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NAVAL POSTGRADUATE SCHOOL

Monterey, California



THESIS

**ELECTRONIC MANEUVERING BOARD AND DEAD
RECKONING TRACER DECISION AID FOR THE
OFFICER OF THE DECK**

by

Joey L. Frantzen
Kenneth L. Ehresman

September 2001

Thesis Co-Advisors:

Richard D. Riehle
Luqi

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**ELECTRONIC MANEUVERING BOARD AND DEAD RECKONING TRACER
DECISION AID FOR THE OFFICER OF THE DECK**

Joey L. Frantzen
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Submitted in partial fulfillment of the
requirements for the degree of

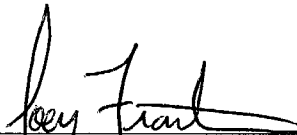
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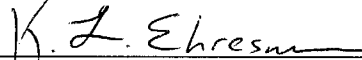
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ABSTRACT

The U.S. Navy currently bases the majority of our contact management decisions around a time and manning intensive paper-based Maneuvering Board process. Additional manning requirements are involved on many Naval Ships in order to accurately convey the information to the OOD and/or the Commanding Officer. When given situations where there exist multiple contacts, the current system is quickly overwhelmed and may not provide Decision-Makers a complete and accurate picture in a timely manner.

The purpose of this research is to implement a stand-alone system that will provide timely and accurate contact information for Decision-Makers. By creating a reliable, automated system in a format that is familiar to all Surface Warfare Officers we will provide the Navy with a valuable decision-making tool, while increasing ease of data exchange and reducing current redundancies and manning inefficient practices.

Our software design is based upon the Unified Modeling Language (UML). UML allows us to construct a software model that is supported by the Ada programming language. Our design is based upon these fundamental tenants: Non-Operating System dependent, Non-Hardware System dependent, Extensible and Modular design. Ada provides a certified compiler, making our code robust and assuring the “buyer” that the program does what we advertise it to do.

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I. INTRODUCTION

A. PROBLEM STATEMENT

The U.S. Navy currently bases the majority of our contact management decisions around a time and manning intensive paper-based Maneuvering Board process. The use of Maneuvering Boards is a perishable skill that has a steep learning curve. In order to overcome inherent human error, it is not uncommon to have up to four people simultaneously involved in solving just one maneuvering problem. Additional manning requirements are involved on many Naval Ships in order to accurately convey the information to the Officer of the Deck (OOD) and/or the Commanding Officer. When given situations where there exist multiple contacts, the current system is quickly overwhelmed and may not provide Commanding Officers and OODs a complete and accurate picture in a timely manner.

Since 1996, there has been an increase in the number of collisions at sea, resulting in the loss of millions of dollars and thousands of operational hours for ships that are critical to our force structure. Although the time-tested method we use to make maneuvering decisions works, its technology has not kept pace with the increase in the ocean's traffic density. What is required is a faster and more accurate means by which this method is executed

The purpose of this research is to implement a stand-alone system that will provide timely and accurate contact information for U.S. Navy Commanding Officers, OODs, and CIC watch teams. By creating a reliable, automated system in a format that is familiar to all Surface Warfare Officers we will provide the Navy with a valuable decision-making tool, while increasing ease of data exchange and reducing current redundancies and manning inefficient practices.

Our software design is based upon the Unified Modeling Language (UML). UML allows us to construct a software model that is supported by the Ada programming language. UML also provides significant benefits to us, as software engineers, by helping to build rigorous, traceable and maintainable models that will support the software development cycle. Our design is based upon these fundamental tenants: Non-

Operating System dependent, Non-Hardware System dependent, Extensible and Modular design. Ada provides a certified compiler and environment, making our code robust and assuring the “buyer” that the program does what we advertise it to do. We also chose Ada because of the Re-usability inherent to the modular design structure. Our program does not use hardware specific libraries/architecture such as MFC.

This system will significantly enhance Safe Navigation at Sea while maintaining the age old, time tested ways of avoiding other vessels at sea.

Our software design is implemented via using Gtk-Ada, which allows the development of a GUI-based program that is neither operating system nor hardware dependent. Gtk-Ada is supported on a wide range of platforms, and its use can ultimately allow the U.S Navy to develop operational tools and programs without being limited to any specific hardware or operating system. The flexibility that this tool affords can reduce development and maintenance cost significantly as the amount of rework due to a paradigm shift in any operating system vendor will be greatly reduced or eliminated. Additionally, Ada’s ability to interoperate with other programming languages make it an excellent candidate for integrating with current stove-piped systems.

Our system provides the basis for a robust fusion analysis plot that, due to its modular design, can interact with virtually any other system.

II. BACKGROUND

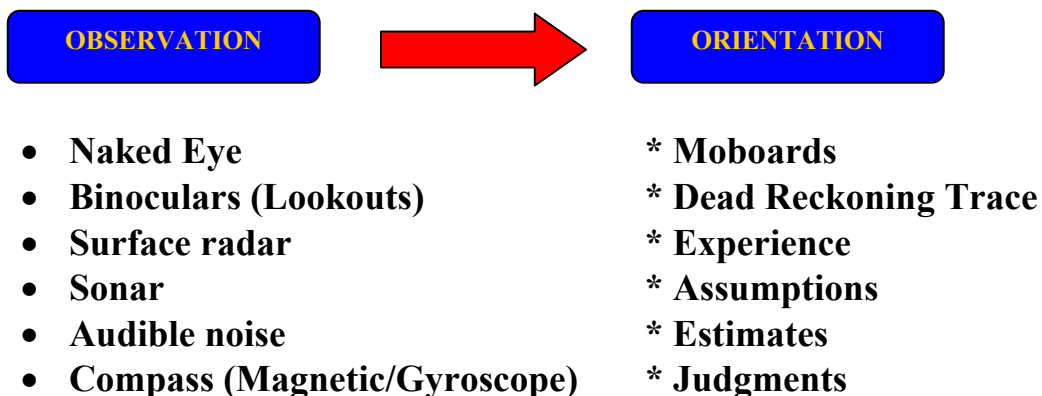
A. TRADITIONAL DECISION-MAKING PROCESS

Prior to Maneuvering Boards, the traditional mariner relied upon the seaman's eye and the knowledge gained from many hours of standing watches on the bridge. This knowledge pool helped the ship driver make the right decision when confronted with other vessels. The evolution of radar allowed vessels to see contacts at great distances and measure the bearing and ranges of those contacts. The Maneuvering Board quickly followed the radar allowing ship drivers an alternate visual representation of radar contacts based upon trigonometric fundamentals. This now allowed OODs and Commanding Officers a better way to frame the problem in more concrete terms.

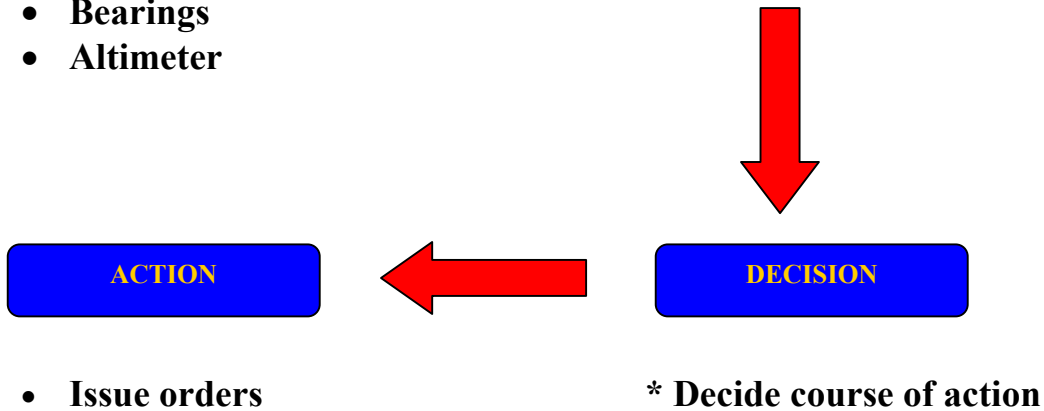
1. The OODA Loop

The OOD decision-making process is designed to try and reduce uncertainty by gathering information, and transforming this information into knowledge and understanding. The utilization of radars and Maneuvering Boards aids a Commander/OOD in reducing the level of uncertainty. This decision process is known as the OODA Loop: Observation, Orientation, Decision, and Action.

Whenever trying to establish Command and Control there exists two fundamental factors that shape the environment: uncertainty and time. The Moboard model lies within the Orientation phase of the OODA Loop. The Electronic Maneuvering Board Decision Aid reduces the level of uncertainty and the amount of time inherent to the Maneuvering Board process.



