Diver Charting and Graphical Display

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Overview

The Diver Charting and Graphical Display (DCGD) software application was developed as a mission planning and data analysis tool for divers using an Integrated Navigation Sonar Sensor (INSS). It is a Microsoft Windows based graphical user interface application that can be installed and executed on computers using a Microsoft Windows based operating systems. The need and usefulness of this tool becomes apparent when one understands what is required to plan, execute and report results from a typical mine countermeasures (MCM) mission using an INSS.

The INSS is a combined navigation and acoustic imaging device used by divers to navigate underwater, search for objects, and mark their locations. To execute an effective mission, a well defined area must be completely searched with no gaps left. This requires precise navigation, a collection of multiple types of data, saving of that data, post mission data review and edit, and reporting of results. A mission must be planned so that a diver can enter the water at a known location, follow a predefined search route, locate predefined search points, collect data in a methodical way to ensure a complete search, and exit the water at a rendezvous location. Once a mission is complete, the data must be transferred from the INSS into a computer for post mission analysis, display, edit and reporting. All data must be referenced and easily related to geographic coordinates to be of value.

The DCGD software tool provides a framework to plan missions using optional geo-rectified overhead images as a background underlay and then adding geographically referenced symbols to create a dive plan virtual map. That map, consisting of a navigation baseline, waypoints and marked positions, is downloaded into the diver's unit (the INSS) and used during the mission. When the dive mission data is collected, the DCGD is used, post mission, to upload the data from the INSS and then review and edit the content. Data from multiple dive pairs and separate missions can be merged to create a large area coverage map. Once the data is reviewed and edited to reduce redundant marks, it can be formatted for reporting or exported to other Navy database programs such as the Mine Warfare Environment Decision Aids Library (MEDAL). For example, a mission might consist of six dive pairs swimming parallel lanes collecting data over a two day period. The data collected would consist of diver paths, object mark locations and type of object, water depth and temperature, and sonar images from selected objects. The data from each unit and each dive would be merged to display the entire area covered with all dive paths and target marks shown.

Objectives

This project seeks to enhance mission MCM effectiveness with the fusion of sensor data collected by multiple divers and/or multiple dive missions into a unified database of areas surveyed by divers. Use of this database will allow more effective planning for future missions. Specifically, a user interface to plan, load, review and manipulate the database will be implemented and evaluated. The principle component of the system will be a software module resident on a PC. This software will communicate through data files with INSS units and merge these data sets to form a single database for a group of dive missions. An intuitive operator interface will provide for interaction with

and evaluation of a merged data set. Examples of such interaction and evaluation include selecting a particular target mark and reviewing all sonar images of the object corresponding to the mark, developing a near-real-time assessment of dive mission area coverage and effectiveness, and planning future dive missions. This software module will also serve as a single interface point through which INSS data can be exported to common fleet data formats and systems. Other software components will be incorporated directly in the INSS unit to facilitate logging (both automatically and upon diver command) data that will later be incorporated into the merger process.

Description

The Diver Charting and Graphic Display project is a descriptive name for this development, but as the project progressed, a more generic name for the DCGD application was adapted by the designers and users. Mission Planner is a simple and direct name for an application such as this. The user menus and user's manual adapted this name and hence we will use the Mission Planner name from now on to describe this product. At this time, the Mission Planner application interfaces with three diver devices, the INSS for the Very Shallow Water Mine Countermeasures (VSWMCM) Detachment, the Underwater Imaging System (UIS) for EOD divers, and the Hydrographic Reconnaissance Littoral Mapping Device (HRLMD) for the Naval Special Warfare divers. Although the file formats and data sets collected are slightly different, the planning and data visualization is quite similar and is hosted by this single application program. This application follows standard windows interface guidelines for file, new, open, save and exit menu items. It uses text based editing for the "record" view. A second view called the "MAP" view shows records in a visual representation with a true North up orientation.

