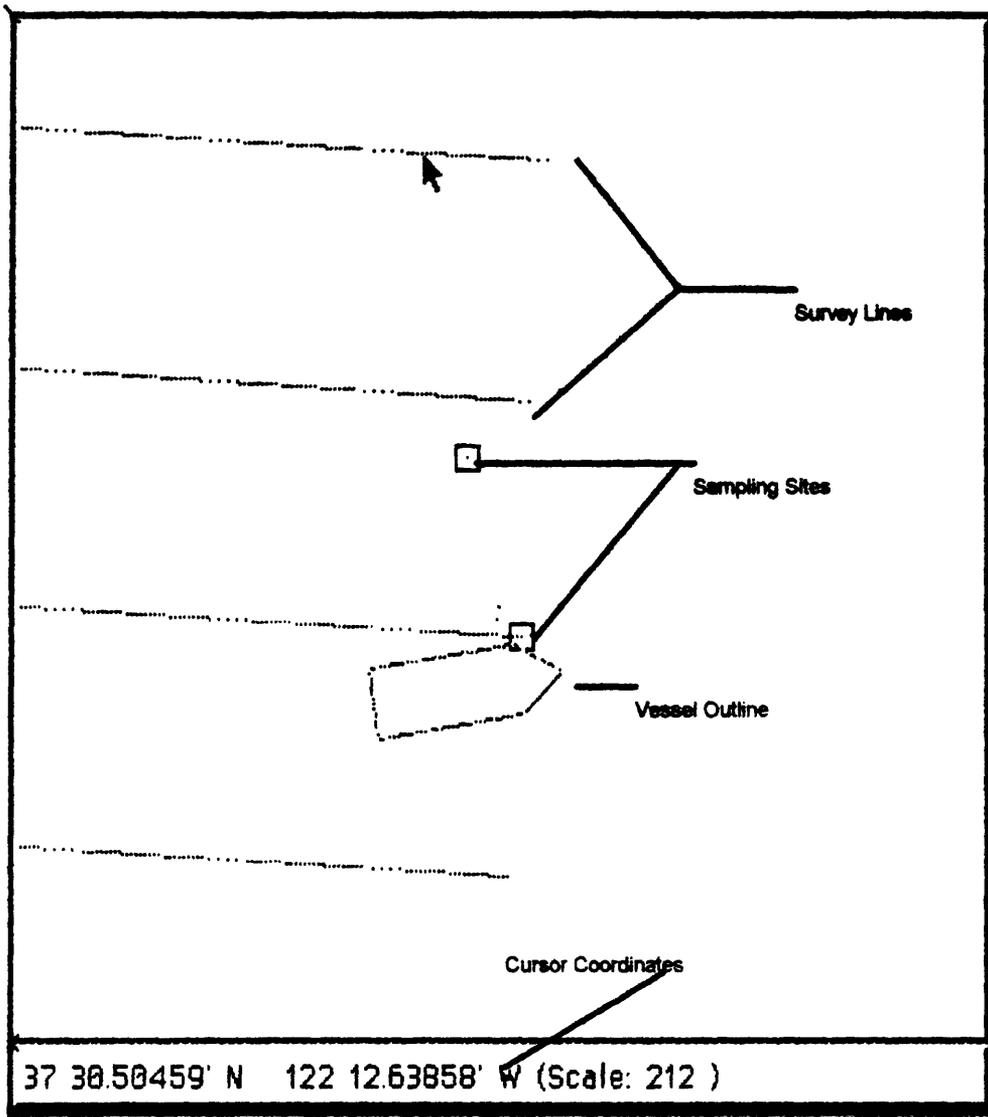
Figure 2. Main Drawing Area

The main drawing area is updated once per second as long as there is not a menu or some other form that would obstruct the drawing. Exactly what is displayed is controlled by the Display Main Menu choices. In this display, north always points to the top of the monitor. The gyro or course information is used to orient the ship symbol to the proper rotation.

Side Panel Display

The side panel display shows the numerical values that are represented pictorially in the main graphics display window. See Figure 3.

Label (left)	Field	Value	Sub-field	Value	Label (right)
	251 20:20:58.000				Day/Time
	37 30.45060' N				Latitude
	122 12.63290' W				Longitude
Depth	0	Trimble NavTrakII			Sensor
Speed Made Good	SMG	0.1	CRO	51	Cross Track Error
Course Made Good	CMG	44.9	ALO	19	Along Track Distance
Ship's Heading	HDG	44.9	END	2015	Distance to End
	Line	L02			Line Name
Line Bearing	Brg	270	Len	2034	Line Length
	Disk Free	C: 2695249			Disk Space Available

Trimble NavTrakII
Trimble NavTrakII
Trimble NavTrakII
Trimble NavTrakII
 — Status Message Area

Figure 3. Side Panel Display

Starting from the top of the display, the operator is presented with a series of display only fields that are updated once per second, regardless of what is happening on the graphics display. Time is displayed as Day of Year followed by the current hour, minute, second and thousandths of seconds. The time displayed is taken from the system clock. (When a GPS sensor is in use, please note that system time is synced to GPS time at regular intervals).

Vessel Time & Position

Next displayed are two fields containing the Y and X coordinates of the Vessel Reference Position (VRP). The VRP is defined under the **Edit/Vessel/Reference** menu selection. The VRP may be displayed in either latitude longitude coordinate system or in a Universal Transverse Mercator (UTM) coordinate system. The user may specify the units for both coordinate systems. See menu selection **Config/Coordinate System** and **Config/Units.** Under the X coordinate are two fields on the same line. The first field is the current depth. The next field is the currently selected navigation sensor. The depth is displayed in meters only when the Raytheon PDD Bathy 2000 depth digitizer is connected. Other depth digitizers may be integrated in future releases. The displayed depth is valid unless followed by an asterisk. The asterisk indicates that the alarm light was lit on the PDD 2000 when the current depth was read. The current sensor is the sensor that is chosen to compute the line and site distances from. This sensor can be selected under the menu pick **Edit/Sensor/Select Nav Sensor.**

Vessel Dynamics

Under the current sensor field are 3 fields that describe the dynamics of the vessel to the left and 3 fields that describe the vessel relative to either a survey line or a sampling site depending on what the operator has requested for display. The field labeled "SMG" is the computed speed made good displayed in knots. This value is computed based on the filter settings controlled by menu selection **Edit/Sensor/Filter**. The speed and course filters are a logarithmic filter with a user specified time constant. The field labeled "CMG" is the computed course made good of the vessel. The same filter function is applied to this value. The field labeled "HDG" represents the vessels heading when a gyro or compass is available. If no gyro source is available this field will display the computed course made good.

<u>Trackline Distances</u>
The trackline distances are described by three fields that are to the right of
the vessel dynamics fields. The topmost field labeled "CRO" is the cross
track distance. The cross track distance is the distance measured
perpendicular from the survey line to the vessel. Positive values indicate
that the vessel is to the right of the survey line and negative values indicate
that the vessel is to the left of the line. The field labeled "ALO" is the along
track distance. The along track distance is the distance traveled parallel to
the survey line. Negative values indicate that the vessel has not yet
reached the start of line point. All distances are displayed in meters. The
field labeled "END" is the distance remaining to the end of the survey line
measured parallel to the line.

Sampling Site Distances
When the user has selected to display the site mode instead of line mode,
the side panel will display range and bearing information instead of
trackline distances.
The field labeled "RNG" contains the range in meters from the vessel
location to the currently selected sampling site. To select a sampling site
see **Edit/Sampling Sites**.
The field labeled "BRG" displays the current bearing from the vessel to the
sampling site. This is the course that the helmsman should steer to hit the
site.

<u>The File Menu</u>
The File Menu contains selections for configuring the data logging, printer
setup and exit functions. Each menu selection and its associated forms will
be discussed in sequence.

<u>Logging</u>
The **Logging** menu selection allows the operator to select both the format
and disk drive upon which to record the navigation data. By selecting the
Log Disk Drive field, the operator can choose the physical disk drive. See
figure 4.

Figure 4. Data Logging Setup Form

There are two check boxes on the **Logging** form that allow the operator to select exactly what will be logged to the disk. By selecting the **Enable Binary Logging** option, **YoNav** will record all raw data from each enabled sensor as specified in the **Edit/Sensor/Port Assignment** form. Note that the logging interval for binary logging is specified in the **Edit/Sensor/Port Assignment** form not in the **Logging** form. The reason for this is to provide the operator will as much flexibility as possible. Since some sensors may be reporting large amounts of data relative to others, the operator may tailor the recording rates of each sensor to their particular requirements. The Enable Ascii Logging check box enables the recording of the currently selected navigation sensor only in an abbreviated standard Ascii format used by the USGS navigation data processing group. Since only one sensor can be the primary sensor, this form provides an interval entry field. Specify the number of seconds between each successive

recording interval. See Appendix A. for both binary and ascii data recording formats. The **Help** button at the bottom of the form contains useful operator tips that about the logging feature, that may be more recent than this manual. The operator may also add comments of their own to this help file by editing the ascii file named **logdata.hlp**. The **Okay** button accepts the form changes and exits the form. The **Cancel** button aborts the form.
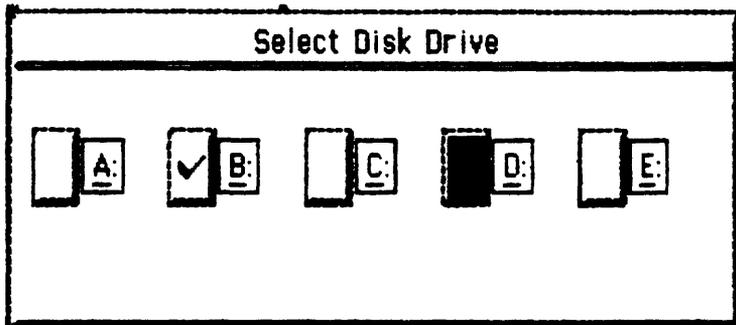
Figure 5. Log Disk Selection Form