- **Bearings**
- **Altimeter**



- **Issue orders**

*** Decide course of action**

Figure 1. The OODA Loop for Officer of the Deck (From: OOD)

a. Observation

Observes the environment (using all sensors, information systems, and situational reports from his subordinates) to collect data about their surroundings and the status of contacts. This data is typically correlated, fused, and displayed in a common tactical picture—a representation or image of the contact space. A Commander or OOD had several methods of retrieving data via visual lookouts, surface radars, sonar, and/or his/her own eyes.

b. Orientation

A Commander/OOD orients themselves to the environment—that is, they form a mental picture of the situation—by converting sensor data and other information into estimates, assumptions, and judgments about what is happening. From this orientation a commander/OOD derives his understanding of the contact space, or situational awareness.

c. Decision

Based on the understanding derived from his/her Orientation, the commander/OOD then decides on a course of action and comes up with a plan.

d. Action

The commander/OOD sets forth his intent and issues orders to put that plan into action.

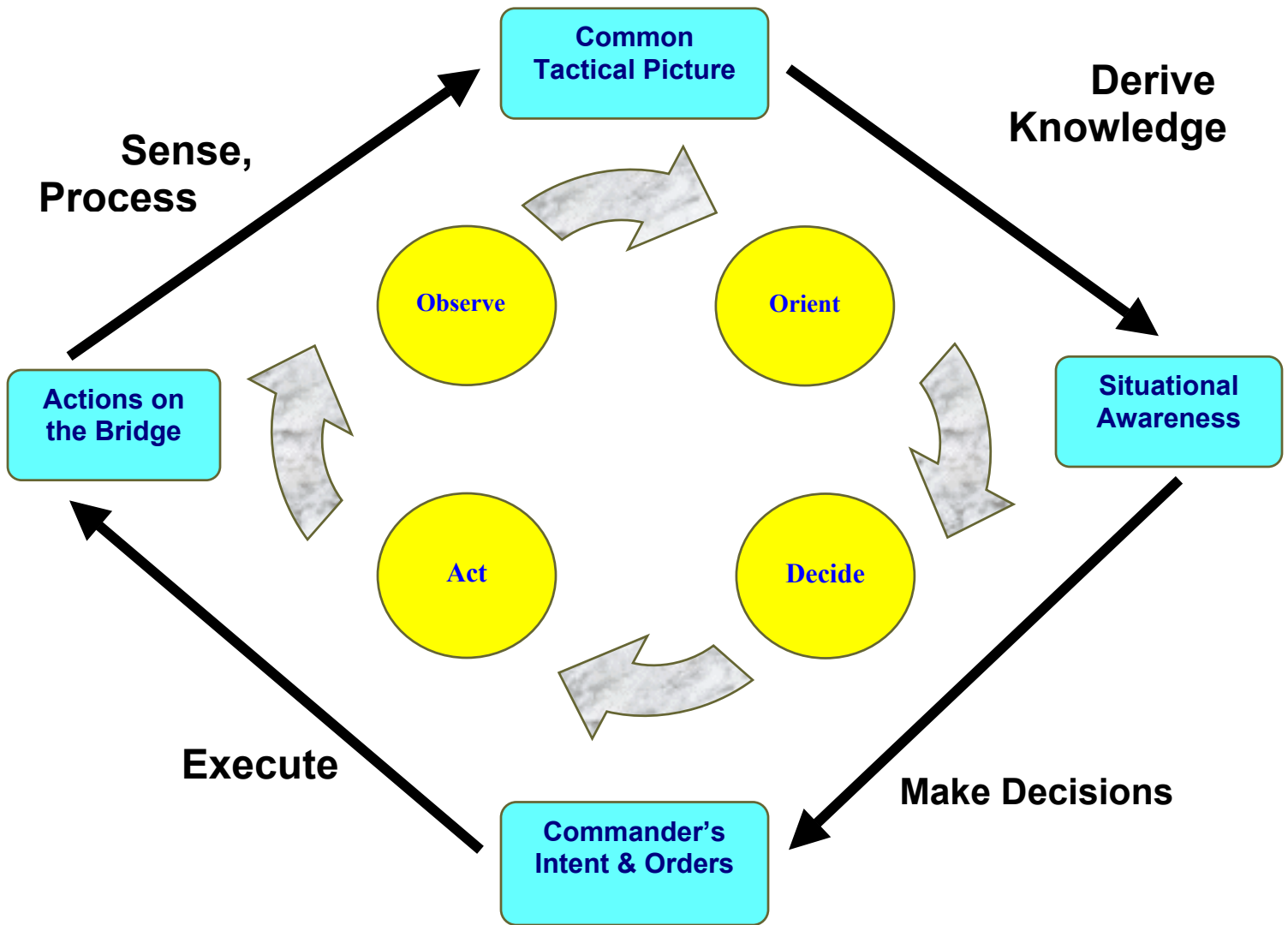


Figure 2. The OODA Loop Cycle

B. INCREASING COLLISIONS AT SEA

Since 1996, there has been a marked increase in the number of collisions at sea, resulting in the loss of millions of dollars and thousands of operational hours for ships that are critical to our force structure. A Navy investigation into the collision of USS

Denver (LPD 9) with USNS Yukon (T-AO 202) found that Captain should have realized his ship was on a collision course with the oiler. In hindsight, had the CO of the Denver had more time to make his critical maneuvering decision and had he been given more accurate contact information in a timelier manner, the CO of the Denver would never have made such a critical mistake.

There are many variables that play a significant part in the reasons for more frequent collisions at sea over the past 5 years. These factors range from inexperience, training, crew fatigue, Op Tempo, and higher traffic densities on today's seas. The end result is OODs and CO's who may not have complete situational awareness, who become complacent, and decision-makers who don't receive safety critical information in a timely and accurate manner. The primary issue is not the decisions that are made when it comes to maneuvering, but the information that decision-makers have when making those decisions. Although collisions are a high profile issue, it's the numerous and countless "near misses" that go unreported and often untreated. Looking back into our crystal ball we can see many instances where Commanding Officers and OODs could have benefited from a better system and a better means by which contact information was being displayed and presented to them. The time-tested method we use to make maneuvering decisions works. The problem is that technology has not kept pace with the increase in the ocean's traffic density. What is required is a faster and more accurate means by which this method is executed.



Figure 3. USS DENVER (LPD 9) pulls into Pearl Harbor Following An at-Sea Collision

C. PAPER VS. DIGITAL

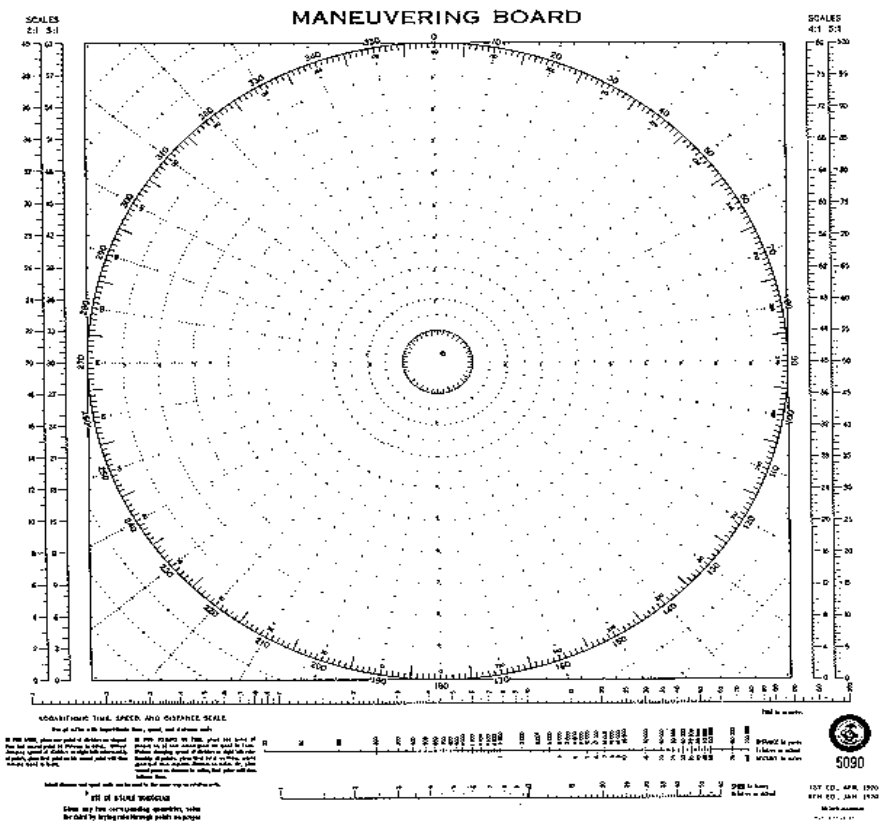


Figure 4. The Paper-based Moboard

The argument for or against traditional paper-based Moboards versus Digital-Based Moboards is based upon two simple factors.