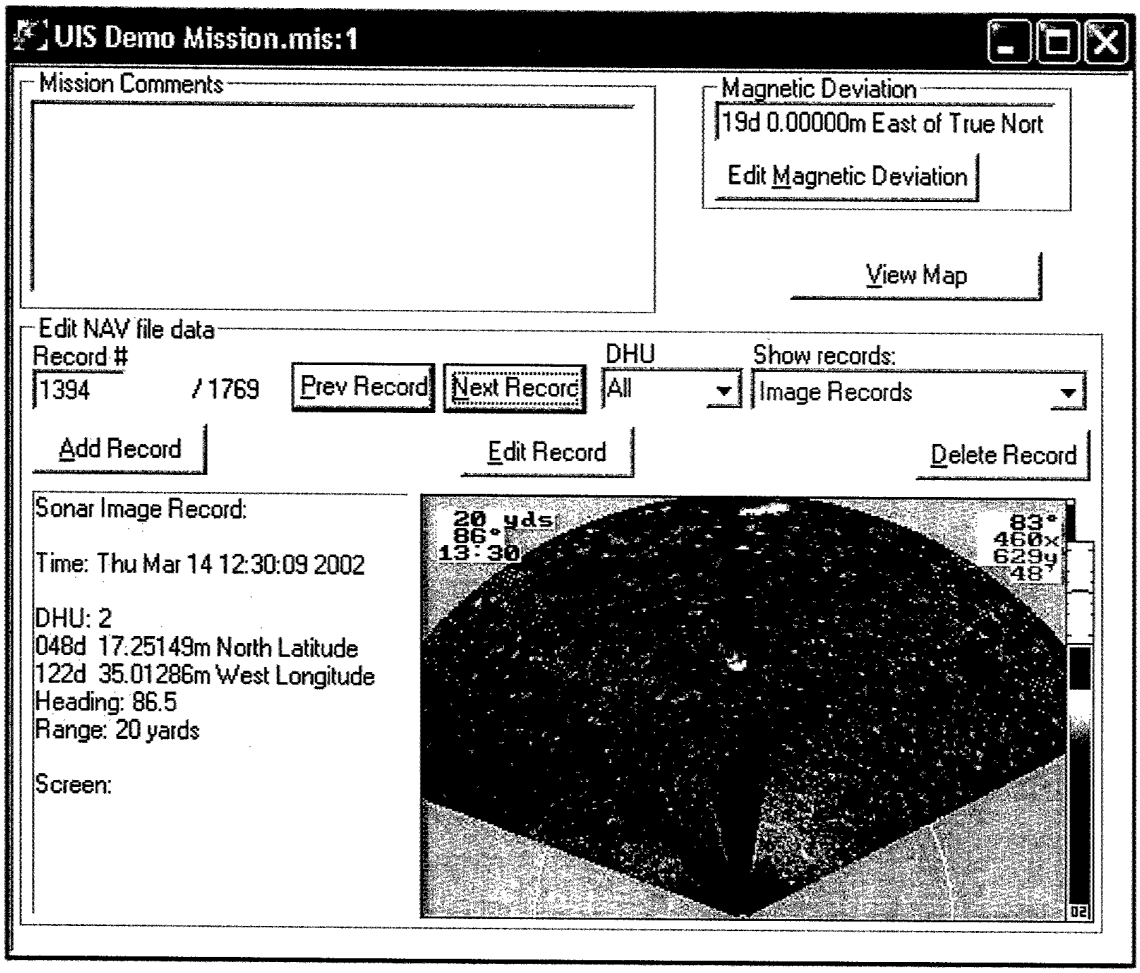
For Pre-mission Planning the user generally performs the following steps:

1. Create a mission using the "Record" window and "MAP" window
2. Saves the work as a Mission file
3. Configures a map that he wishes to load to the diver handheld unit and exports it as a NAV file
4. Saves that exported NAV file
5. Uploads the NAV file to one or many diver handheld units