Printer Configuration

The **Printer** menu selection allows the operator to enable/disable and select the printer to be used for graphic screen dumps and regular printer logging of navigation data. The printer is enabled by checking the **Printer Enabled** check box. The interval between successive routine navigation printouts is specified in minutes in the field labeled **Print Interval (minutes)**. The field labeled **Width/Columns** specifies the width of a printed line in characters. The field labeled **Height/Rows** specifies the number of lines per page for printouts. See Figure 6.
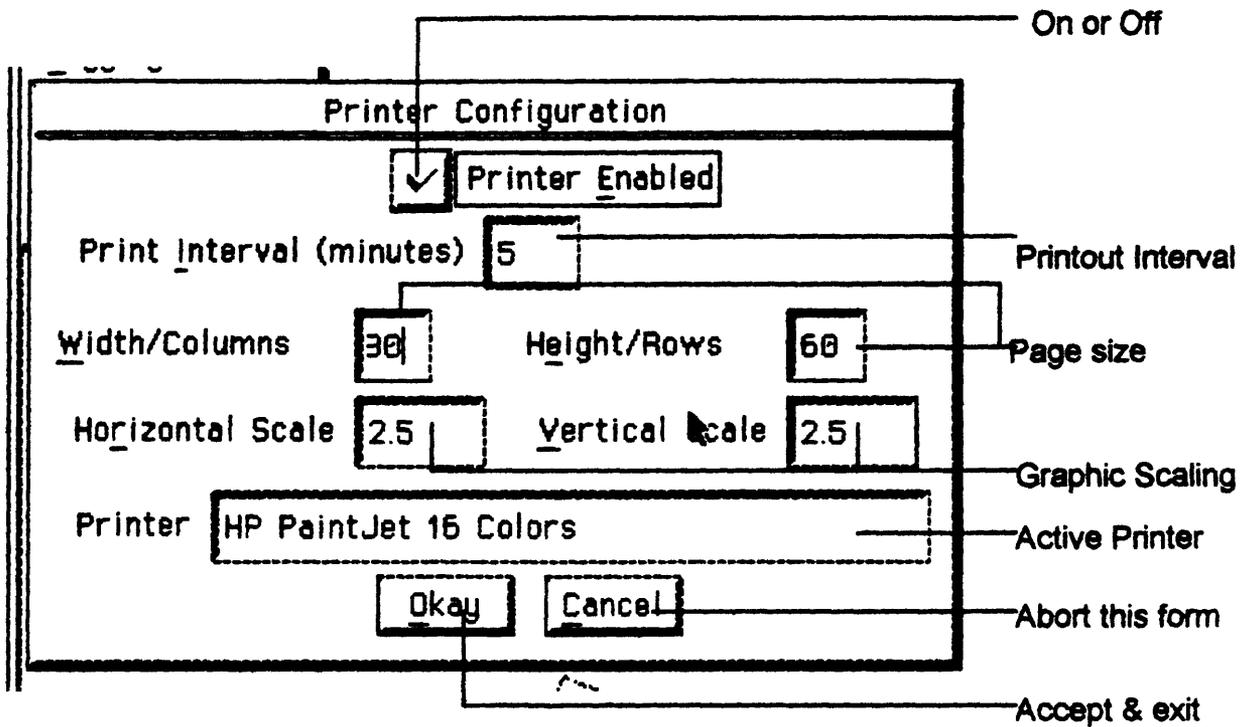
Figure 7. Printer Setup Form

The **Printer Setup** form allows the operator to configure **YoNav** to operate
correctly with a particular printer. See Figure 8. The two scaling fields
labeled **Horizontal Scale** and **Vertical Scale** are used to scale the
graphical image on your particular printer. These two fields only affect the
screen dumped printed image. The operator uses these two values to
stretch or shrink the printed image in either the horizontal or vertical
direction. You will need to experiment with these settings to get the desired
size.

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```
┌─────────────────────────────────────┐
│        ┌─────────────────┐          │
│        │ Select a Printer│          │
│        └─────────────────┘          │
│  ┌─────────────────────────┐  ┌──┐  │
│  │ Acer LP-76              │  │ ⊠ │  │
│  └─────────────────────────┘  └──┘  │
│  ┌─────────────────────────┐  ┌──┐  │
│  │ Acer LP-76              │  │ △ │  │
│  ├─────────────────────────┤  ├──┤  │
│  │ AEG Olympia 24-pin Models (B/W) │  │
│  │ AEG Olympia 24-pin Models (B/W) │  │
│  │ AEG Olympia Laserstar 6 │       │
│  │ Alps 8-pin Models (B/W) │  ┌──┐  │
│  │ Alps 8-pin Models (Color)│ │ ▽ │  │
│  │ Alps 24-pin Models (B/W)│  │ ⊠ │  │
│  └─────────────────────────┘  └──┘  │
│  ┌─────┐ ┌───────┐ ┌──────┐ ┌────┐ │
│  │ Okay│ │Default│ │Cancel│ │Help│ │
│  └─────┘ └───────┘ └──────┘ └────┘ │
└─────────────────────────────────────┘
```
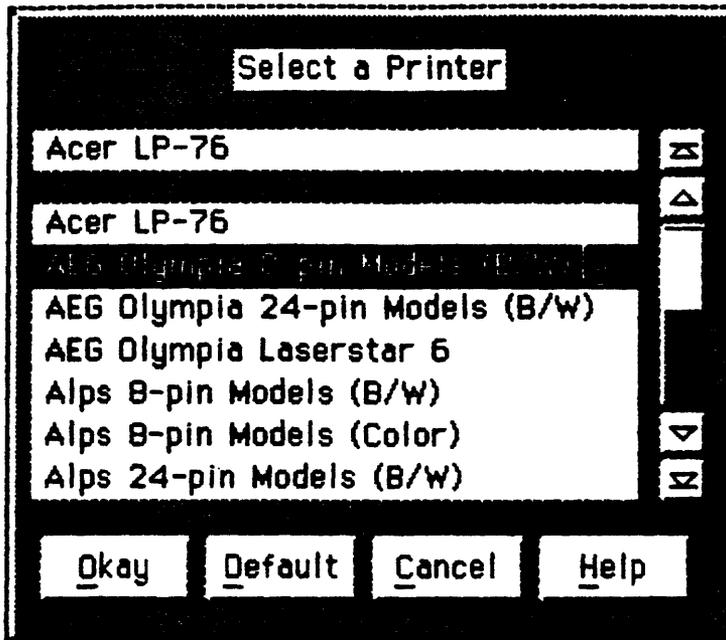
Figure 8. Printer Selection Form

By selecting the field labeled **Printer**, the operator is presented a list of possible printers that can be supported by **YoNav**. Select the printer that matches yours and press the **Okay** button. See Figure 8.

Change Diskette

By selecting the **Change Diskette** option, the operator can close the navigation log files on the logged diskette and insert another pre-formatted diskette into the disk drive. This function will detect if the current **Log Disk** is removable media. If the log disk is the hard drive or some other non-removable media, **YoNav** will display the error message "**Non-removable media**" and continue logging. Note that only preformatted diskettes should be used with YoNav. Never remove a floppy diskette from the drive when that floppy is selected for logging. If you need to remove the diskette, you must first stop data recording. Data recording can be disabled by using the **File/Logging** menu selection.

Exitt

The exit function closes all data logging files, disables serial interrupts, restores the text mode and returns the computer to DOS.

The Edit Menu

The Edit menu allows the operator to configure the system to their particular needs. The operator may configure the sensors and sensor related features, setup survey lines, configure the UTM parameters, describe the vessel, and configure sampling sites.

```
File    [Edit]   Utilities   Display   Config
     ┌──────────────┬──────────────────────┐
     │ [Sensor]     │ Select for Nav       │
     │ Lines        │ Port Assignment      │
     │ Geodesy      │ Select Gyro          │
 ····│ Vessel       │ Nav Stations         │
     │ Sampling Sites│ Filter Constants    │
     │              │ Calibrate Range Sys  │
     └──────────────┴──────────────────────┘
```
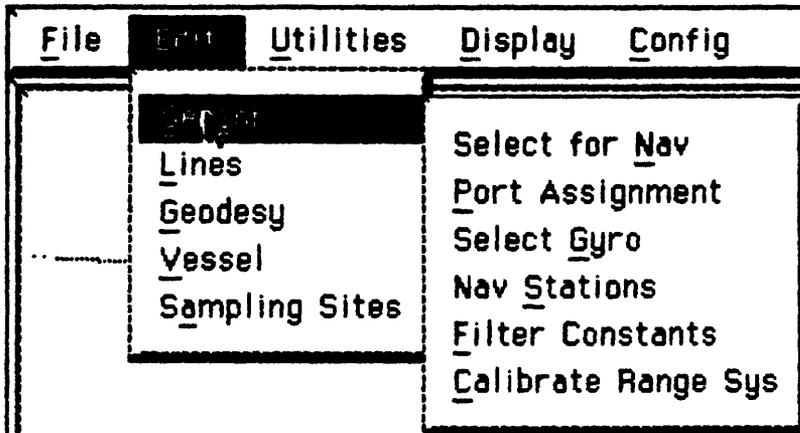
Figure 9. The Edit Menu

Edit Sensor Menu

The **Edit Sensor** menu allows the operator to configure the sensors and their related parameters.

Select for Nav

The **Select for Nav** menu allows the operator to select the sensor that will be used to compute steering information to lines and sampling sites. See Figure 10.
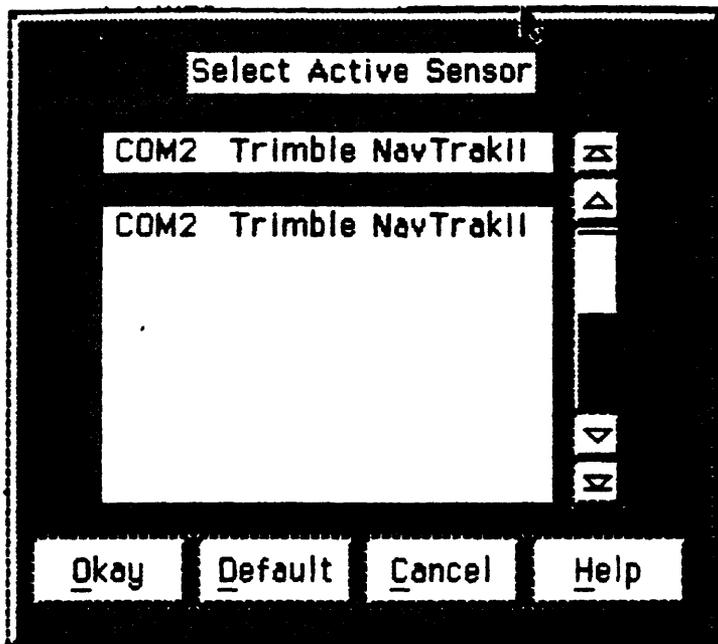
Figure 10. Select for Nav

. When a sensor that can provide full steering information has been enabled, it will appear in the list presented by the **Select for Nav** form. To select a sensor for steering select the name of the sensor so that it appears in the top line of the form, then select **Okay**. Note that selecting a sensor for steering has no effect on the binary logging function. If binary logging is enabled, then all sensors that are enabled will be logged at the specified frequency. **Select for Nav** does however affect what is logged in the ascii data log file. Only the sensor that is being used for steering will be recorded in the ascii data log file.

Port Assignment

The **Port Assignment** menu allows the operator to assign each serial sensor to a specified serial port. See Figure 11.