Traditional paper-based Moboards are done with a pencil and straightedge. This process can be inaccurate and is often prone to human error. Even a very experienced sailor can make mistakes when doing a Mboard solution, especially in time critical situations, periods of rough seas, night time operations, or situations where there are multiple contacts.

Digital-based Moboards will speed this process up and eliminate the inherent human error innate to the paper-based Mboard process. By decreasing the time required to produce a Mboard solution it in turn decreases the time required to complete the orientation process and thus speeds up the overall decision process. Having more time and more accurate information in an understandable and easy to assimilate presentation is every Commander's desire. This is what Digital-based Moboards provide.

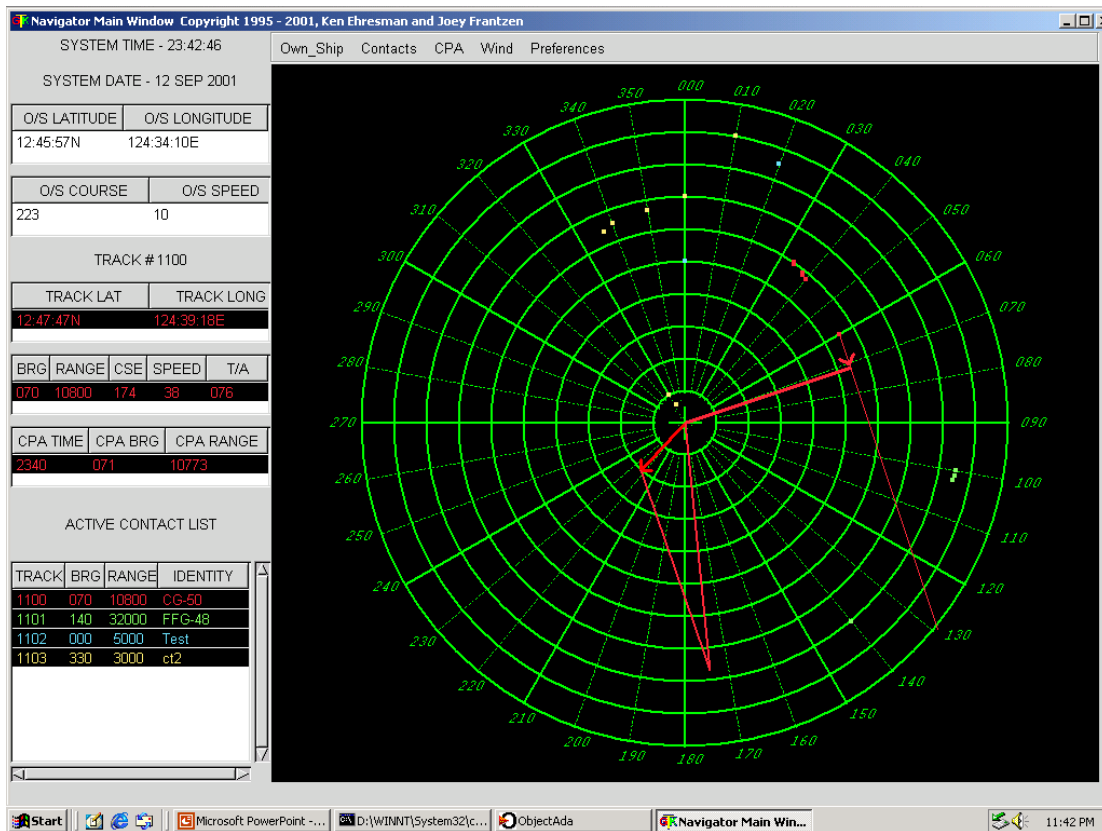


Figure 5. The Digital Mboard

D. MANNING THE FUTURE NAVY

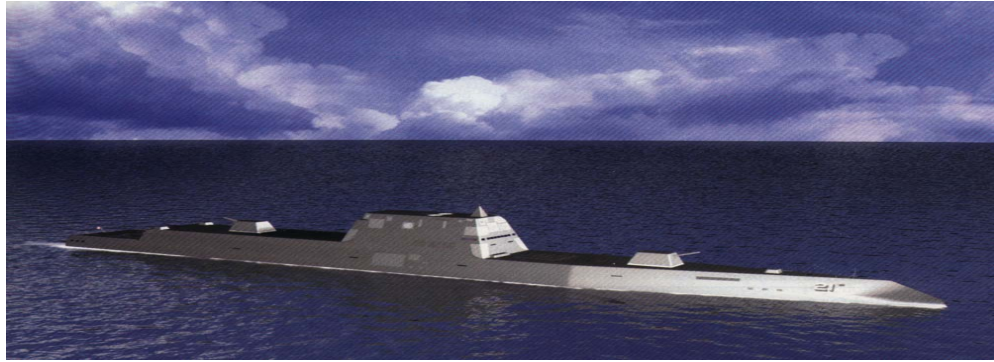


Figure 6. Picture of DD-21 Concept

With the evolution of “Smart Ship” and the DD-21 initiative the manning of Navy Ships has become a high profile issue. The future Navy will no longer have the luxury of 350-manned combatant ships. The Navy of the future will require less men and women who are more technically proficient and better trained. The bridge of the next generation will still rely on good seamanship, experience, and a trained eye while instead of using paper-based tools, the tasks and aids used to process contacts and information will be done in a digital-based medium. The modern Navy will have to depend on exceptional sensors and computer systems that are able to frame an abundance of information into a manageable and clear presentation. The Electronic Maneuvering Board Decision Aid is designed to meet this emerging need. With this computerized decision tool the requirements for multiple junior officers doing Moboards or several Operation Specialists in Combat maintaining a DRT contact picture will be reduced greatly. GPS will automatically be updated into the system, instantly giving the Commanding Officer and OOD Latitude and Longitude information of all the local area contacts at the mere click of the mouse.

Additionally our computer program will have the ability to maintain a digital log, vice having a paper-based Deck Log maintained by the Quartermaster (QM). This may be another avenue by which the U.S. Navy can reduce the manning requirements on the bridge while maintaining and improving upon the safety of ships at sea. The Quartermaster will no longer be required to log each course and speed change, OOD watch changes, casualties, etc. This will all be maintained in a central database allowing for a visual playback of events for any post-operations analysis. This feature will allow

the evaluator to view a list of events as well as display a visual contact picture chronologically corresponding with these logged events. Thus, the end result is better post-operations analysis and understanding of the environment on the bridge at the time of the operation, mishap, or exercise.

III. OVERALL SOFTWARE DESIGN

A. UNIFIED MODELING LANGUAGE

Our software design is based upon the Unified Modeling Language (UML). UML allows us to construct a software model that is supported by the Ada programming language. UML also provides significant benefits to us, as software engineers, by helping to build rigorous, traceable and maintainable models that will support the software development cycle. Our design is based upon these fundamental tenants: Non-Operating System dependent, Non-Hardware System dependent, Extensible and Modular design. Ada provides a certified compiler and environment, making our code robust and assuring the “buyer” that the program does what we advertise it to do. We also chose Ada because of the Re-usability inherent to the modular design structure. Our program does not use hardware specific libraries/architecture such as MFC.

Our design was based upon the following UML diagrams: Use-Case, Sequence, Class, Object, and Deployment Diagrams.

1. Use-Case Diagram

The Use-Case Diagram was based upon what an OOD or CO would require the computer system to do. Basic functions such as Plot Contact, Display Contact, Calculate Contact Course and Speed, and Calculate CPA were the primary Use-cases for the basic computer program. Other actors such as Global Positioning System and Generic Radar System will be required for implementation at a later date. All of these actors interact with two systems, Dead Reckoning Trace and Maneuvering Board. These two systems are just separate views of the same data, framing our visual representation for the user.