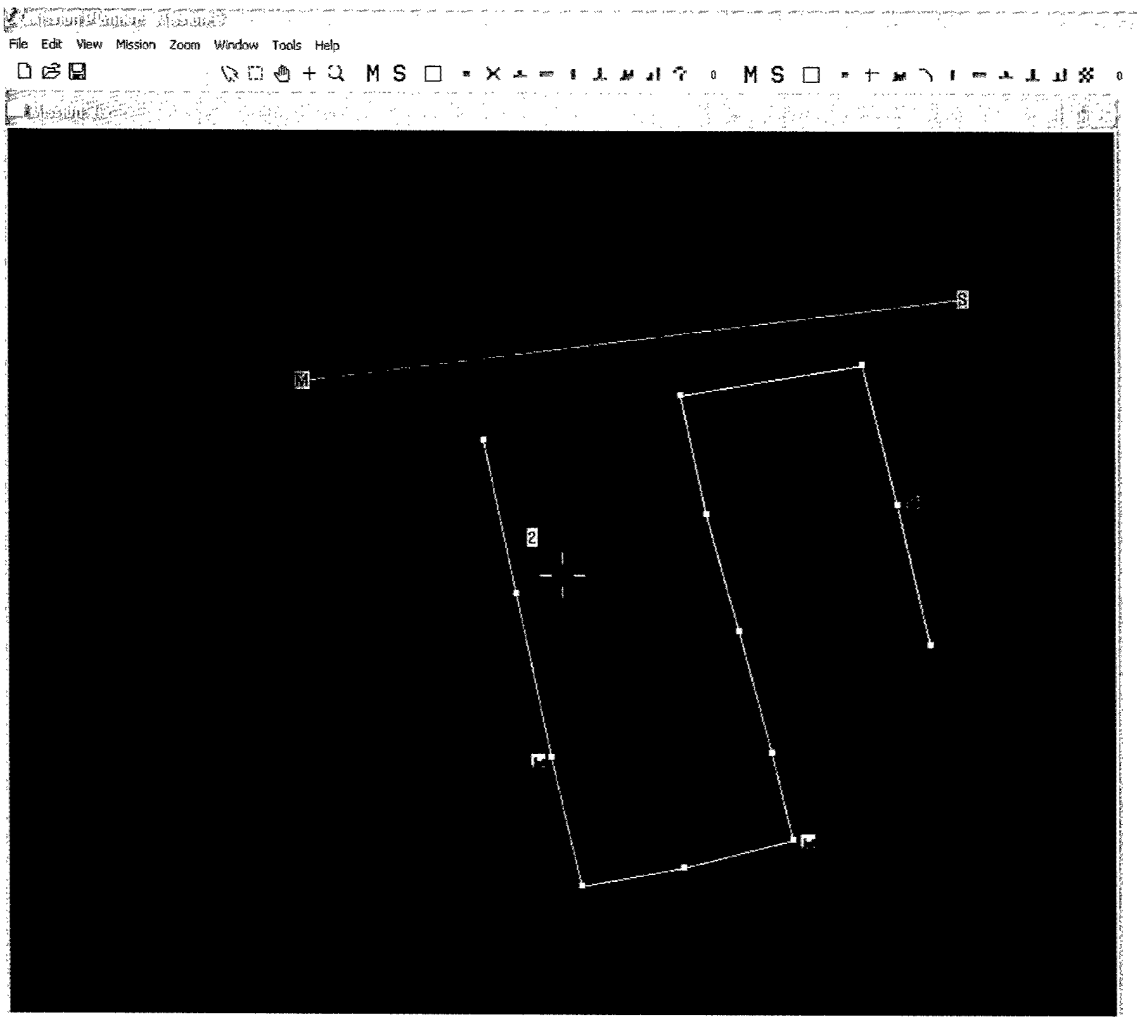
For Post mission visualization the user performs the following steps:

1. Download data from one or many diver handheld units
2. Creates a new mission file
3. Imports each NAV file into Mission Planner
4. User turns on and off various record types for each DHU to filter superfluous data.
5. User may export mine data to a MEDAL formatted text message or hydrographic survey data to SWAMPS.
6. User may take screen snapshots for import into MS Word or PowerPoint
7. User may export all records or a subset of records to create a new NAV file.