```
┌─────────────────────────────────────────────────────────────────┐
│              Select Parameters for COM1                          │
├─────────────────────────────────────────────────────────────────┤
│  ┌─┬──────────┐  ┌─┬──────────┐                        ┌───────┐ │
│  │✓│ Disable  │  │ │ Enable   │  Log/Xmit Interval (sec)│  2_  │ │
│  └─┴──────────┘  └─┴──────────┘                        └───────┘ │
│                                                                   │
│              Sensor                           Baud                │
│  ┌──┬────────────────────────────┬──┐  ┌──┬──────────┬──┐        │
│  │△│     HP Compatible Plotter   │▽│  │△│   9600   │▽│        │
│  └──┴────────────────────────────┴──┘  └──┴──────────┴──┘        │
│  Handshake                                                        │
│  ┌─┬────────┐       Parity    Data Bits        Stop Bits         │
│  │✓│ None   │     ┌─┬──────┐  ┌─┬───┐       ┌─┬───┐              │
│  └─┴────────┘     │✓│ None │  │ │ 7_│       │✓│ 1_│              │
│  ┌─┬────────┐     └─┴──────┘  └─┴───┘       └─┴───┘              │
│  │ │XON/XOFF│     ┌─┬──────┐  ┌─┬───┐       ┌─┬───┐              │
│  └─┴────────┘     │ │ Odd  │  │✓│ 8_│       │ │ 2_│              │
│  ┌─┬────────┐     └─┴──────┘  └─┴───┘       └─┴───┘              │
│  │ │CTS/RTS │     ┌─┬──────┐  ┌────────────────────────┐        │
│  └─┴────────┘     │ │ Even │  │ COM1: 9600, N, 8, 1    │        │
│  ┌─┬────────┐     └─┴──────┘  └────────────────────────┘        │
│  │ │DTR/DSR │                                                    │
│  └─┴────────┘                                                    │
│  ┌────────┐   ┌────────┐   ┌───────┐  ┌───────┐  ┌────────┐      │
│  │ Okay   │   │ Next   │   │ Prev  │  │ Save  │  │ Cancel │      │
│  └────────┘   └────────┘   └───────┘  └───────┘  └────────┘      │
└─────────────────────────────────────────────────────────────────┘
```

Figure 11. Port Assignment

Each serial port in the system can be described by the use of the Port
Assignment form. The port that is being configure by this form is indicated
at the title area of the Port Assignment form, e.g. "**Select Parameters for
COM1**". The user may Enable/Disable a serial port by checking either the
Disable or **Enable** box on the **Port Assignment** form. When a port is
disabled, any input that appears at that port will be ignored. If the port is
enabled, then **YoNav** will attempt to read and parse the incoming data
using the RS232 parameters contained on this form. The field labeled
Log/Xmit Interval (sec) contains the interval in seconds between either
successive binary data logging or serial data transmissions for this sensor.
Some sensors such as Mudshark, are write-only sensors, i.e. these sensors
are only sent navigation data, they do not provide it. By setting the
Log/Xmit Interval field, the operator can control how frequently a write-only
sensor will be updated. In contrast, any sensor that provides navigation
data can have all of its data recorded in a compact binary format. The
Log/Xmit Interval will control the logging frequency of these sensors as
well. The field labeled **Sensor** contains the name of the current sensor that

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is assigned to this port. This field has 2 arrow buttons on either end of it. By selecting either of the arrows, the operator can scroll through the list of possible sensors that YoNav supports. When the appropriate sensor is in view continue by configuring the RS232 parameters for that particular sensor. The **Handshake** buttons configure the type of handshake protocol used by the selected sensor. All of the currently supported YoNav sensors will work with no handshake. The **Parity** buttons should be set to reflect the parity of the sensor. The **Data Bits** buttons should be set to 7 or 8 again to match the sensor. The **Stop Bits** button should be set to 1 or 2 to match the selected sensor. Finally, the baud rate must also match the sensor. Select the baud rate by selecting the arrows at the end of the field labeled **Baud**. There is a non-selectable field directly below the **Data Bits** field that shows the current RS232 settings. If the current port is not the port you wish to modify, you may select either the **Next** or **Previous** buttons to advance or retard the port. If you are satisfied with the port settings you may select either the **Okay** or **Save** buttons. The **Okay** button will keep the changes you have made and return you to the previous menu. The **Save** button will keep the changes you have made and allow you to modify other port assignments. The **Cancel** button will allow you to bail out of the current form without saving any changes.

Select Gyro

The **Select Gyro** menu allows the operator to assign a sensor as the source of ship's heading data. Some sensors may interface directly to a ship's gyro through a synchro to digital or stepper to digital board. These sensors may then provide this heading information directly to YoNav. The **Select Gyro** form lists all of the sources of heading information that YoNav is currently interfaced to. See Figure 12.

```
┌─────────────────────────────────────┐
│ ┌─────────────────────────────────┐ │
│ │        Select Gyro Source       │ │
│ ├─────────────────────────────────┤ │
│ │  ┌──┐┌─────────────────┐         │ │
│ │  │  ││Magnavox 1107│             │ │
│ │  └──┘└─────────────────┘         │ │
│ │  ┌──┐┌─────┐                     │ │
│ │  │  ││KVH│                       │ │
│ │  └──┘└─────┘                     │ │
│ │  ┌──┐┌──────────────────────┐    │ │
│ │  │✓ ││Buster Gyro Digitizer│     │ │
│ │  └──┘└──────────────────────┘    │ │
│ │  ┌──┐┌──────────────────────┐    │ │
│ │  │  ││No Gyro - Use Course│       │ │
│ │  └──┘└──────────────────────┘    │ │
│ │                                  │ │
│ │   ┌────────┐   ┌─────────┐       │ │
│ │   │ Okay   │   │ Cancel  │       │ │
│ │   └────────┘   └─────────┘       │ │
│ └─────────────────────────────────┘ │
└─────────────────────────────────────┘
```
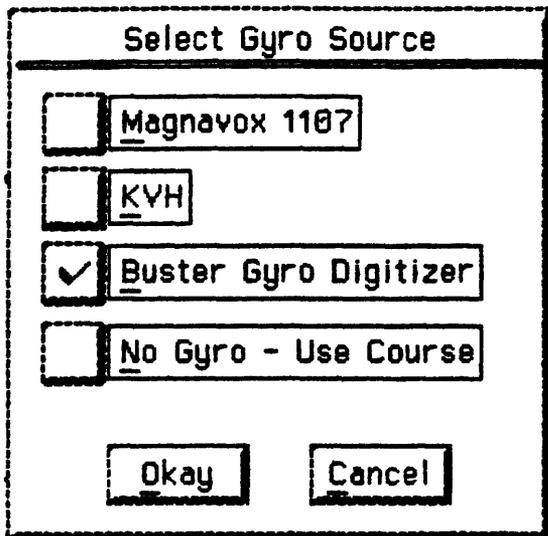
Figure 12. Select Gyro Source

Nav Stations

The **Nav Stations** menu allows the operator to set up locations and transponder info for shore based navigation beacons such as the Del Norte Model DDMU540. See Figure 13.

```
┌─────────────────────────────────────────────┐
│              Station 1 of 10                 │
├─────────────────────────────────────────────┤
│                                              │
│                 [✓] Enabled                  │
│                                              │
│   Station Name  │USGS Marine Facility│       │
│                                              │
│     1. Latitude │37 30.45000' N│             │
│                                              │
│     2. Longitude│████████████████│           │
│                                              │
│        Height   │37.00000│                   │
│                                              │
│  Transponder Id │804│                        │
│                                              │
│     Range Bias  │0.0│                        │
│                                              │
│  [Okay] [Previous] [Next] [Cancel] [Save]    │
│                                              │
└─────────────────────────────────────────────┘
```

Figure 13. Nav Stations

The **Nav Stations** form contains an **Enabled** check box which enables the station for use. If a station transponder is received, but the transponder is not enabled, that station will be ignored. Up to 10 stations may be in use at any time, although only 4 stations at a time have been tested. There is a field labeled **Station Name** which can be modified to contain a descriptive name of up to 30 characters. The **Latitude** and **Longitude** fields should be entered in WGS-84 coordinates. The **Height** field should contain height of the transponder antenna above sea-level in meters. The height of the antenna is used to correct the slant range received from the ranging receiver. Be sure that the Del Norte receiver does not also correct for height of the transponder by placing zeroes in the receiver field for height. The **Transponder ID** field should contain the 3 digit Del Norte transponder code that matches the transponder installed at this location. The **Range Bias** field should contain **0.0** unless you have information about a range error with this transponder. The Range Bias field allows the operator to enter a bias value in meters to be applied to the observed range during the least squares reduction. If the current station is not the one that you wish to modify you may select either the **Next** or **Previous** buttons to call up the next or previous station. To save the changes on this form you may select either the **Okay** or the **Save** buttons. The **Okay** button will apply the contents of the current form and exit. The **Save** button will apply the

contents of the current form and select the next station in the list. The Cancel button exits the current station form without saving any changes.

Filter Constants

The **Filter Constants** form allows the operator to set up a smoothing and time constant filter that is used for course and speed calculations. The Filter Time Constant field is the length of position history that will be used to compute course and speed. Longer the filter times result in more dampened response times. The Filter Smoothing field is the relative weight given to the current observation. The higher the smoothing constant the more weight that will be applied to the current observation. See Figure 14.
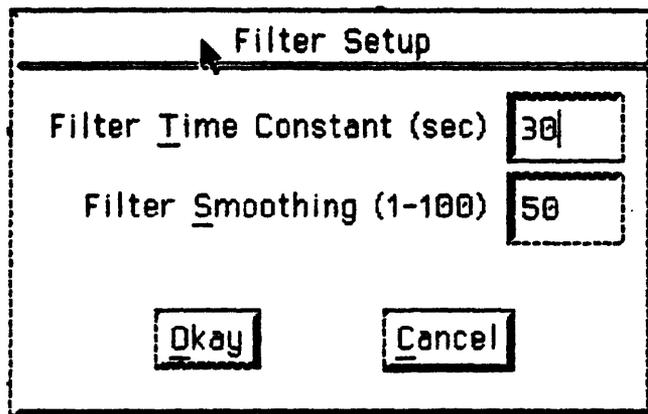
```
┌─────────────────────────────────────────┐
│          ▶ Filter  Setup                 │
│ ════════════════════════════════════════ │
│                                          │
│  Filter Time Constant (sec)  ┌──────┐    │
│                              │ 30   │    │
│                              └──────┘    │
│  Filter Smoothing (1-100)    ┌──────┐    │
│                              │ 50   │    │
│                              └──────┘    │
│                                          │
│         ┌─────┐      ┌────────┐          │
│         │Okay │      │ Cancel │          │
│         └─────┘      └────────┘          │
│                                          │
└─────────────────────────────────────────┘
```

Figure 14. Filter Constants

Calibrate Range System

The **Calibrate Range System** form allows the operator to troubleshoot and calibrate the Del Norte 540 system. See Figure 15.

Figure 15. Calibrate Range System

To start the calibration procedure, select the **Calibrate** button. Each station's name, transponder ID and observed range is displayed as it is received by **YoNav**. Then using the currently selected navigation sensor as truth, a theoretical range to each station is computed. The difference between the theoretical range and the observed range is displayed in the C-O (computed minus observed) column. If the C-O values are higher than a few meters it may indicate that a station coordinate has been entered incorrectly. If this is the case, check the navigation station coordinates and reenter if necessary. When satisfied with the results select the **Done** button. If you wish to use the current C-O values as **Range Bias** values in the least squares solution, then select the **Accept** button.

Edit Line Menu
The Edit Line Menu selections allow the operator to Add, Edit, Delete, List, Select and Generate survey lines.

Add Lines
The **Add** menu selection allows the operator to add individual survey lines to a list of survey lines. See Figure 16.