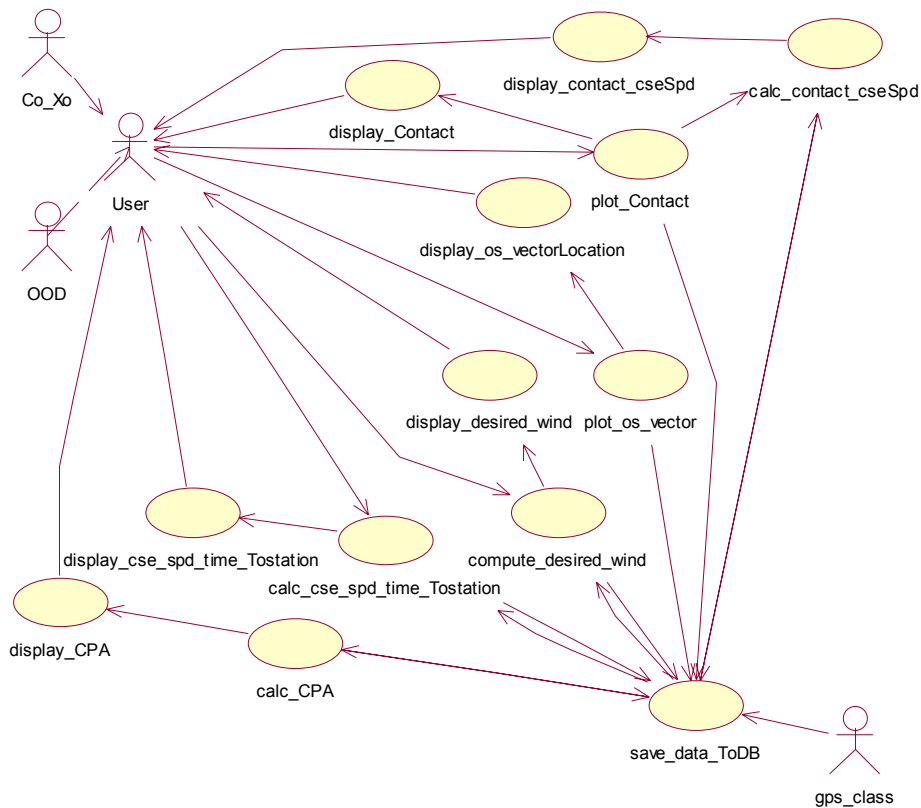


Figure 7. Use-Case Diagram

2. Class Diagram

To truly make a computer program reusable, modular, and maintainable the programmer must adhere to a strict Objected Oriented Methodology (OOM). Understanding this key concept, the programmer must build his/her classes in an Object Oriented approach. With this in mind, our Electronic Mboard and DRT was structured to be modular, maintainable, and reusable.

a. DRT Class

Description: The DRT Class is similar to the Mboard Class in that it displays information from the Ownship and Tracks Class. The main difference is the DRT Class presents a true picture vice a relative picture presented in the Mboard Class.

b. Date Class

Description: The Date Class contains a type Date (Day, Month, Year).

The Class includes Functions and Procedures to Get a Date from the computer system or GPS, as well as, return all the Date values and set all the Date values.

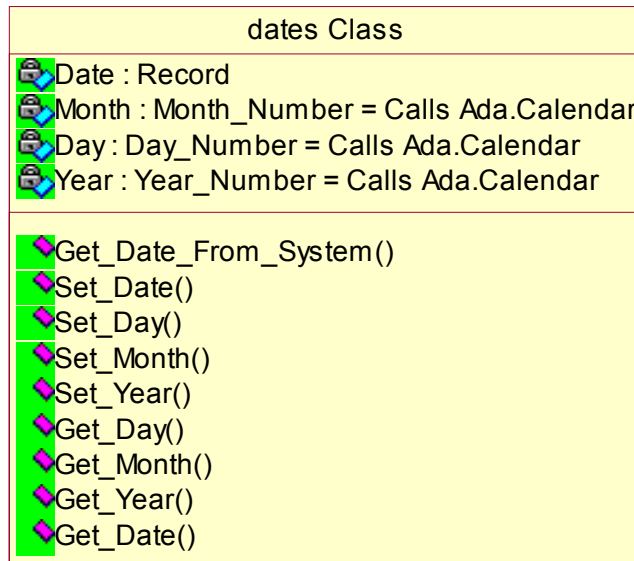


Figure 8. Dates Class

c. Time Class

Description: The Time Class contains a type Tim (Hours, Minutes, Seconds).

The Class includes Functions and Procedures to Get a Time from the computer system or GPS, as well as, return all the Time values and set all the Time values.

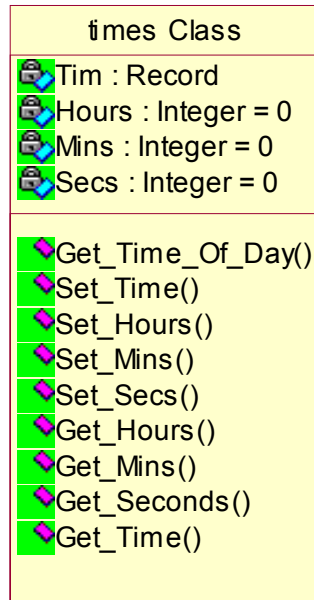


Figure 9. Times Class

d. Latitude/Longitude Class

Description: The Lat_Long Class contains a type Latitude (Degrees, Minutes, Seconds, Sign) and type Longitude (Degrees, Minutes, Seconds, Sign). The Class includes functions to convert from Nautical Miles to Kilometers, Yards to Kilometers, Yards to Nautical Miles and the converse functions as well. Also included in this class are two unique procedures. The first, Calculates a Latitude and Longitude given a bearing and range from a known Lat/Long Position. This Procedure also returns the back bearing based on trigometric formulas that take into account the curvature of the earth. The other Procedure takes two known Lat/Long Positions and then calculates the distance between them and the forward and back bearings. The Class also contains the basic set and get procedures/ functions for each Latitude and Longitude type.









































Lat_Long Class	
	Latitude : Record
	Longitude : Record
	Lat_Degree : Lat_Degree 0..90
	Lat_Min : Lat_Min 0..60
	Lat_Sec : Lat_Sec 0..60
	Long_Degree : Long_Deg 0..180
	Long_Min : Long_Min 0..60
	Long_Sec : Long_Sec 0..60
	Get_NM_From_Yards()
	Get_Yards_From_NM()
	Get_KM_From_Yards()
	Get_Yards_From_KM()
	Get_NM_From_KM()
	Get_KM_From_NM()
	Lat_To_Degrees()
	Long_To_Degrees()
	Deg_To_Lat()
	Deg_To_Long()
	Calc_Lat_Long()
	Calc_Bearing_Distance()
	Set_Latitude()
	Set_Longitude()
	Set_Lat_Deg()
	Set_Lat_Min()
	Set_Lat_Sec()
	Set_Lat_Sign()
	Set_Long_Deg()
	Set_Long_Min()
	Set_Long_Sec()
	Set_Long_Sign()
	Get_Latitude()
	Get_Lat_Deg()
	Get_Lat_Min()
	Get_Lat_Sec()
	Get_Lat_Sign()
	Get_Long_Deg()
	Get_Longitude()
	Get_Long_Min()
	Get_Long_Sec()
	Get_Long_Sign()

Figure 10. Lat_Long Class

e. Hit Class

Description: The Hit class contains all of the data necessary when a hit is taken (a bearing and range to a contact from a radar scope). A hit type includes Bearing, Range, Latitude, Longitude, Date, Time, Ownship Course and Speed, Target Course and Speed, and

Target Angle. Hit Class contains all the procedures necessary to set and get data from each element of the Hit type.

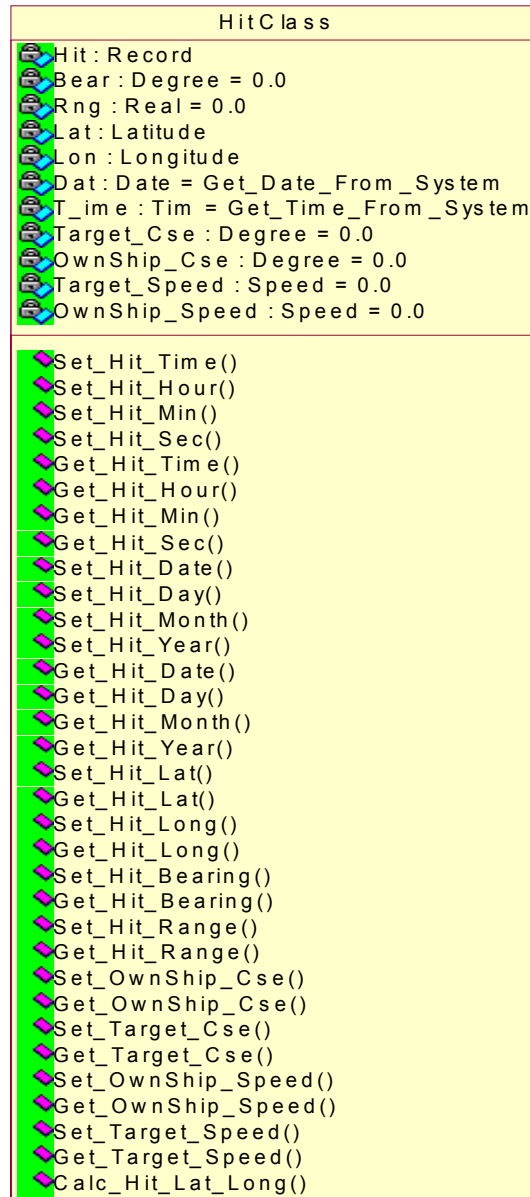


Figure 11. Hit Class

f. Track Class

Description: The Track Class contains all of the data necessary to track a contact. The track type includes Track Number, Track Ident, Track Course and Speed, CPA Bearing, CPA Range, CPA Time, a Hit Count and a List of Hits. Track includes

functionality to set and get all of the elements of hit type. Track also maintains an array of 10,000 elements that are of type track. This is the memory allocation for all of the tracks prior to being saved onto a harddisk or storage device.