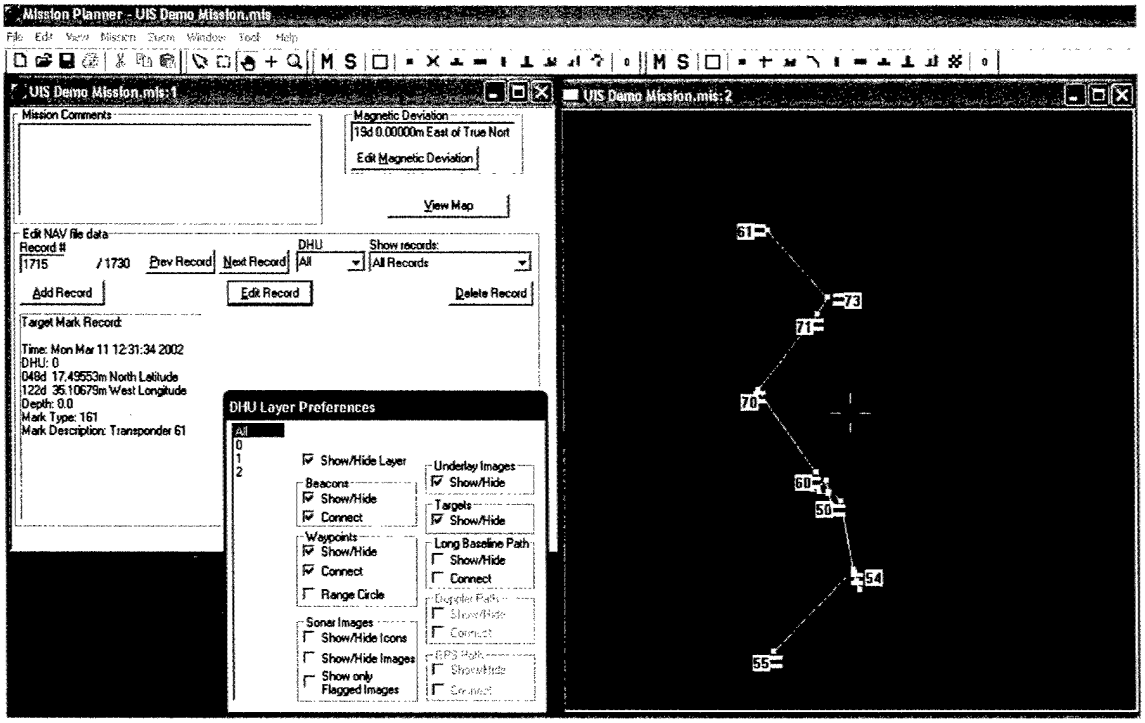
Shown below are examples of some of the windows, menus and data visualization tools the operator uses to plan, analyze, and report mission data.