```
+-----------------------------------------------------------+
|                    Line Entry Form                        |
+-----------------------------------------------------------+
|                                                           |
|    Line Name  | R41                                   |   |
|               +---------------------------------------+   |
|                                                           |
|            Starting                    Ending             |
|                                                           |
|  1. Lat | 37 30.99058' N |    3. Lat | 37 30.99058' N |   |
|                                                           |
|  2. Lon | 122 12.61999' W |   4. Lon | 122 14.00000' W |  |
|                                                           |
|         +-------------------------------------------+     |
|         | Range | 2033.7 |  Bearing | 270.0 |       |     |
|         +-------------------------------------------+     |
|   | Okay |    | Default |    | Cancel |    | Flip |       |
|                                                           |
+-----------------------------------------------------------+
```

Figure 16. Line Entry Form

The operator may provide a name in the **Line Name** field that may be up to 30 characters in length. The starting and ending coordinates can be entered in either UTM or latitude longitude coordinates depending upon the selected coordinate system. The range and bearing of the line are computed when the **Okay** button is selected and the line is added. The **Flip** button can be used to make the starting coordinates become the ending coordinates and vice versa. To abort the operation press the **Cancel** button.

Edit Lines
The **Edit Line** menu selection allows the operator to edit individual survey lines. See Figure 17.

24
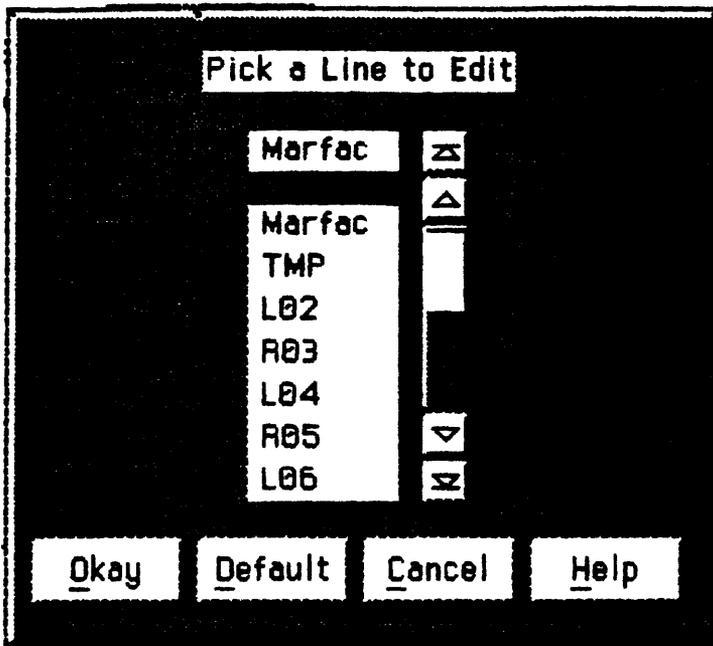
Figure 17. Line Edit Selection Form

The operator may select the line to be edited by highlighting the desired line and pressing the **Okay** button, or may elect to cancel the editing operation by selecting **Cancel**. If a selection is made, a line will be presented using the **Line Entry Form** above. All edits can be made as described in the above section on adding lines.

Delete Lines

The **Delete Line** menu selection allows the operator to delete some or all of the survey lines See Figure 18.

Figure 18. Line Delete Selection Form

The operator may check individual lines for deletion by clicking on the desired line name or all lines may be selected for deletion by selecting the **All** button. No lines can be selected for deletion by selecting the **None** button. To abort the operation select the Cancel button. To execute the deletion select the **Okay** Button

List Lines

The **List Line** menu selection allows the operator to display and optionally print an ascii list of all of the currently entered survey lines. See Figure 19.

Figure 19. Line Display Form

The user may print the contents of this form by selecting the **Print** button. When finished viewing the window, select **Okay** button.

Select Line

The Select Line option allows the operator to select the survey line that will be displayed on the **Side Panel** display and the **Bridge Display** if one is active. The selected line is chosen by highlighting the desired line and pressing the **Okay** button. The **Cancel** button will abort the line selection procedure. See Figure 20.
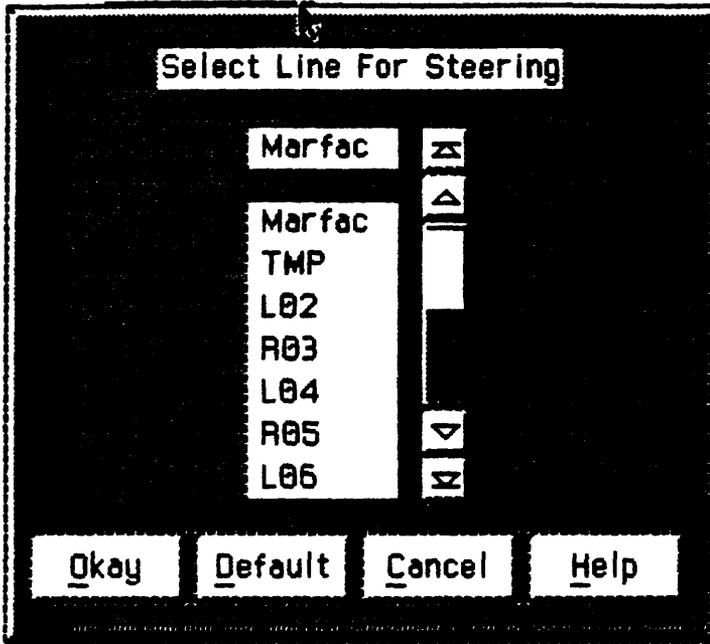
Figure 20. Select Line Form

Line Generator

The Line Generator option allows the operator to automatically generate regular line coverage for a specified area. The operator defines a Root Line around which lines will be generated at user specified spacing and bounded by a user specified limit. See Figure 21.

```
┌─────────────────────────────────────────────────────────────┐
│                  Line Generator Setup                        │
│═════════════════════════════════════════▼═══════════════════│
│                       Root Line                              │
│          Starting                      Ending                │
│        ┌──────────────────┐         ┌──────────────────┐    │
│ 1. Lat │00 00.00000' N    │  3. Lat │00 00.00000' N    │    │
│        └──────────────────┘         └──────────────────┘    │
│        ┌──────────────────┐         ┌──────────────────┐    │
│ 2. Lon │000 00.00000' E   │  4. Lon │000 00.00000' E   │    │
│        └──────────────────┘         └──────────────────┘    │
│                          ┌──────┐                            │
│    Line Spacing (m)      │0.0   │   Generate lines to ...    │
│                          └──────┘   ┌──────────────────────┐ │
│                                     │ ┌──┐┌────┐           │ │
│                          ┌──────┐   │ │  ││Left│           │ │
│  Bounding Limit (m)      │0.0   │   │ └──┘└────┘           │ │
│                          └──────┘   │ ┌──┐┌─────┐          │ │
│                                     │ │  ││Right│          │ │
│  ┌─────────┐┌──────┐┌──────┐┌──────┐│ └──┘└─────┘          │ │
│  │Generate ││ Done ││ View ││Accept││ ┌──┐┌────┐           │ │
│  └─────────┘└──────┘└──────┘└──────┘│ │✓ ││Both│          │ │
│                                     │ └──┘└────┘           │ │
│                                     └──────────────────────┘ │
└─────────────────────────────────────────────────────────────┘
```

Figure 21. Generate Lines Form

The root line coordinates are entered just as they are in the Line Entry
Form. Each line that is generated will be parallel to the root line. The **Line
Spacing** field determines the separation between each line. The
Bounding Limit is the perpendicular distance from the root line to the
outermost survey line. Thus the **Bounding Limit** field controls the area
width for which lines will be generated. Lines may be generated either to
the left or right or on both sides of the root line by selecting the appropriate
check box in the **Generate Lines To Field**. To actually generate the lines
select the **Generate** button. To view or print the lines that were generated,
select the **View** button. To attach the generated lines to the list of survey
lines that **YoNav** can select from, press the **Accept** button. To exit the line
generation form select the **Done** button.

Geodesy Menu
The Geodesy menu currently only contains one option that allows the
operator to set up a default UTM zone for grid line computations. The UTM
grid zone number is used in line calculations that span across two UTM
zones. See Figure 22.
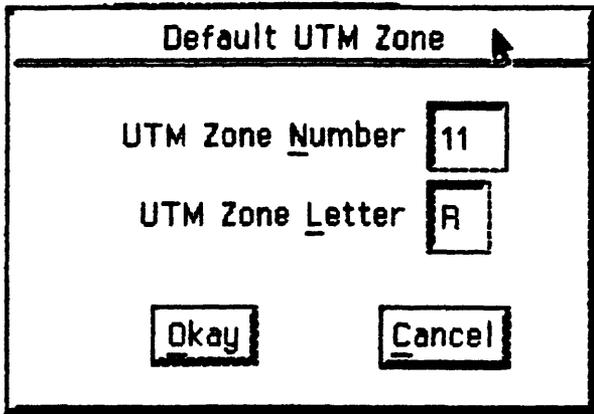
Figure 22. Default UTM Zone

Edit Vessel Menu

The Edit Vessel menu provides the operator the means to define the shape of the vessel and to specify the location of navigation sensors relative to the user specified vessel reference location.

Vessel Shape

The Vessel Shape selection allows the operator to select among various vessel outlines, that will be the graphic icon that represents the ship. See Figure 23. for an example of shape files to choose from.
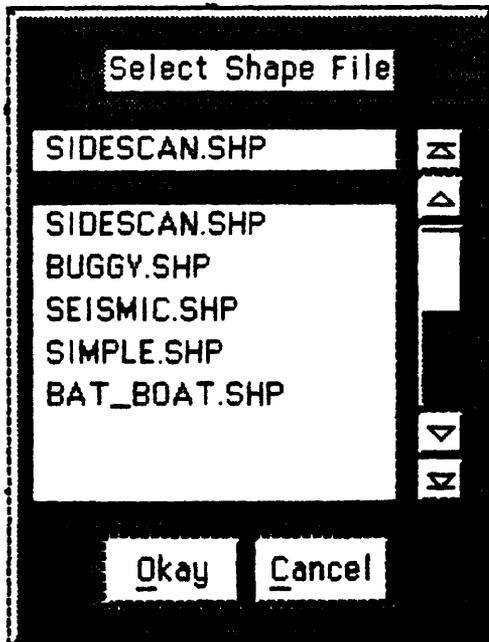
Figure 23.Select Vessel Shape

Vessel Offsets

The **Vessel Offsets** selection allows the operator define the exact location of various shipboard sensors relative to some defined reference position, usually the center of motion of the vessel. By defining the offset of each sensor on the ship, any sensor can be used to determine the location of the bow, stern hydrophone or any other point very easily. The coordinates for each sensor are entered in relative meters of offset from the user defined reference position. See Figure 24.

```
Sensor Offsets
Relative to Vessel
Reference Position

            Sensor
    ┌──┐                      ┌──┐
    │ △│ Northstar 7000 Loran │ ▽│
    └──┘                      └──┘

       DX        DY        DZ
    ┌─────┐   ┌─────┐   ┌─────┐
    │5    │   │3.1  │   │4    │
    └─────┘   └─────┘   └─────┘

    ┌──────┐          ┌────────┐
    │ Okay │          │ Cancel │
    └──────┘          └────────┘
```

Figure 24.Vessel Offsets

Vessel Reference Position

The Vessel Reference Position selection allows the operator define the position on the vessel to which all sensors will be referenced. Normally, this will be the center, bow or stern of the ship. See Figure 25.
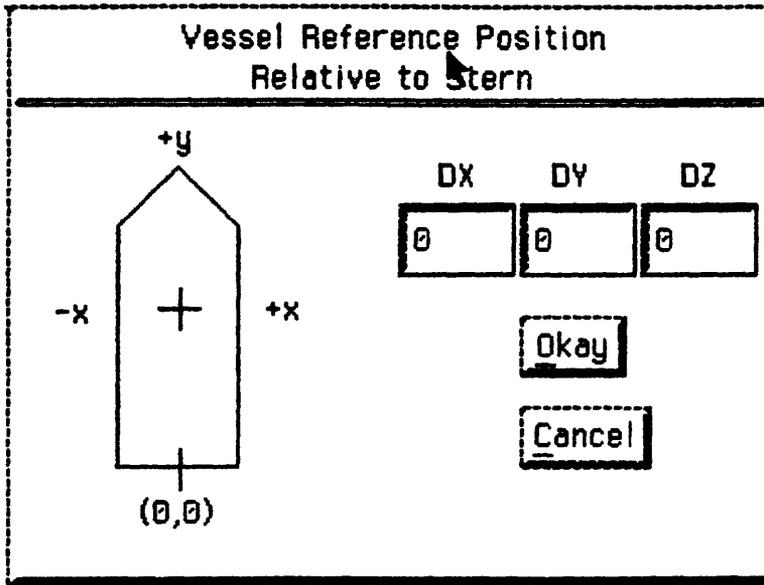
Figure 25. Vessel Reference Position

Sampling Sites Menu

The Sampling Sites menu selection allows the operator add, edit, delete, select and list the sampling site location list. Sampling sites are defined by a geographic position. They can be used as way points to steer to in a range and bearing mode. To Add a site, select the **Add** option under the **Sampling Site** Menu selection. See Figure 26.

Add Sites

The **Add Sites** menu selection presents the user with the **Site Entry** form. See Figure 27.