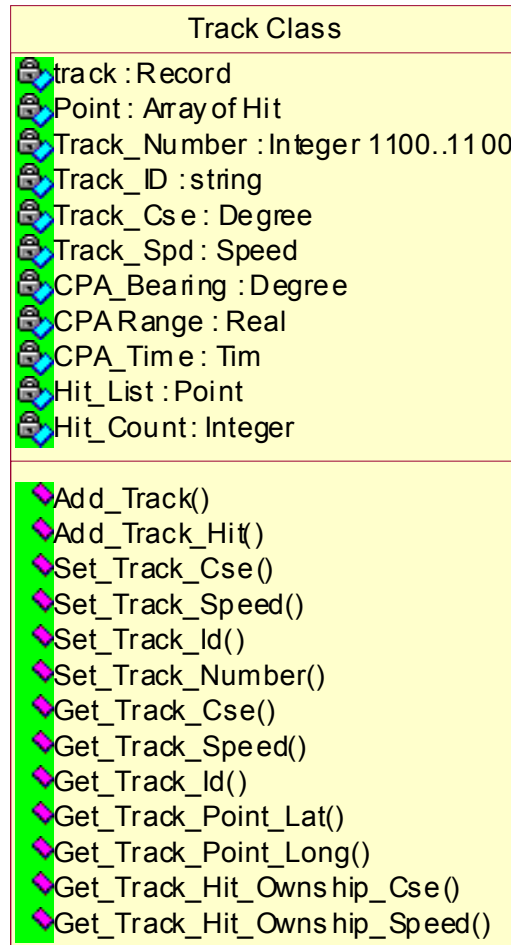


Figure 12. Track Class

g. OwnShip Class

Description: OwnShip Class manages and maintains all information concerning OwnShip. This includes Number, Identification, Course and Speed, Latitude, and Longitude. The OwnShip Class contains all of the required Get and Set functions and procedures necessary to modify and retrieve type data. OwnShip Class also retrieves Latitude and Longitude Information from either manual keyboard entry or from a GPS port (ex. COM1). This is based upon the user-selected mode.

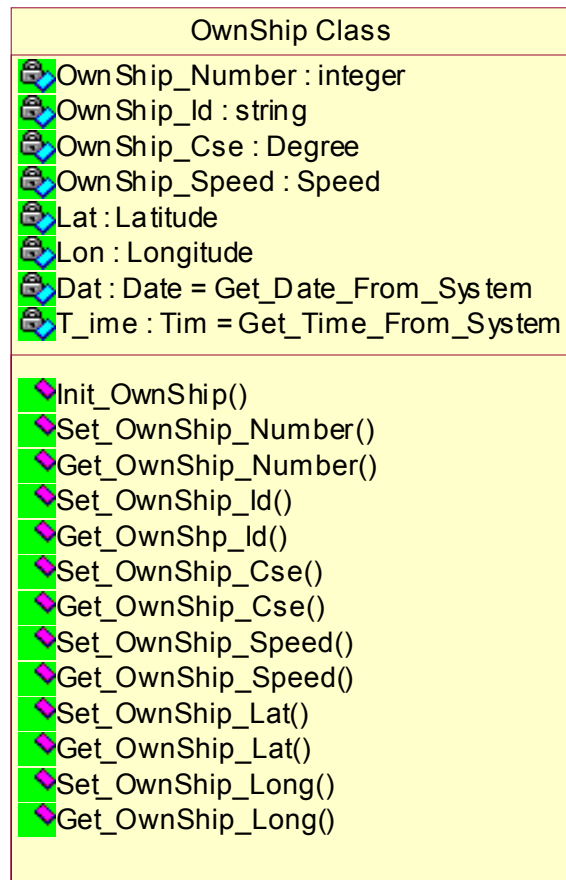


Figure 13. Ownship Class

h. GPS Class

Description: This Class manages the interface between the GPS System and the Computer system. This Class retrieves GPS information from the designated port (ex. COM1) then parses and stores this information into usable formats, i.e. Latitude, Longitude, Date, Time, etc.

i. Speed Class

Description: Defines subtype Speed that is a Real type with digits 1 range 0.0 to 130.0 This maximum values was chosen based on the simple fact that our design of this system is intended to track surface vessels, not aircraft, etc.

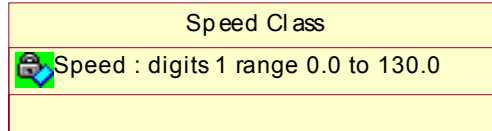


Figure 14. Speed Class

j. Realnum Class

Description: Defines subtype Real that is digits 12. This class instantiates Generic_Elementary_Functions (Real) allowing the Real Type to use all of the Generic Elementary Functions.

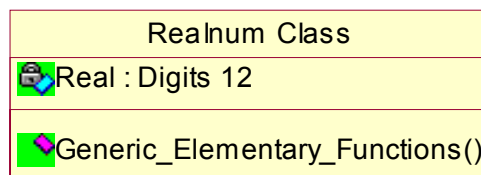


Figure 15. Realnum Class

k. Degree Class

Description: Defines subtype Degree that is a Real type with digits 1 range 0.0 to 359.9

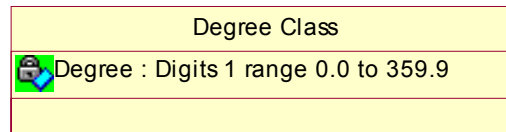


Figure 16. Degree Class

l. Radar Class

Description: This is a future Class that will be designed to handle Radar input of track information and manage the interface between the two systems.

m. Network Class

Description: Manages all of the network traffic and sequence of events required to pass data over a small network.

n. CPA Class

Description: This Class handles all Closests Point of Approach (CPA) calculations and then plots those DRM, SRM, and Associated Speed Traingle and CPA information to the Mboard, DRT, or specified view.

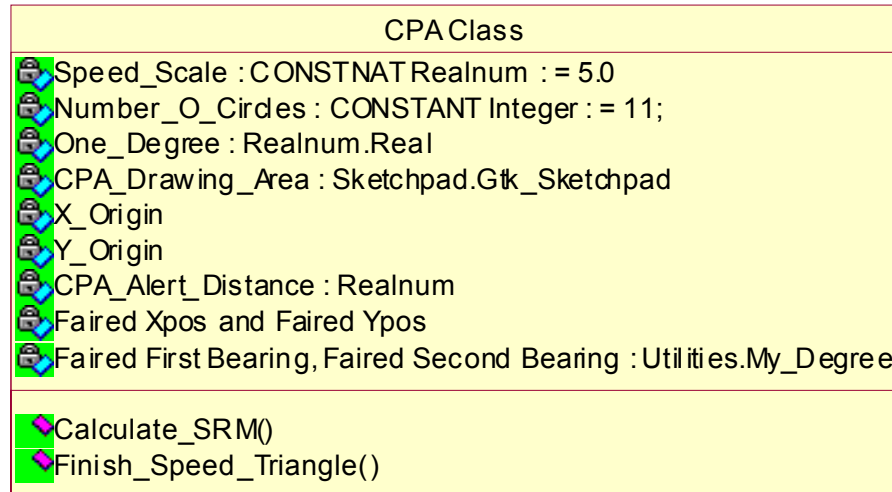


Figure 17. CPA Class

o. Mboard Class

Description: The Mboard Class displays OwnShip and Track Class Data in a relative 0 to 360 degree coordinate system scale based upon the speeds of the vectors..













































Moboard Class	
	Current_Contact_Number
	Current_Contact_Bearing
	Current_Contact_Range
	Moboard_Radius
	Black, Current_color, Red
	Ratio-Array
	Number_O-Circles : Constant
	One Degree
	Own_Ship_Course
	Own_Ship_Speed
	Set_Up-Distance
	Current-Area
	Contact Xpos
	Contact Ypos
	Ship Xpos
	Ship Ypos
	Draw Width
	Draw Height
	X orig
	Y orig
	Dashed Green GC
	Green GC
	Blue GC
	Red GC
	Get_Black_Color()
	Get_Red_Color()
	Get_Current_Contact_Num()
	Get_Current_Contact_Bearing()
	Get_Current_Contact_Range()
	Get_Current_Color()
	Get_Ship_XPos()
	Get_Ship_YPos()
	Get_Own_Ship_Course()
	Get_Own_Ship_Speed()
	Set_Current_Color()
	Set_Current_Contact_Bearing()
	Set_Current_Contact_Num()
	Set_Current_Contact_Range()
	Set_Contact_XPos()
	Set_Contact_YPos()
	Set_Own_Ship_Course()
	Set_Own_Ship_Speed()
	Find_Distance()
	Find_DRM()

Figure 18. Moboard Class

p. MainScreen-Pkg Class

Description: This Class handles all the Packages for the Mainscreen.
