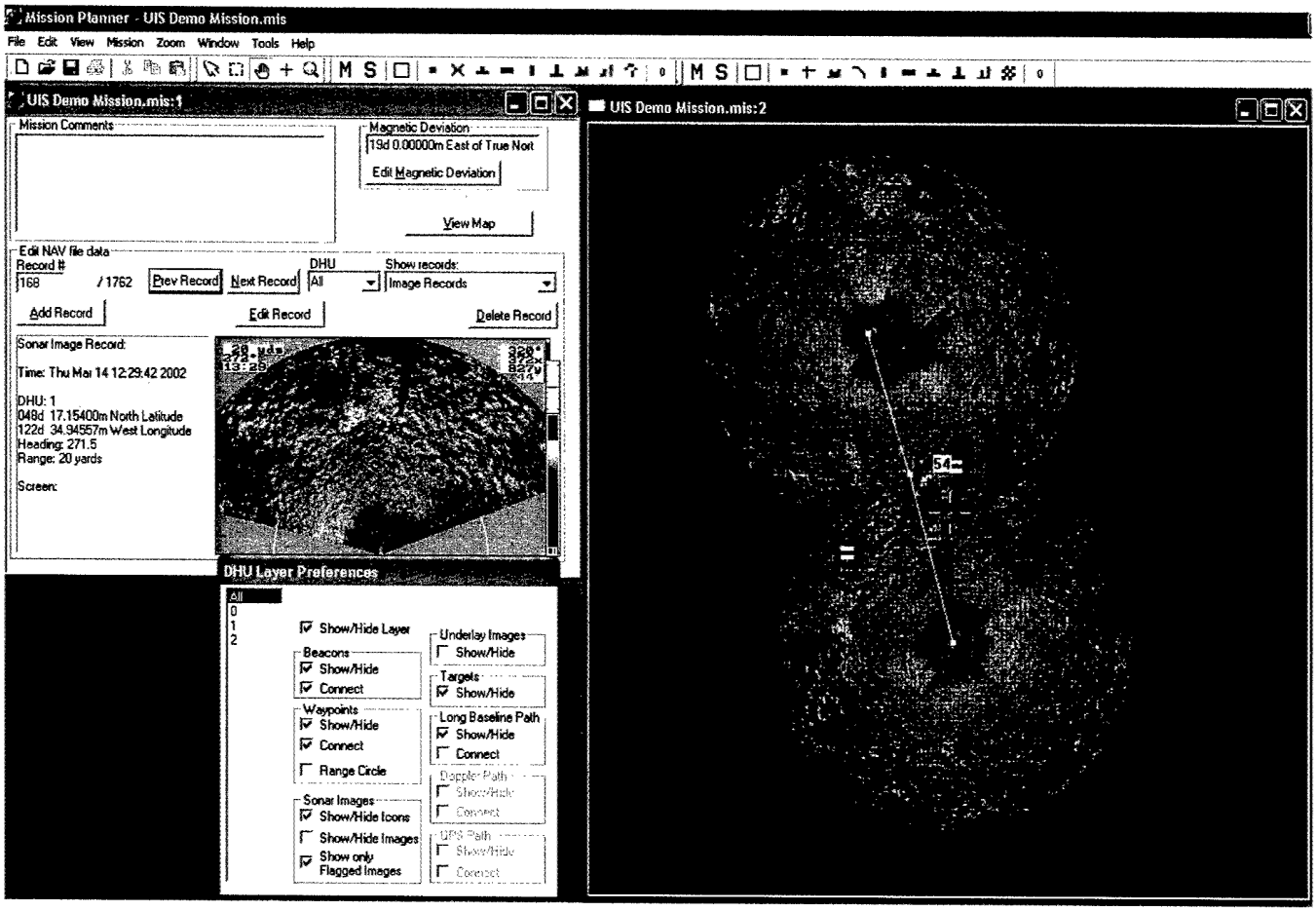
In the "Record" view, the user manipulates the list of records using standard windows controls such as buttons, edit boxes, and drop-down combo boxes. The attributes of each record are displayed as text. Sonar images are displayed in their native resolution of 320 X 200 pixels. These images are not modified in any way from what the diver sees underwater.