```
┌──────────────────────────────────────────────────────────┐
│                     Site Entry Form                       │
├──────────────────────────────────────────────────────────┤
│                                                            │
│     Site Name  │Site 85                              │     │
│                                                            │
│     1. Latitude │36 37.88819' N                    │      │
│                                                            │
│     2. Longitude │121 52.58245' W                  │      │
│                                                            │
│        Depth  │8.8          │                              │
│                                        Sample Type         │
│          │ │Display│              │△│   Box Core   │▽│     │
│                                                            │
│    │ Okay │  │ Default │  │ Cancel │  │ Info │  │ Video │   │
│                                                            │
└──────────────────────────────────────────────────────────┘
```

Figure 27.Site Entry Form

To enter the name of the site select the Site Name field. Site names may
be up to 30 characters in length. The position may be entered in the
current coordinate system. See Appendix B for a description of coordinate
entry. The **Depth** field is only used for annotation purposes. A square
symbol may be used to indicate the sampling site on the graphic display.
To have the symbol displayed, check the **Display** check box. The sampling
type may also be logged by selecting among the various sampling types in
the **Sample Type** list. When the Site Entry form is complete, you may save
the entry by pressing the **Okay** button. The **Cancel** button allows the
operator to abort the site entry form at any time.

Edit Sites
The **Edit Sites** menu selection allows the user to select a site entry to be
edited See Figure 28.
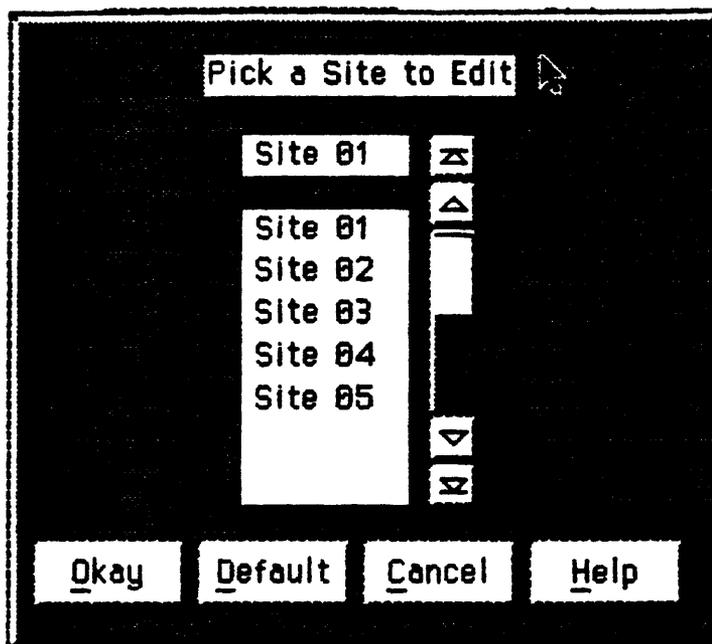
Figure 28. Edit Site Selection

The Site Selection form allows the operator to select which site to edit. Select **Okay** once the desired site has been selected. Select **Cancel** to abort the site editing process. If the operator selects a site for editing, the **Site Entry** form will be displayed with the requested site entry. The operator may change any of the site form parameters as discussed above in the section on **Add Sites**. The **Info** button will display any **Logbook** comments that may have been entered during the time that this site was selected as the current site. (See the section on logbook entries under Utilities/Logbook). The **Video** button will recall any video images that were recorded during the time that this site was the active site. (See also Display/Video for a discussion of saving video images).

Delete Sites

The **Delete Sites** menu select ion allows the user to select one, some or all of the site entries for deletion. When all but a few sites need to be deleted, the best way to do it is to select the **All** button to flag all of the sites. Then toggle off the sites that are not to be deleted. A site will be deleted when there is a check mark beside it. To clear all of the check marks, i.e. delete no sites, select the **None** button. To abort the delete operation select the **Cancel** button. To execute the deletion of the checked site entries select the **Okay** button 29.

34
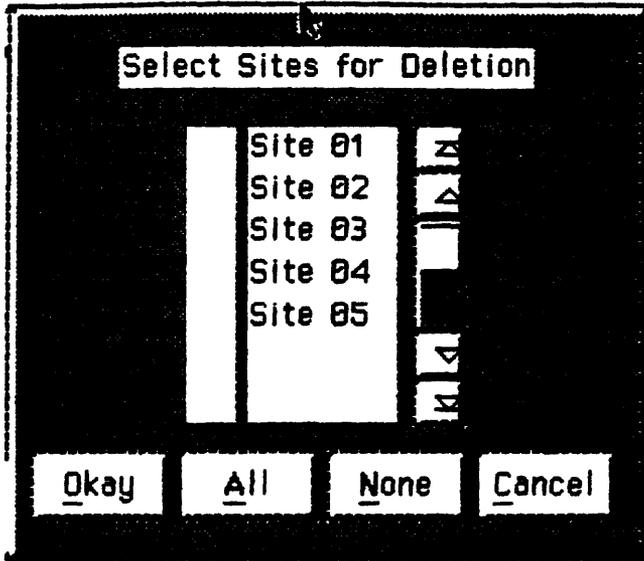
Figure 29.Delete Sites Selection

Select Site

The Select Site menu selection allows the operator to select the site that the vessel is attempting to steer towards. If the Side Panel Display is displaying site information then the newly selected site will be the site referenced. Selection of a new site will affect the display on the bridge if the bridge display is active and in site mode. Select the active site by selecting the name of the desired site and pressing the **Okay** button See Figure 30.
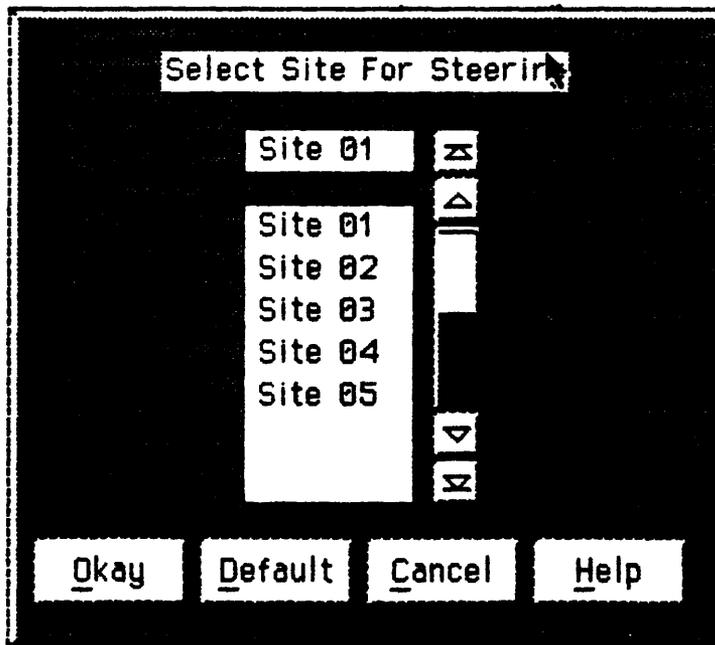
Figure 30.Select Active Site

List Sites

The List Sites menu selection allows the operator to view and optionally print a formatted ascii list of the current sampling sites. To print this list select the **Print** button. When finished viewing this display select the **Okay** button or press the **Esc** key. See Figure 31
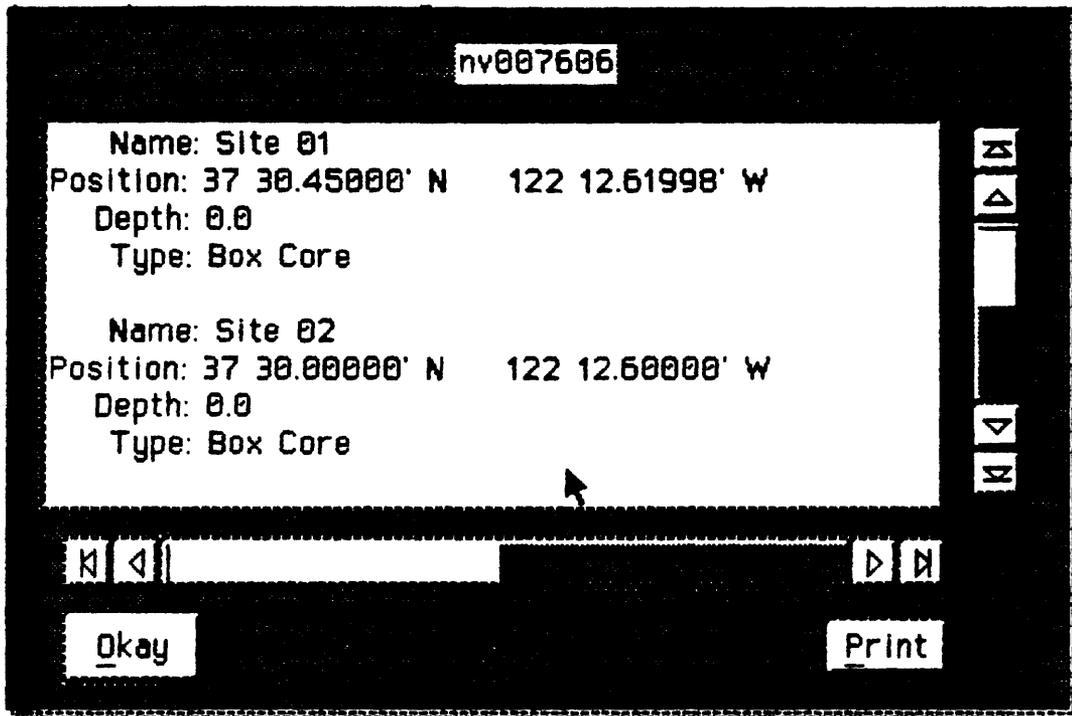
Figure 31.List Sites Display

The Utilities Menu

The Utilities menu selection allows the operator to perform various utility tasks without affecting the real-time navigation function. These utilities include range and bearing between two points, inverse calculations, UTM to latitude/longitude conversion, a general logbook entry form and a post plotting utility. The coordinates used in the utility functions are saved so that on subsequent invocations the last coordinates you used will still be entered in the utility forms.

Range/Bearing

The Range/Bearing menu selection allows the operator to compute the range and bearing between two points. Calculations are performed on the ellipsoid using WGS-84 for the defining parameters. See Figure 32.

36