MainScreen-Pkg Class	
	Show_Cpa1
	Show Lines1
	Add_New_Contact1
	Input_Contact_Hit1
	Drop_Contact1
	Update_Contact1
	OwnShp Lat Clist
	Ownshp Course Clist
	CPA Clist
	Contact Clist
	Track Clist
	Track Lat Clist
	Course Text1
	Speed Text1
	Lat Degrees Text1
	Lat Minutes Text1
	Lat Seconds Text1
	Lat Hemisphere Text1
	Long Degrees Text1
	Long Minutes Text1
	Long Seconds Text1
	Long Hemisphere Text1
	Display CPA()
	Display_Track Info()
	Gtk New()
	Initialize()
	Input Lat Long()
	Input Measured Wind()
	Input New Contact()
	Input New Hit()
	Input CPA Alert Distance()

Figure 19. MainScreen-Pkg Class

q. MainScreen-Pkg-Callbacks Class

Description: This Class handles all the Callbacks for the Main Screen Packages.

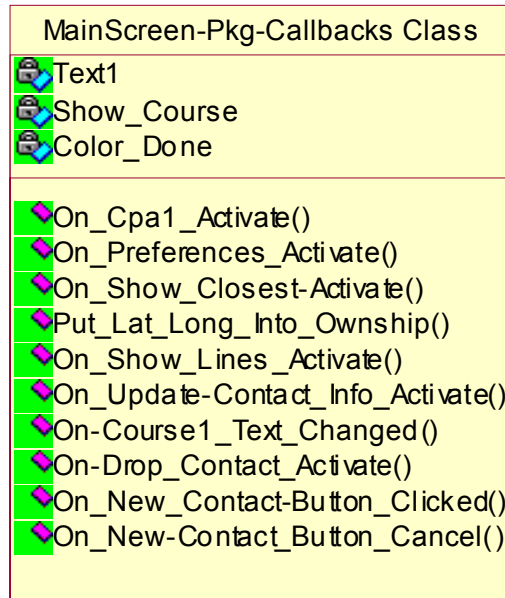


Figure 20. MainScreen-Pkg-Callbacks Class

r. Sketchpad Class

Description: This class is similar to the name, it's a Sketch Pad that allows the programmer to draw in the back ground and then load the information to the front of the view.

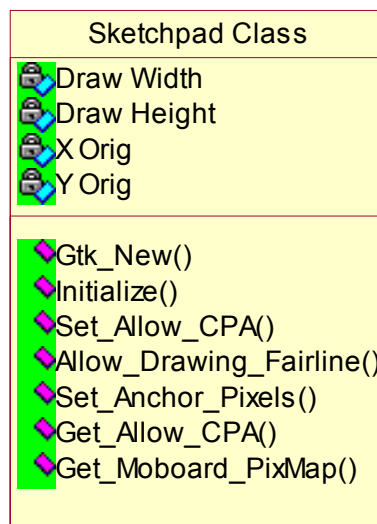


Figure 21. Sketchpad Class

s. Utilities Class

Description: This Class is designed to encompass all generic functions and procedures, such as converting real and integer numbers to strings, as well as any generic type definitions that multiple classes require to use as part of the program.

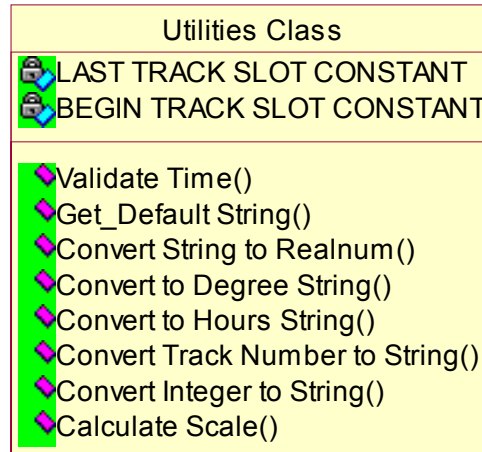


Figure 22. Utilities Class

t. File IO Class

Description: This Class is designed to handle all data recovery/restoration of track, hit, and ownship information. The database maintains the last known state in three (3) separate files. Should the system shutdown or crash, the program will automatically load the last stored information from the Latest files kept under File_IO Class.

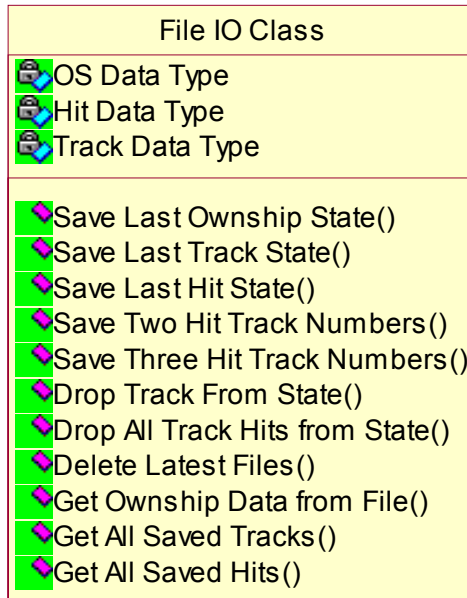


Figure 23. File_IO Class

v. *Historical IO Class*

Description: This Class is designed to save all data for every change or update made to ownship, track, or hit information. The database is a sequential database that has a sentinel designating the type of data to be stored. This will allow for future expansion for data re-play, reconstruction of events, and/or data playback for mishaps, exercise evaluations, etc.

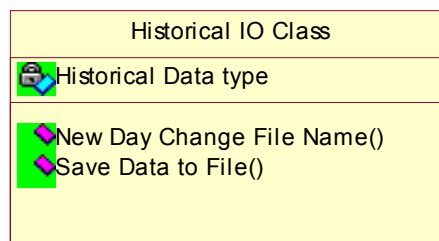


Figure 24. Historical IO Class

w. Wind Class

Description: This Class is designed to calculate True wind and Desired wind and then ploat the result onto the Moboard, DRT, or specified view that the user desires.

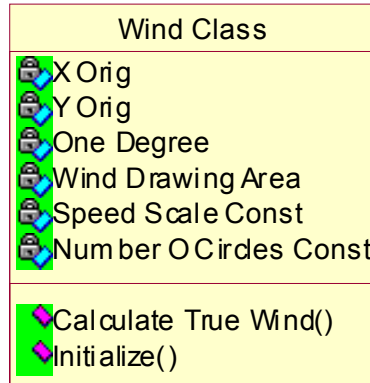


Figure 25. Wind Class

3. Deployment Diagram

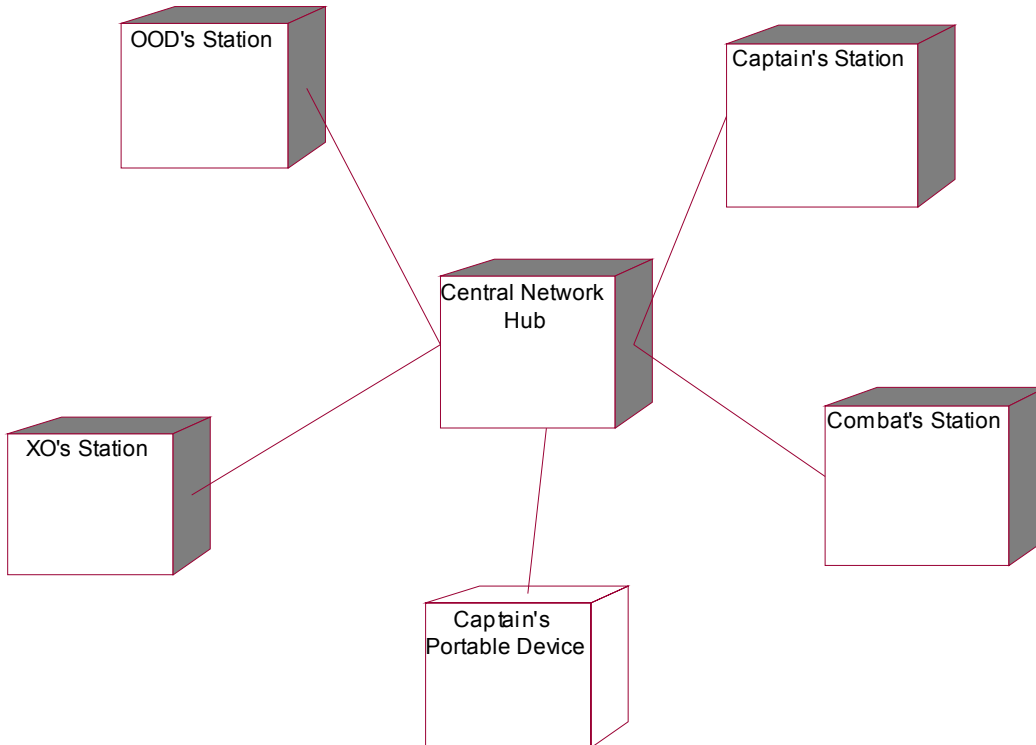


Figure 26. Deployment Diagram

4. GtkAda and GNAT

There are several reasons we chose to use GtkAda and GNAT compilers. First off, as students with no funding, both of these compilers are free, a very attractive quality. Secondly, part of our research was to design a computer program that was hardware and software (Operating System) independent, thus portable. GtkAda is a high level portable graphical toolkit based on the gtk+ toolkit and one of the official GNU toolkits. Additionally, GtkAda uses Ada95 features and supports Object Orientation. Another attractive feature of GtkAda is that it supports OpenGL.