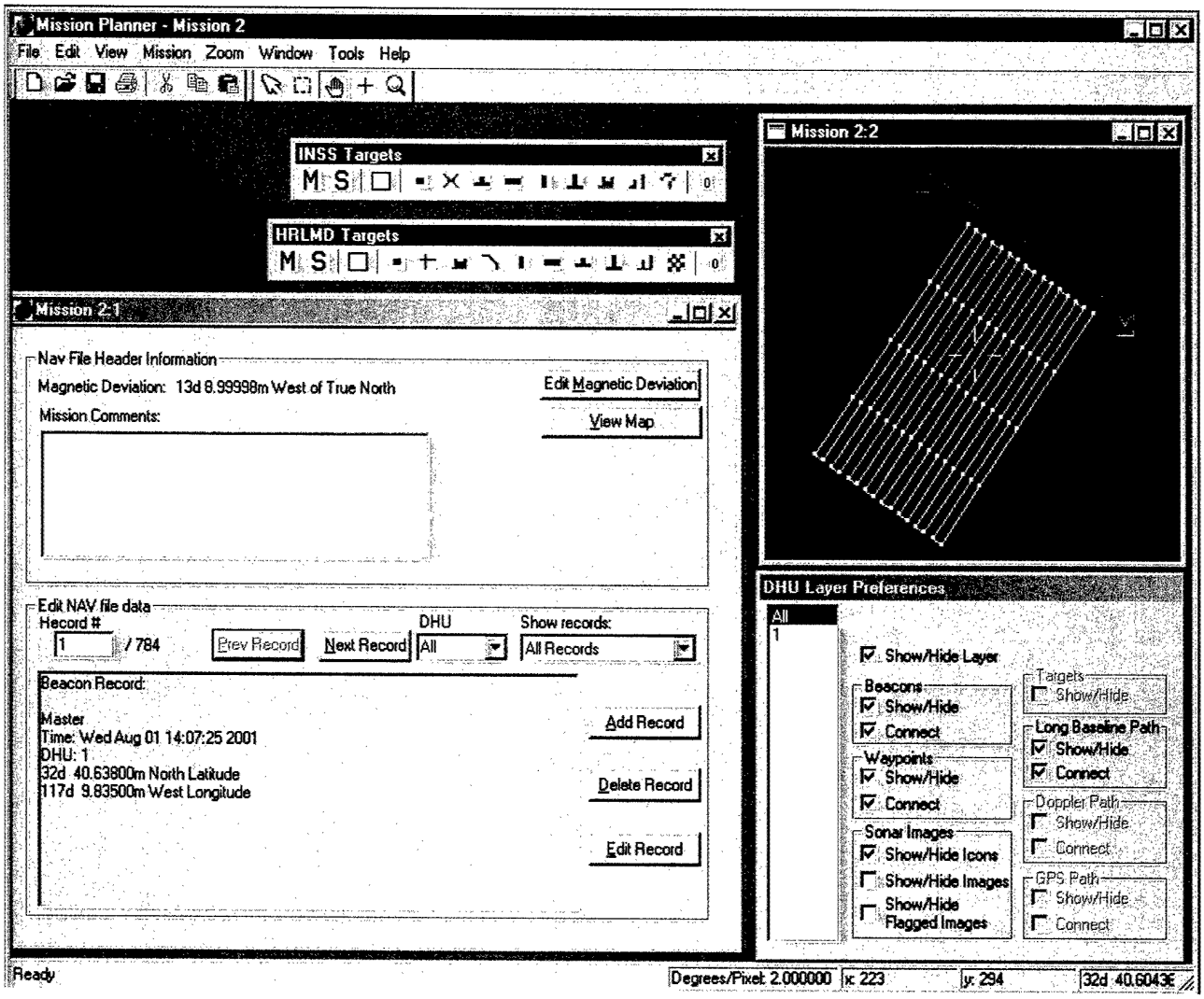
In the "Map" view, the user manipulates records by clicking and dragging them around the window. The window represents the earth with the top part of the screen being true north. Clicking and dragging an object causes that object's location to change. There are three toolbars at the top of the screen that become active when the MAP window is active. These toolbars contain buttons that enable tools and objects to be inserted. The tools have to do with moving, selecting and deleting records as well as a zoom tool to show finer detail or a broader overview of a mission. The object buttons are for the creation of Master and Slave beacon locations, waypoints, target marks, and transponder records. These objects are inserted by simply selecting the object, then clicking somewhere in the MAP window. The location where the record is placed is shown in the status bar at the bottom of the screen.