```
┌──────────────────────────────────────────────────────────────┐
│            Range and Bearing Computation                       │
├──────────────────────────────────────────────────────────────┤
│              From                              To               │
│                                                                 │
│  1. Lat  │37 30.00000' N│        3. Lat  │37 30.00000' N│       │
│                                                                 │
│  2. Lon  │122 12.00000' W│       4. Lon  │122 15.00000' W│      │
│                                                                 │
│  Range   │  4421.5  │ (m)    Bearing  │270.0 │ (deg)            │
│                                                                 │
│   -        │ Calculate │              │ Done │                  │
└──────────────────────────────────────────────────────────────┘
```

Figure 32.Range/Bearing Utility

The range and bearing can be computed by entering the starting and ending
coordinates as described in **Appendix B. Entering Coordinates.**
When the coordinates are entered correctly, select the **Calculate** button to compute the
range and bearing. Select the **Done** button when finished.

Inverse Computation
The Inverse Computation menu selection allows the operator to compute the new
endpoint that is projected at a user specified range and bearing away from a user
specified position. The results will be displayed in the current system coordinates. All
computations are done on the WGS-84 ellipsoid. See Figure 33

```
┌─────────────────────────────────────────────────────┐
│                Compute New Endpoint                 │
│                 Range and Bearing                   │
│                 From a Known Point                  │
├─────────────────────────────────────────────────────┤
│  1. Lat  │37 38.88888' N│   Range  │4421.5│  (m)    │
│                                                      │
│  2. Lon  │122 11.99999' W│  Bearing │278.8│  (deg)  │
│                                                      │
│            ┌───────────────────┐                    │
│            │ │37 29.99936' N│ ─────────── Answer     │
│            │                   │                     │
│            │ │122 15.88881' W│ ──────────  shown     │
│            └───────────────────┘            here     │
│                                                      │
│         ▓▓▓▓▓▓▓▓▓▓         │ Done │                  │
└─────────────────────────────────────────────────────┘
```

Figure 33.Inverse Utility

To set up the computation, enter the latitude and longitude of the start point as described in **Appendix B: Entering Coordinates**. Next enter the range in meters for the desired endpoint. Then enter the bearing in degrees clockwise from north of the desired endpoint. When the form entry is complete, select the Calculate button. The results of the calculation will appear as shown in Figure 33

LogBook Entry

The LogBook Entry menu selection allows the operator to record comments that may be pertinent to post processing of the cruise data. Such information might include sea and weather conditions, maneuvering for traffic or obstructions, progress and results of sampling efforts and system problems. See Figure 34

```
┌─────────────────────────────────────────────────┐
│                 LogBook Entry                   │
├─────────────────────────────────────────────────┤
│ │Box Core In Water                           │  │
│                                                 │
│            │ Okay │   │ Cancel │                │
└─────────────────────────────────────────────────┘
```

Figure 34.LogBook Entry

To enter a LogBook entry, just begin typing your entry. There is no need to enter the time or system position since **YoNav** provides that for you. When you are finished with your entry, press the **Okay** button to record it. All logbook entries are saved in an ascii file named **LOGBOOK** that is recorded on the Log Disk. (See section on **File/Logging**). If the printer is enabled and on line, the logbook entry will also be sent to the printer. To enter a logbook entry at any time, the F1 key may be pressed. This key is provided as a short cut to selecting the menu item.

Post Plot Nav Data

The Post Plot Nav Data menu selection allows the operator to generate a screen or plotter dump of the binary log file for any recorded sensor. This feature continues as a background operation and does not inhibit real-time data acquisition in any way. See Figure 35

Figure 35.Post Plot Nav Data

To plot navigation data, you must be recording the binary data for the sensor you wish to plot.

The **Post Plot Setup** form allows the operator to specify the time interval between successive plotted points in the field labeled **Interval (sec)**.

To plot every position recorded for a given sensor enter a 1 for the interval. The operator may enter a start and stop time for the times of interest. Positions found for a sensor will only be plotted if they fall within the time window set by the **Start Plotting** and **Stop Plotting** fields. The scale can be used to zoom in on an area of interest. The scale value defines a box around the field **Center Lat** and **Center Lon** which define the center of the box to be plotted. Positions found that do not fall within the area defined by the **Center Lat**, **Center Lon** and **Scale** fields will not be displayed. The filename that contains the binary data that is to be plotted is displayed in the field labeled **Filename**. If this is not the file you wish to plot from, select this field and you will be presented the standard file dialog box that will allow you to specify another filename. The post plotting utility can only plot one sensor at a time. Select the sensor to plot from the spin list labeled **Plot Track From**. To select the destination of the plot information select either the **Screen** or **Plotter** check box. If the plotter is selected and there is no serial port dedicated to the plotter, you will be prompted to select a port for the plotter. When the above form is complete, select the **Okay** button to plot the data or select the **Cancel** button to abort the operation.

The Display Menu

The Display Menu contains selections for controlling both the main graphic drawing area and the side panel display. See Figure 36.
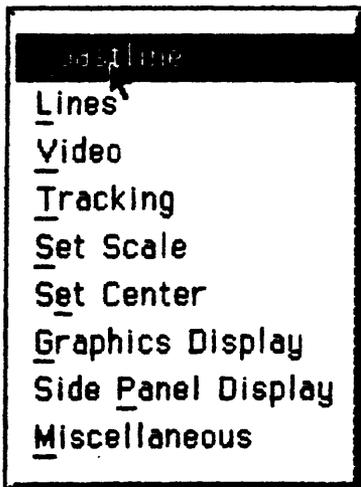

Figure 36.The Display Menu

Coastline

The **Coastline** menu selection allows the operator to select from a set of vectored coastline files. See Figure 37.
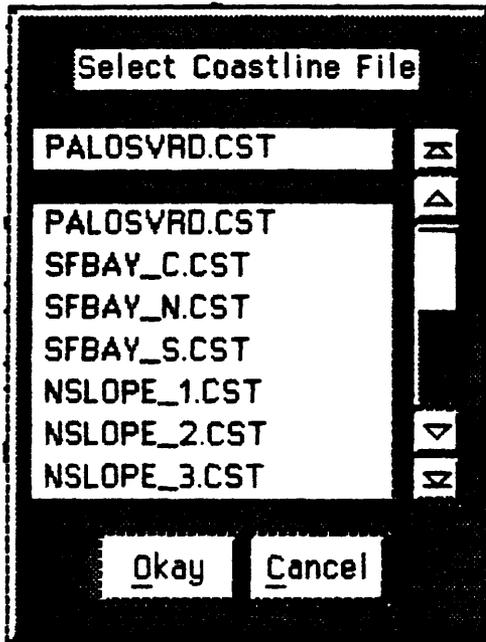

Figure 37.Coastline File Selection

The coastline file format is documented in Appendix C. To select a coastline for display, select the name of the coastline file from the scrollable list and press the **Okay** button. The display of the coastline may be overridden by the Display/Miscellaneous form member for **Draw Coastline**. If **Draw Coastline** is not enabled, then no coastline will be drawn even if one has been selected using the **Coastline** selection option.

Lines

The Lines menu selection allows the operator to control exactly which lines will be displayed on the graphical display. When this option is selected the operator will be presented a scrollable checklist form that allows flagging of some, all or none of the current lines for display. See Figure 38.

41
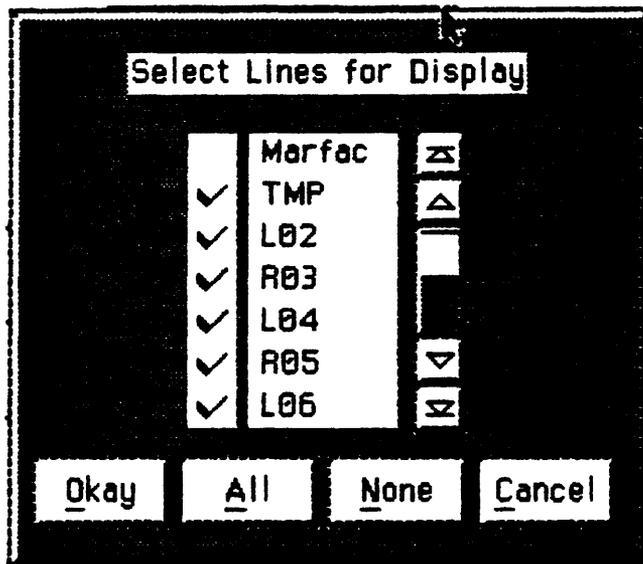
Figure 38.Line Display Control

To toggle a line for display, select the name of that line by clicking the mouse on it. Line names that are checked will be displayed. To view all of the survey lines, select the **All** button. To display none of the lines, select the **None** button. To abort this form select the **Cancel** button. To update the display with the newly selected lines select the **Okay** button.

Video

The Video menu selection will allow the operator to create and open a window on the main display for displaying real-time video. This option requires a LiveWindows video board to operate. The first time that the video menu selection is pressed a small video window will open in the lower left corner of the display. The video window may be moved by dragging the window with the mouse. The video window may be resized by clicking on its lower right-hand corner. A smaller highlighted area on the border will appear. This is a handle that can be stretched in the X and Y axes. By selecting the video menu again, the operator will be presented with a form of video controls for changing the appearance of the video image. See Figure 39.

42
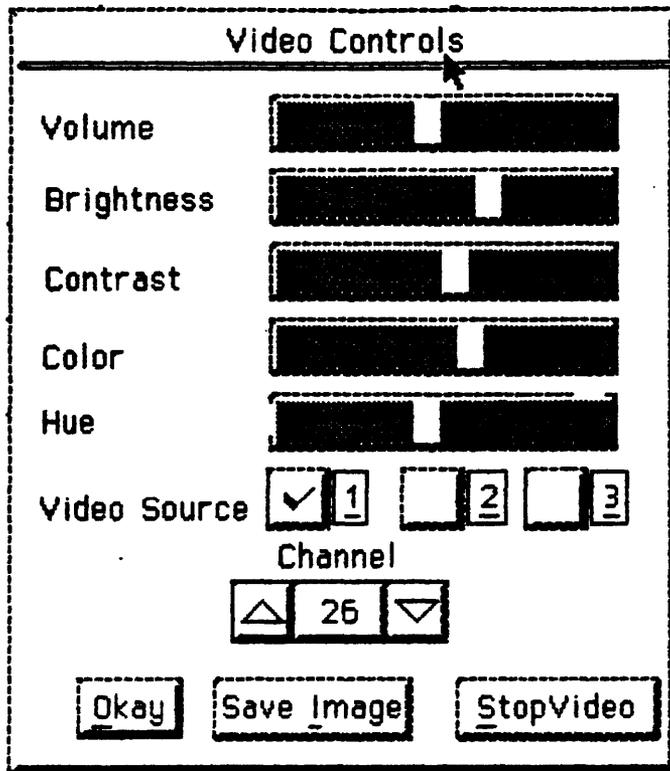
Figure 39.Video Control

There are five slide bar controls on the **Video Control** form for changing the **Volume, Brightness, Contrast, Color and Hue** of the video image. To modify any of the settings, drag the control indicator to the left or right to decrease or increase the control. There are 3 check boxes that control the input source of the video window. **Source 1** is the onboard TV tuner. **Source 2** selects the external video and audio input jack on the back of the LiveWindows board. **Source 3** is for other Chips and Technologies PC Video (9001 or 9001A) compatible boards that have a third video source. **YoNav** is configured to accept only NTSC video format although the hardware will support the European PAL format. The Video Control form contains a spin list control for changing channels on the onboard TV tuner. This control has no effect on the other sources of video input.

Tracking

Occasionally, when switching between one sensor and another, the operator will want to look at the performance of the other sensor. The Tracking display option allows the operator to graphically view the track of sensors other than the primary sensor before actually making the switch. When the Tracking option is chosen, the operator is presented with a scrollable checklist of all the available sensors that can produce a track. See Figure 40.