Figure 27. GtkAda layered structure

There is no guarantee that the DOD will be using Windows NT or Linux, or any other operating system 5 years from now. Our program is designed to be and is hardware and software independent. This is an attractive feature that gives the DOD flexibility in operating system procurement, as well as, makes our code more maintainable and robust. Our code can be run on all of the following platforms:

- Linux/x86
- Linux/sparc
- Linux/ppc
- Solaris/sparc
- Solaris/x86
- Dec Unix
- SGI IRIX 6.5
- HP/UX
- NT 4.0
- Windows 2000

- Aix 4.3.2
- SCO UnixWare 7.1
- FreeBSD 3.2

5. GNU Visual Debugger (GVD)

GVD is a graphical front-end for the text based GDB debugger that is provided with the GNAT package. The GNU Visual Debugger enables you to see what is going on inside the program while it is executing, or what the program is doing when it crashes and where it crashes. During the preliminary stages of our research, GVD was not available for use. This required us to do Ada.Text_IO style debugging. If there were runtime errors, it was a requirement to insert dos based Print Lines, or Ada.Text_IO.Put_Line statements into the code in order to track down the procedure or function that the program was halting/crashing in. This was a very time consuming and tedious method of debugging. With the release of GVD, debugging became a much easier task. The debugger itself is very user friendly, it's style is consistent with any standard debugger that an accomplished programmer would be familiar with. GVD features of note include Open Core Dump, Edit Source, Attach to process, Detach process, Show call stack, show local variables, show arguments, show registers, examine memory, and simple task analysis.

GVD is a very simple debugger and does not take a lot of time to become familiar enough with to use. GVD has many advanced features like the ability to list the threads an executable is currently running by internal identifier, name, and status. Then the user can click on the thread and change the context variables, call stack, or source file.

The Call Stack Window gives you a list of frames that correspond to the current stack of execution for the current thread or task. By simple mouse click you can choose what information you want to display in the call stack window. By default the subprogram and parameters are displayed. The options to display frame number, program counter, and file location are available.

Overall, GVD was a very robust and usable tool. Attractive to students because of the wonderful price tag of being free, the quality of the product is on a much higher scale than the typical Freeware that floats around on the Internet. Our experience was

very positive. The only negative comment is that when using GtkAda graphics, it is sometimes difficult to step through line by line while within the graphics portions of the code and it often became necessary to run to specific points in the code, and then do step-by-step debugging. We would recommend this Visual Debugger front-end to anyone doing large or small Ada programs using the GNAT compiler.

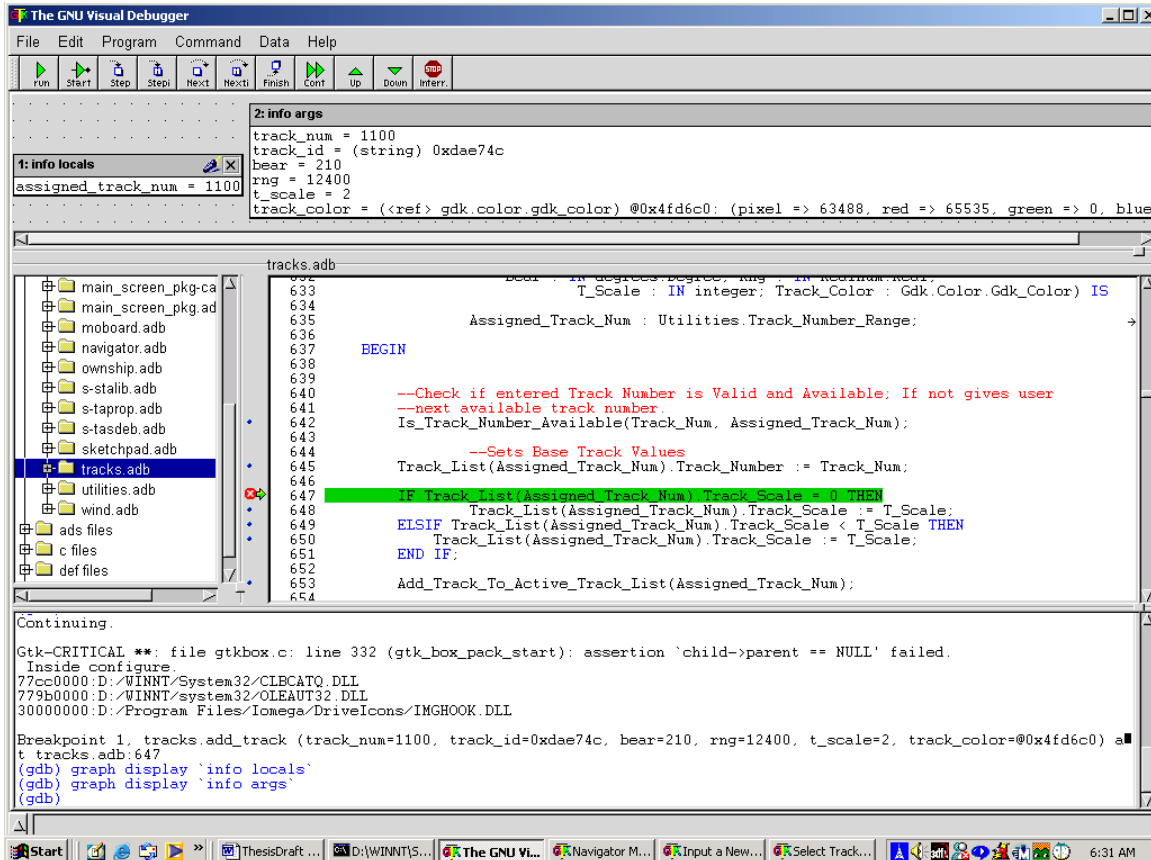


Figure 28. Screenshot of GVD Version 1.2.1

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IV. CONCLUSION

A. SUMMARY

The project began with a very simple idea. Take a proven method, known and understood by all Surface Warfare Officers and make the means by which the process is executed better. The Mboard is based on technology of the 1940s, we know the process works, and it has been time-tested over generations of sailors. The method of using pencil and paper is littered with points where even the most capable naval officer can make a mistake that can result in less than accurate answers. The paper-base process takes time to complete, and when given more than one contact to track, the problem becomes increasingly harder, especially when dealing with different range scales on a single Mboard.

What our program has done is change the medium by which the traditional Mboard is calculated. There is no doubt, that given a head-to-head match-up our program as accurate, if not more accurate than the paper version, and much faster. In our current version there is limited Artificial Intelligence that alerts the user when a contact will be coming closer than the Captains set standing order distance, or when a track is Constant Bearing Decreasing Range (CBDR). The project has the potential to grow into a much more intelligent program and there is a host of future work to be studied and worked on.

B. RECOMMENDATIONS FOR FUTURE WORK

Future work will include a set of additional views (an extensibility of our design). There are extensive areas of follow-on work. For this program to truly meet the needs of tomorrow's navy, continued and future research is required. We expect the project will evolve to incorporate (but not limited to) the following technologies:

1. GPS Integration

Our current implementation is in the development stages of receiving GPS via a computer COM port. These receivers are inexpensive and offer a high degree of accuracy. One of the tenants of our software design is to maintain platform portability, by remaining hardware and operating system independent. To date, we have been unable to design the system to be completely operating system independent due to the differences between how Windows NT based systems and Linux based systems handle COM ports. Future work will include building drivers and program integration that supports USB interfaces and designing for portability. Additionally, work on integrating shipboard based GPS systems is an additional avenue that could also be pursued in future research. Additionally, the integration of Wireless GPS connectivity in a shipboard environment (where a hard mounted GPS receiver broadcasts to a mobile platform and continuously updates a ship's position to the program) would make the system entirely mobile within the confines of the ship.