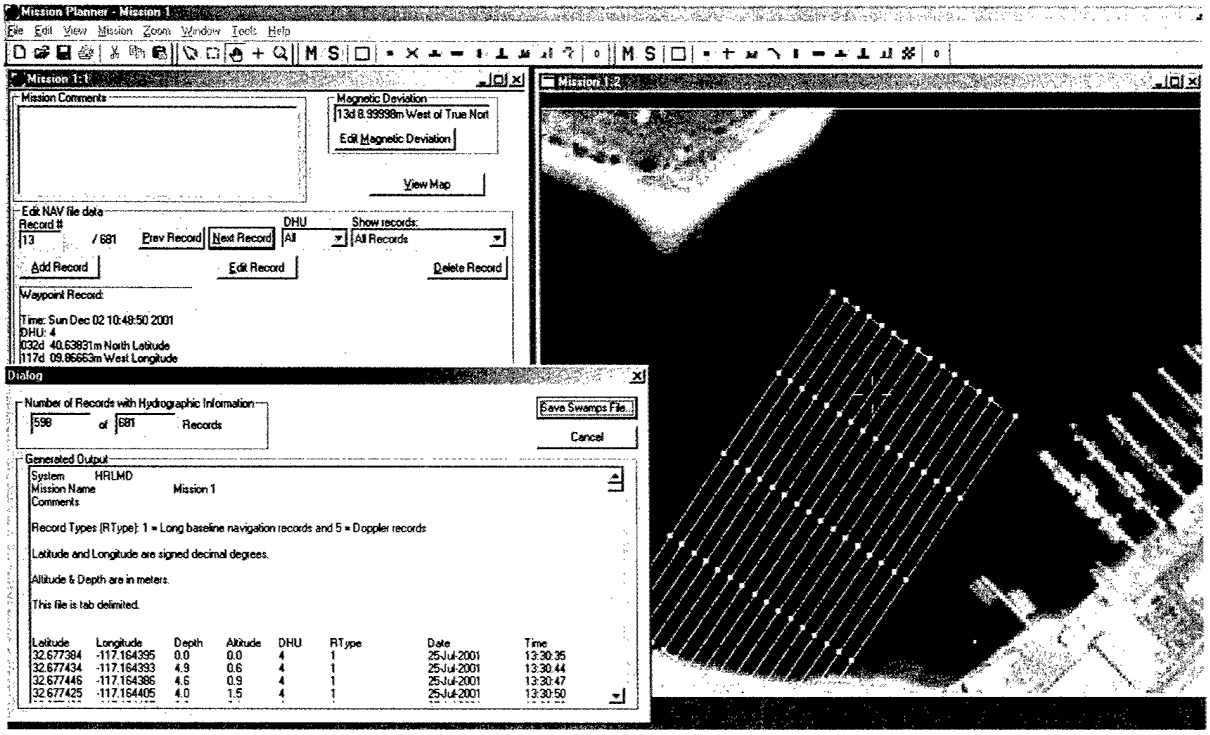
DHU is an abbreviation for Diver Held Unit. The "DHU Layer Preferences" window is shown whenever the MAP view layer is shown. It gives the user the ability to turn on and off various record types for each data record and for each diver held unit. All three windows (Record, Map and Layer) are shown above where the user is laying out a waypoint search pattern with marks at locations of interest.



When a mission is complete, data is downloaded from the DHU and analyzed. A mosaic of images is shown here along with target marks. This mosaic shows the area covered by the sonar scans.



Another search pattern created from a "wizard" is shown here. This wizard generates a lane pattern for a hydrographic survey mission. The path covered by one dive pair is also shown in red.



These windows show a divers track data overlaid on top of a visual satellite image and a formatting window for exporting data to another Navy program known as SWAMPS.

User Feedback

Mission Planner was initially developed based on past knowledge of how the VSWMCM Detachment planned and performed searches. Some of their tactics are however continuously developing and changing. For this reason, it was planned that the development of Mission Planner would be an iterative process relying heavily on user evaluation and feedback to guide its development. An early version of Mission Planner was first evaluated by Detachment personnel and much feedback was provided to the developers to improve its use. Changes were made and the next period for user evaluation was planned based on personnel availability and test schedules. Evaluation periods usually coincided with a period defined for testing of other equipment where the Mission Planner could be used "on the side" to aid in mission planning and analysis. Following this process for incremental improvements continued throughout the entire project. Later in the project, the UIS and HRLMD diver devices were added to the list of supported equipment and user evaluations from those communities were also included. A list of field trials where Navy personnel used Mission Planner is provided to document the amount of user evaluation and feedback that went into making this application a truly useful product.