```
┌─────────────────────────────────────────┐
│  ┌───────────────────────────────────┐  │
│  │ Select Sensors for Main Display   │  │
│  └───────────────────────────────────┘  │
│  ┌─────────────────────────────────┬──┐ │
│  │   COM2  Trimble NavTrakII       │▣ │ │
│  │   COM3  Magnavox MX1187         │△ │ │
│  │   COM4  Ashtech GPS             │  │ │
│  │                                 │  │ │
│  │                                 │▽ │ │
│  │                                 │▼ │ │
│  └─────────────────────────────────┴──┘ │
│  ┌──────┐ ┌─────┐ ┌──────┐ ┌───────┐    │
│  │ Okay │ │ All │ │ None │ │ Cancel│    │
│  └──────┘ └─────┘ └──────┘ └───────┘    │
└─────────────────────────────────────────┘
```
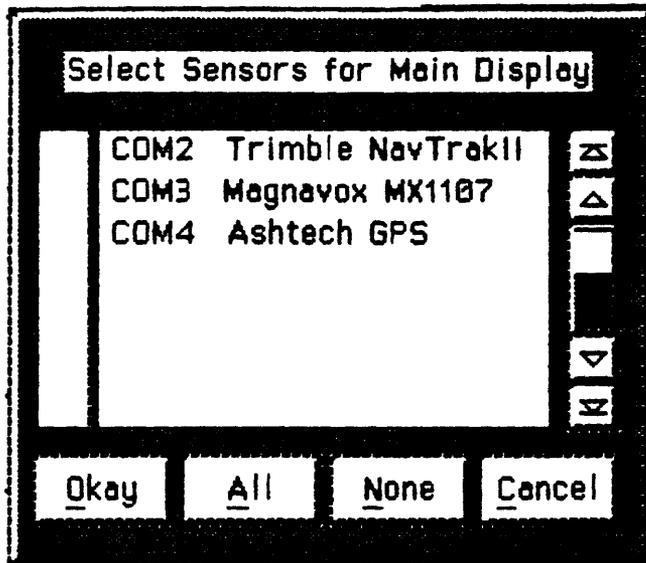
Figure 40.Video Control

Check the sensors that you want to display. More than one may be chosen. There is no need to check the current sensor since it will always be tracked automatically. Each additional sensor will be displayed in a different color from the primary sensor.

Set Scale
The Set Scale menu provides a sub menu of two options to change the graphic screen scale. The scale may also be changed by using the PgUp and PgDn keys. See Appendix D.

Choose Scale
The Choose Scale menu presents the user with a spin list of possible scale values to choose from. Select the desired scale and press the **Okay** button to activate it. To abort this form use the **Cancel** button. See Figure 41.

```
┌─────────────────────────────────┐
│      Choose Scale               │
│ ┌─────────────────────────────┐ │
│ │     Scale in Meters         │ │
│ │  ┌──┬──────────────┬──┐     │ │
│ │  │△ │     100      │▽ │     │ │
│ │  └──┴──────────────┴──┘     │ │
│ │                             │ │
│ │   ┌──────┐    ┌────────┐    │ │
│ │   │Okay  │    │Cancel  │    │ │
│ │   └──────┘    └────────┘    │ │
│ └─────────────────────────────┘ │
└─────────────────────────────────┘
```
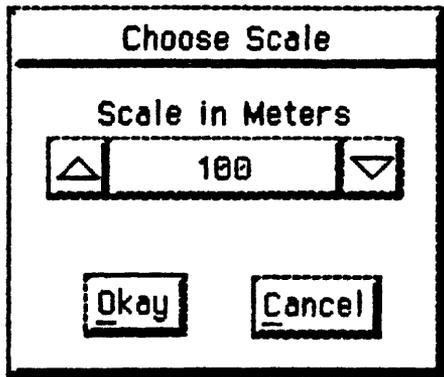
Figure 41.Choosing the Scale

Window Zoom

The **Window Zoom** option allows the user to draw a box around the area of zoom using the mouse cursor. This feature can also be implemented by a quick double click of the mouse any where in the graphical drawing area. To abort the **Window Zoom** function press the **Esc** key. Note that the graphics are not updated until the drop down menus have been removed. For this reason, it is probably easier to use the double-click method of zoom than the menu pick method.

Set Center

The **Set Center** function allows the user to center the graphics display about a point selected with the cursor. When this item is selected, the message window at the bottom of the display will tell the operator to click on the new center of the display. When this operation is performed, the screen will be redrawn centered around the selected point. Note that the screen will not be redrawn until the pull down menus have been closed. Note that the default option for the graphics display is to always keep the ship in view on the screen. When this mode is active, if you try to set the center to a location that would force the ship off the screen, the set center operation will be canceled and the ship will remain in view. Auto ship centering can be overridden by using the **Display/Miscellaneous** selection. The **Home** key can also be used to select the new screen center, see Appendix D.

Graphics Display

The **Graphics Display** function allows the user to select the graphics display for the main drawing area. See Figure 42.
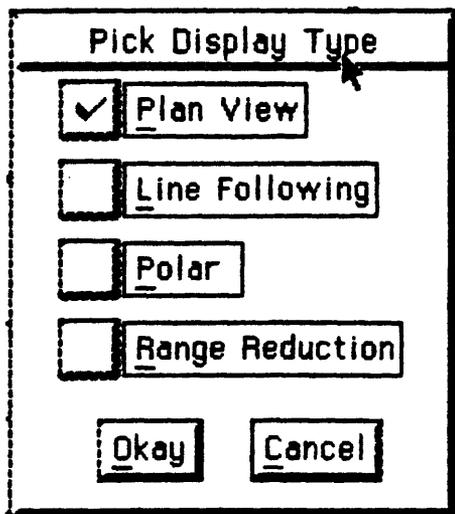
Figure 42.Graphics Display Type

There are four possible options for the graphics display type of which only two are finished in this release. The **Plan View** check box will display a plan view of the ship, tracklines, sampling sites and historical ship track. The **Range Reduction** selection will display the results of the least squares reduction when using the DelNorte 540 or other ranging system. This form is primarily a programmer's debugging feature and will probably be removed in future releases.

The **Line Following** and **Polar** displays are not yet implemented.

Side Panel Display

The Side Panel Display function allows the user to select the type of information to display on the side panel. See Figure 43.
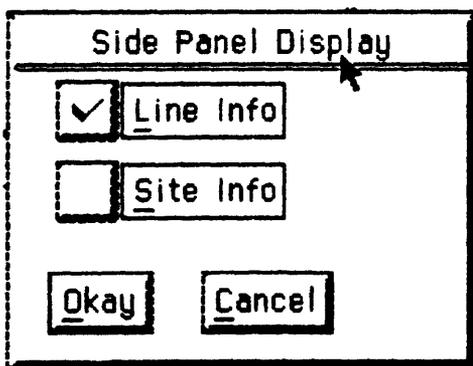

Figure 43.Side Panel Display

For line steering information choose the **Line Info** check box. For sampling site steering information choose the Site Info check box. Select the **Okay** button to activate the change or the **Cancel** button to abort.

Miscellaneous

The **Miscellaneous** provides some general display features. See Figure 44.