May 2001 - Initial evaluation VSWMCM Detachment (San Diego)
July 2001 – HRLMD DT-IIA tests (San Diego)
September 2001 – HRLMD DT-IIB and DT-IIC tests (Norfolk)

December 2001 – HRLMD training for upcoming exercises
December 2001 – HRLMD exercises (NSW forces only) (North Carolina)
January 2002 - HRLMD reliability tests (Key West)
February/March 2002 –UIS DT-IIB tests (Crescent Harbor)
March 2002 - HRLMD OPTEVFOR observed tests (Panama City)
June 2002 – UIS DT-IIC tests (Charleston)

Examples of user feedback obtained in these test periods and the resulting changes made are summarized as follows:

- Every record type was edited in the raw data format specified by the NAV file specification. This was cumbersome to the user. The primary request was that waypoints could be entered in latitude and longitude format rather than yards away from the Master Beacon.
- The ability to display the results of multiple missions from multiple DHUs forced a significant rewrite of Mission Planner. Now all records are stored in terms of latitude and longitude. When importing multiple NAV files, the records are converted from their native format to latitude and longitude. This has two significant benefits. The records can be edited in terms of latitude and longitude. Also, the display of a mission is now shown with a true North up orientation.
- The ability to export post mission data to other Navy database programs in specific formats was requested and implemented. The data is now exported to MEDAL, SWAMPS and a generic tab delimited text file format.
- The user wanted the ability to preview sonar images in the NAV window prior to scaling, rotation and display on the map window. This was implemented.
- The user wanted the ability to view and filter various record types for the map display in order to display only select data. A layers dialog box was implemented
- The user wanted the ability to label special targets for the HRLMD missions. An additional set of target icons and labels were added.
- The user wanted the ability to enter, display and convert latitude and longitude in either decimal degrees, degrees minutes seconds or degrees and decimal minutes. This feature was implemented.
- The user wanted to record accurate water depth measured to the tenths of a foot for the HRLMD hydrographic reconnaissance mission. The navigation file and displayed data format were modified to enable higher precision numbers at shallower depths.

Many more features and fixes were implemented via user suggestion but are too numerous to mention here.

User's Manual and Software Description

A User's manual describing the use of Mission Planner is available. It is considered "For Official Use Only" due to the fact that EOD and NSW forces use this tool now for their missions. Copies of this manual (NAVSEA drawing number 7518377) can be obtained through request from PMS-NSW. A software design description is also

written for this product. It too is "For Official Use Only". This document is a detailed description written for programmers describing all software modules, external interfaces and the overall application architecture of Mission Planner. Copies of this document (NAVSEA drawing number 7606061) can be obtained through request from PMS-EOD.

Transition of Technology to Acquisition Programs

As of this writing, the ONR sponsored project Diver Charting and Graphical Display (Mission Planner) has produced the Mission Planner application through extensive user evaluation and feedback. The program offices responsible for coordinating the user exercises and feedback are PMS-EOD and PMS-NSW. Their use of this product has facilitated a transition of Mission Planner from an ONR development into two acquisition programs. The PMS-EOD program for the Underwater Imaging System (UIS) has developed test and evaluation documentation to formally evaluate, measure and validate the Mission Planner through Navy acceptance testing. The documentation produced under PMS-EOD sponsorship is the software development plan and the software design description. The PMS-NSW program for the Hydrographic Reconnaissance Littoral Mapping Device (HRLMD) has contributed in developing the Operator's Manual and the software test plan. Both programs maintain configuration control of this product. This executable application, its associated documents and version controlled source code are a part of the technical data package for both the UIS and HRLMD programs.