```
┌─────────────────────────────────────┐
│        Miscellaneous Options        │
│ � ═══════════════════════════════════ │
│   ┌──┬───────────────────┐          │
│   │ ✔│Keep Ship Centered │          │
│   └──┴───────────────────┘          │
│   ┌──┬───────────────────┐          │
│   │  │Draw Ship To Scale │          │
│   └──┴───────────────────┘          │
│   ┌──┬───────────────────┐          │
│   │  │Display Coastline  │          │
│   └──┴───────────────────┘          │
│                                     │
│            Fix Symbology            │
│                                     │
│   ┌──┬───┐ ┌──┬─────┐ ┌──┬─────┐   │
│   │ ✔│Dot│ │  │Cross│ │  │Other│   │
│   └──┴───┘ └──┴─────┘ └──┴─────┘   │
│                                     │
│        ┌────┐   ┌──────┐           │
│        │Okay│   │Cancel│           │
│        └────┘   └──────┘           │
└─────────────────────────────────────┘
```

Figure 44.Miscellaneous Display Options

The check box labeled **Keep Ship Centered** when checked forces the ship to always stay in the graphical viewing area. To view objects that are in another operating area, uncheck this box and zoom in on the new area. Checking the box labeled **Draw Ship to Scale** forces the ship to be drawn relative to the current viewing scale. So at large scales the ship will appear very small and at small scales very large. Uncheck this box to view the ship at a fixed size regardless of the scale. Checking the box labeled **Display Coastline** causes the current coastline file to be drawn during screen refresh operations. On slower systems this may take 1-5 seconds. If the coastline is not needed, this option is better left unchecked. There is a group of three check boxes labeled **Fix Symbology**. These boxes determine the shape of the symbol to be placed on the screen at each ship fix. Check the symbol that suits your display the best. To update **YoNav** with these changes, select the **Okay** button. To abort this form select the **Cancel** button.

The Config Menu

The Config menu provides functions to set up global parameters such as coordinate system and display units. There are also provisions for configuring a specialized depth correction feature and bridge display control options. An optional optically isolated relay board may also be configure to update analog recorders at user specified intervals.

Coordinate System

The Coordinate System function allows the user to select the coordinate system for all system coordinate displays. See Figure 45.
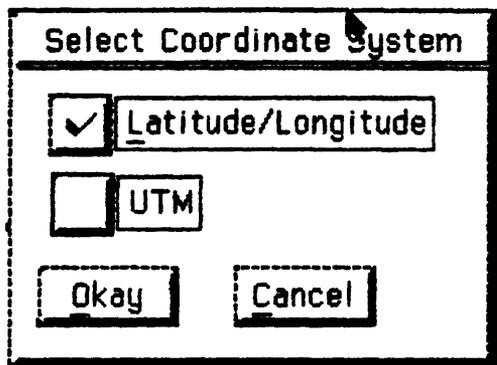
Figure 45.Coordinate System Selection

Select the coordinate system of choice and press the **Okay** button to activate it or the **Cancel** button to abort it.

Units

The Units function allows the user to select the angular units for latitude and longitude as well as the decimal accuracy displayed for all floating point numbers. See Figure 46.

Figure 46.Units Selection

Select the desired display format units and press the **Okay** button to accept or the **Cancel** button to abort. Note that the units feature is for display and printouts only and does not affect the accuracy of the recorded data.

Depth Correction

The Depth Correction function is a very specialized option for correcting the depth value received from the Raytheon PDD Bathy Digitizer. This option allows the operator to optionally correct the depth using an operator supplied sound velocity. See Figure 47.

Figure 47.Depth Correction

The check box labeled, **Depth Correction Enabled** when checked will cause this correction to be performed on all depths received from the PDD. The field labeled **Sound Velocity m/s** should contain the new two-way sound velocity to use in the correction. Select the **Okay** button when ready to accept these settings or select the **Cancel** button to abort them.

Bridge Terminal

The Bridge Terminal function allows the operator to set the display type on the remote bridge terminal, if one is active. See Figure 48.


Figure 48. Bridge Display Configuration

The operator may choose either **Line Following** or **Range/Bearing to Site** for the bridge display type by checking the appropriate check box. Additionally, the operator can send a message to the bridge display that will cause the bridge terminal to beep and display a small dialog box with the message. To send a message to the bridge, enter the text of the message in the field labeled **Msg**, then select the **Send Msg** button.

Press the **Okay** button to accept the bridge display type settings or press the **Cancel** button to abort this form.

Contact Closures

The **Contact Closures** function allows the operator to set up the optional relay board for event marking analog recorders. To activate a relay, check the box next to that **Relay #**. To set the interval between event marks, enter the number of seconds between event marks in the field labeled **Interval (s)** for that relay. Up to 8 relays can

be active at any time. When this form is complete, press the **Okay** button to accept the changes or press the **Cancel** button to abort. See Figure 49.

Figure 49.Contact Closures Configuration

About the Hardware

YoNav was designed to be easy to setup and use, provide the functionality required for USGS marine research programs, and be easily extensible by the average programmer. YoNav can support specialized hardware but does not require any in its simplest form. See Table 1 for a complete list of recommended and required hardware.

Description	Purpose	Vendor	Action
Amet SmartPort-8	Provides 8 channels of RS232 Serial I/O	Amet Corporation Nashville, TN	Recommended
PDISO-8	Provides 8 optically isolated relays for event marking analog recorders	Keithley Metrabyte Associates	Recommended
LiveWindows Video	Provides a real-time video display & frame grab capability.	Software Interphase Foster, RI	Recommended
Generic Math CO Processor	Provides hardware floating point support	Intel, Weitek and others	Recommended
Bus Mouse	Provides pointing device.	Logitech, Microsoft and others.	Recommended
Minimum 4Mb RAM	Provides EMS or XMS support for YoNav	Any good computer store	**Required**
VGA Graphics Card	Provides required graphics resolution.	Any good computer store.	**Required**
At Least One available serial port.	To handle at least one navigation input.	Any good computer store.	**Required**
Hard Disk with at least 15 Mb available disk space.	To store executables, source, resource files as well as temporary file storage.	Any good computer store.	**Required**
80386 or better CPU	Host CPU	Any good computer store.	**Required**

Table 1. Recommended and Required Hardware

About the Software

YoNav is written mainly in C using the Microsoft C/C++ 7.0 compiler. There is only one assembly language routine for handling the DOS Critical Error interrupt. There are several third party libraries that are needed to rebuild the YoNav package. They are listed below.

Library Name	Used For	Vendor	Phone Number
MW_D1DMC.LIB MET_BD1D.LIB	Low level graphics	Metagraphics Software Corporation Scotts Valley, CA	(408) 438-1550
LW_MSCL.LIB	Live Windows Video Interface	Software Interphase Foster. RI	(401) 397-2340
MNMNM637.LIB MNUTM637.LIB	Menu handling and High Level Graphics	Autumn Hill Software Boulder, CO	(303) 494-8865
CT6_M6L.LIB	DOS Memory Map Utility	Blaise Computing Berkeley, CA	(415)540-5441
ECLL.LIB	low-level Serial I/O	South Mountain Software, Inc. South Orange, NJ	(201) 762-6965

Table 2. Third Party Libraries

The makefile that is supplied with this report uses the Mortice Kern Systems (MKS) make utility. The linker that is used is the Pocket Soft RTLINK product. Note that the YoNav executable is larger than 640K. RTLINK provides the virtual memory management needed to operate with the limits of DOS Real Mode.

Program Name	Used For	Vendor	Phone Number
MKS Make	Make Utility	Mortice Kern Systems Waterloo, Ontario	(519) 884-2251
RTLINK.EXE	Virtual Memory Linking	Pocket Soft Houston, TX	(713)460-5600
navcfg.exe	Configuration control for YoNav	USGS Marine Facility Redwood City, CA	(415) 329-5876

Table 3. Ancillary Programs

Appendix A: Data Formats

Ascii Navigation Data
Following is a sample of the ascii navigation data file format:

Start	End	Length	Item
1	3	3	day
4	5	2	hour
6	7	2	minute
8	9	2	second
10	10	1	tenth
11	11	1	blank
12	20	9	latitude
21	21	1	blank
22	31	10	longitude
32	32	1	blank
33	38	6	depth
39	39	1	depth flag
40	40	1	blank
41	45	5	speed
46	46	1	blank
47	51	5	heading
52	52	1	blank
53	57	5	course
58	58	1	blank
59	EOR	varies	sensor name

Binary Navigation Data
The binary data recording format is simply a binary write of the C-language data structure named t_nav. Each t_nav structure contains as its first element an id word that identifies the sensor type that it came from.. The id word determines the contents of the union member named msmts. msmts will contain raw sensor information particular to the identified sensor. The following data structures define the t_nav data structure:

2D position
```
typedef struct pos
  {
  double lat;        // radians of latitude
  double lon;        // radians of longitude
  } t_pos;
```

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Navigation Station

```c
typedef struct station
{
    char enabled;          // is the station enabled for use
    char display;          // is the station enabled for display
    int id;                // transponder code
    char name[30];         // name of station
    t_pos pos;             // location of station
    double height;         // height above ellipsoid of station in meters
    double bias;           // What to add to the observed range in meters
    double delay;          // Transponder turnaround delay in meters
} t_station;
```

Raytheon PDD 2000

```c
typedef struct pdd_struct
{
    char alarm;            // alarm state
    char dummy;            // Keep structure aligned
    double rawDepth;       // raw depth value from PDD
    double corDepth;       // corrected depth value from PC
    double soundVel;       // sound velocity in m/s
} t_pdd;
```

GPS data

```c
typedef struct gps
{
    char sat_buf[40];      // constellation in use
    int sat_count;         // number of SV's used in fix
    double pdop;           // dilution of precision
    int dgps;              // differential mode ??
} t_gps;
```

Range Observation Data

```c
typedef struct observation_struct
{
    int numObs;                         // How many observations we have
    int iterations;                     // How many iterations it took
    double ranges[MAX_NAV_STATIONS];    // the observations
    double bearings[MAX_NAV_STATIONS];  // the angle from pos to
station
```

```
    double residuals[MAX_NAV_STATIONS];     // the least squares
residuals
    t_station * stations[MAX_NAV_STATIONS];     // the corresponding
stations
    } t_observations;
```

Loran Data

```
typedef struct loran
    {
    int gri;                            // group repetition interval
    double tds[MAX_TDS];                // time delays
    double emiss_delays[MAX_TDS];       // emission delays
    double coding_delays[MAX_TDS];      // coding delays
    double masterToa;                   // master time of arrival
    t_observations obs;
    } t_loran;
```

Transponder Data

```
typedef struct trispo
    {
    t_observations obs;
    } t_trispo;
```

Ultra Short Baseline Data

```
typedef struct usbl_struct
    {
    int transponder_id;             // target #
    double compass_heading;             // if connected degrees
    double horiz_angle;             // rel bearing degrees
    double slant_range;             // slant range meters
    double x;                   // relative x
    double y;                   // relative y
    double z;                   // relative z
    double telemetry;               // depth meters
    int err_codes;              // error codes
    } t_usbl;
```

Video image hook information for sampling sites

```
typedef struct videoHook_struct
    {
    char fileName[15];                  // image filename
    int imageType;                      // 0=Native, 1=TIFF, 2=BMP
```

```c
int x1;              // bounding coordinate of image
int y1;              // bounding coordinate of image
int x2;              // bounding coordinate of image
int y2;              // bounding coordinate of image
} t_videoHook;
```

Sampling Site Data

```c
typedef struct sample_struct
{
struct sample_struct * previous;    // pointer to previous site
int type;                    // type of sample
int display;                 // display the symbology ??
char name[30];               // site description
t_pos pos;                   // intended site location
double depth;                // actual depth of site
char historyFile[15];        // filename of history data
t_videoHook vHook;           // video image info
struct sample_struct * next; // pointer to next site
} t_site;
```

Range and Bearing Data to Site

```c
typedef struct rngBrg_struct
{
int initialized;     // do we have the current station info
t_site site;         // site info
double range;        // meters from current pos to site
double bearing;      // bearing from current pos to site
} t_rngBrg;
```

Line Following Data

```c
typedef struct track_struct
{
int initialized;     // is the structure current ?
char name[30];       // name of the line being tracked
double solX;         // UTM X of the start of line
double solY;         // UTM Y of the start of line
double eolX;         // UTM X of the end of line
double eolY;         // UTM Y of the end of line
double slope;        // slope of the line
double bearing;      // radians
double length;       // length in meters
double cross;        // meters of cross track distance
double along;        // meters of along track distance
```

```
double toend;          // meters to end of track distance
} t_track;
```

Communications Packet for Bridge Display

```
typedef struct super_packet_struct
  {
  int navType;            // line or station work ?
  t_track  line;          // line info
  t_rngBrg site;          // site info
  } t_super_packet;
```

The binary navigation data record

```
typedef struct nav
  {
  unsigned char id;            // ID byte
  unsigned char status;          // current sensor status byte
  double tim;          // dos time
  double lat;          // radians
  double lon;          // radians
  double alt;          // meters of height above ellipsoid or depth
  double spd;           // Knots
  double crs;           // radians of course made good
  double hdg;           // radians
  union  msmts          // measurements
    {
    t_super_packet navPacket;     // everything needed to navigate
    t_usbl usbl;            // Ultra Short Baseline Acoustics
    t_trispo rng;          // ranging system
    t_loran lor;          // loran system
    t_gps gps;           // GPS
    t_pdd pdd;            // PDD Raytheon Bathy Digitizer
    } msmts;
  } t_nav;
```

Appendix B: Coordinate Entry

The process of entering coordinates is ubiquitous in any navigation system and YoNav is no different. Much effort was devoted to a flexible coordinate system entry model. At present, all coordinates are assumed to be in the same datum, WGS-84. This will be changing in the next release. For now, coordinates may be entered as either latitude longitude pairs or northing and easting pairs in UTM. Latitude and longitude can be entered as decimal degrees, degrees minutes decimal minutes or as degrees minutes seconds and decimal seconds. The hemisphere may be indicated with a +, -, N, n, E, e, W, w, S, or s character. Negative coordinates are interpreted as either west longitude or south latitude depending on the context of the field. For example, 37° 30.00' North latitude could be entered as:

37.5
37 30
37 30 00
N37 30.0
37.5n

Similarly, all of the following longitudes are equivalent to 122° 12.00' west longitude:

-122 15.0
w122 15
122 15 W
122 15 00.00w
-122 15 00
-122.25
W122.25

Appendix C: Coastline File Format

The format for the binary coastline files is provided below. The manifest constant MAX_COASTLINE_SIZE is defined in the header file navdefs.h as 2500 points. The first word of each coastline file contains the number of actual inflection points that are in the coastline file. Each point in the coastline file should be radians of WGS-84 latitude and longitude as specified in the following structure. The only mechanism for control in this structure is that when a coordinate value of 0.0 is encounter, the pen will be lifted until another valid coordinate is encountered.

Coastline File Structure

```
typedef struct coast_struct
    {
    int numPts;              // number of current elements
    t_fpos pts[MAX_COASTLINE_SIZE]; // array of positions
    } t_coast;
```

32 bit floating point structure

```
typedef struct fpos
    {
    float lat;          // radians of latitude
    float lon;          // radians of longitude
    } t_fpos;
```

Appendix D Function Keys

There are several shortcut function keys that make the operation of YoNav possible with systems that have no mouse. The keys listed in Table 4. are often handy to use on platforms that do have a mouse as well.

Key Name	Function
F1	LogBook Entry
F2	Mark Position
F7	Debug Options
Home	Set Center
PgDn	Scale Down by 10%
PgUp	Scale Up by 10%
Ctrl-P	Print Graphics Area
Alt-any underlined key	Same as Mouse Press on that item.

Table 4. YoNav Function Keys

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