2. Radar Data Integration

When you discuss radar integration with any system, it is important to design your system to be able to integrate with any current or future radar. Our modular design will enable us to integrate easily and quickly with new and existing radar systems. There are two thought processes when we discuss radar integration. One system would maintain the "man in the loop" principle, and the other is a more automated system, similar to the SPY-1 radar system.

Considering radar integration with a man in the loop, the vision is a radar repeater similar to the SPA-25 where the actual "blip" or radar return is displayed on the scope. Our Mboard program would be the overlay on the repeater scope. When a new track is seen on the scope, the JOOD/OOD or whoever is designated as the operator takes a plastic pen device and clicks on the screen "New Contact" and then takes the pen and touches the screen where the radar video is. A hit symbol and all the info associated with that point is automatically displayed and it automatically calculates associated information. Then to track the contact, the operator simply selects the track they are interested in, and then marks a new position of the radar video. This automatically gives

the operator warnings and alerts for CBDR, vessels of high interest, rules of the road, and any vessel projected to be within the Captains standing distance.

The second avenue that radar integration could follow is a more automated system where the system detects, based on some level of sensitivity, a new contact, and automatically plots and calculates all associated information. This could also have automatically generated alerts and warnings. This could be an option on the program, either in manual mode or auto mode. The auto mode would still have the ability to add hits manually. The potential for extensive follow work exists in the area of Radar integration.

3. Touch screen displays

In a similar fashion, part of our usability studies resulted with feedback from Surface Warfare Officers who felt that the system and the idea were a great start, but to make the system even better we could replace the mouse or touch pad with a touch-screen. This would make the system more usable and easier to operate in “at-sea” conditions.

We envision a future system being completely touch-screen based. In this system the operator or user would not have to operate a mouse or touch pad. There is considerable work in applying touch-screen technology. The current system is modular enough that reprogramming would mesh well with the integration of touch-screens. The future work would include integrating touch-screens, developing the callbacks and new code to handle the different events from a touch-screen. Additionally, linking this work and technology with the integration of the radar video. The ultimate vision is a flat-screen display above the Commanding Officers chair on the bridge where the CO can instantly look up and get critical safety information related to the maneuvering of his/her ship. If the CO desires to get additional information or tunnel deeper into the problem, then he/she can simply pull the information with a touch of the screen.

4. Wireless LAN connectivity

Another area of work is Wireless LAN connectivity. Specifically we are talking about the connectivity of wireless data transfer internal to the ship. The work would be related to the Wireless portion of the LAN. That is, ensure that the LAN, barring hardware

failures, from a software viewpoint is error free and maintains continuous connectivity. For, example, if a Commanding Officer has a portable device, and the OOD sends a signal to notify the Captain that there is a contact of interest or contact report for him, the system must have a level of reliability that ensures that regardless of where the CO is onboard the ship, he will be guaranteed to receive those messages with some level of confidence. Additionally, there is work in design, coding, and implementation of the Ada modules that would handle the Wireless Network traffic and functionality.

5. Voice recognition technology

Extensive work remains in the area of Voice recognition technology. If in the future, a voice recognition system is implemented where the Conning Officer can wear a headset and give commands like “Right Standard Rudder” and the steering system simply responds, then this type of system must have 100 percent reliability and be zero error prone.

On a less critical level, the Automatic Deck Log could utilize voice recognition technology. In less scaled version of this design, the OOD or Conning officer would give the commands and voice recognition technology would automatically enter speed and course changes into the Automatic Deck Log as well as the Digital Moboard Computer. The voice commands would not be connected to the steering system directly, a Helmsman would still be “in the loop” per say, and respond to the commands and execute the order.

6. Mobile headset/communications

This area of research is closely related to the voice recognition technology, but focuses more on the area of headset usability, environment analysis of headset technology, and the suitability of those products in the shipboard environment. Additionally, research in the area of wireless headset communications, the reliability of those communications, maximum noise and distortion levels allowed while still maintaining the clarity and reliability required for continuous uninterrupted communications is required. Extensive work must be done testing this type of system to validate and verify its reliability. One of the most important aspects of maneuvering the ship is safety and reliability of any system. Before implementing this type of system, the

system must be thoroughly tested to demonstrate adequate data integrity and reliability to allow safety critical information to be transmitted via wireless communications.

7. Automated Deck Log

This research is a direct follow-on from our Digital Mboard program. The Deck Log should be written in Ada using the GNAT compiler and the GtkAda toolkit so that our original design of hardware and operating system portability, maintainability, extensibility are maintained with the additional functionality. The Automated Deck Log could be integrated with our Digital Mboard program in the following aspects. The Automated Deck Log would be a separated entity, a separate program that would maintain a log of events. The information could be entered via keyboard input, voice data entry, or stylis touch-screen type technology. The means by which the data or log entries are made is part of the follow-on research, but the design of the program should be modular enough that it does not matter how the data gets there, a standard interface and common protocol should be used. When either a speed or course is made in the Digital Mboard, a message would be sent to tell the Automatic Deck Log to make an entry, for example, "Course 183 Speed 13 knots." Customized entries could be made in the log. During watch turnover the oncoming and offgoing OODs could digitally sign with the stylis on the screen. At the end of the day, the deck logs would be backed up for permanent archives, and both the paper and digital version would be signed by the Commanding Officer.

8. Palm Pilot/CE devices providing information on demand

Imagine that you're the OOD underway; you have a contact that you have done a mboard on, and you need to call the Captain. The Captain is down in Engineering doing a Walkthrough, you have called, done an announcement on the IMC and still have not heard from the Captain. What do you do? The vision we forsee is a portable device that the Captain can carry on his belt with a graphical display that would display a mirror image of what the OOD sees on the bridge. When a contact of interest requires the Captain's attention, his/her portable device vibrates and/or beeps until he reviews the contact of interest and presses his approval of the OODs recommendation or sends the OOD a message saying, "Do this instead." Now that the CO has an instantaneous

graphical picture of the situation on the bridge; he/she can call the OOD and discuss the situation further if he/she feels necessary, or make his/her way to the bridge.

Research should include a comprehensive study on types of portable devices, from both a usability point of view to a functionality point of view. Additionally, research should be linked with the Wireless connectivity of those devices on a shipboard environment.

9. Integrated multiple views (FalconView, Heads-up displays, etc.)

Research in the area of developing and/or integrating multiple views of the track information that we have in our system could include: Integrating FalconView style programs. These programs will use the Latitude and Longitude information that Digital Mboard contains and display the track hits within FalconView so that the user can see the geographical location on a NIMA chart of both your own ship as well as any contacts that you are tracking via radar. Additional views or uses remain open to research; such studies include usability work on the best way to present data to the ship driver. Additional research can be done in the area of Heads-up display screens, 3-D Graphical representations, Holographic data representations, etc.

10. Ada enabled Applets for browsers exchange

Future work in this area would include enabling Ada Applets for Web based applications. This would include, the ability to pull information up from specific platforms to a web browser as well as tunnel down into the data that specified platforms have. This would allow the Battle Group Commander to view the “picture” that each ship has, or consolidate the data from each platform and display it in a web-based format.

11. Artificial Intelligent Maneuvering Modules

Our program contains the functionality to alert the OOD and CO when a contact will be within a set distance based upon the Commanding Officers Standing Orders. Future work includes more expert systems that generate signals for the OOD and/or CO that the designated contact will be within minimum distances set combined with maneuvering recommendations. The program should include functionality that gives the OOD recommendations based upon a standard Rules of the Road library. This library will alert the OOD/CO of important Rules of the Road and give recommended course and

speed changes based upon those rules and the Captains Standing Orders. The default being, maneuver the ship to maintain minimum set Closets Point of Approach (CPA). The computer program will also alert the OOD/CO if a course and/or speed change will affect the CPA of other contacts adversely or affect the safe navigation of the ship. These enhancements will be a guide/aid to the OOD/CO helping ensure safe navigation at sea thereby preventing collisions resultant to human-error, fatigue, or oversight.

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APPENDIX A. DIGITAL MOBOARD CODE

This appendix contains the object-oriented code of the Digital Moboard program. Included in this appendix are all of the .ads files used in our Object-orientated design.

The current version of the program is divided into twenty-two classes. Enclosed are the .ads files and the Main program start point Navigator.adb

A-1 DATES.ADS

```
--*****  
--| FILE: dates.ads  
--| AUTHOR: Joey L. Frantzen, Naval Post Graduate School  
--| LAST MODIFIED: 11 September 2001  
--| OPERATING ENVIRONMENT: Windows 2000(Designed to be O/S Independent)  
--| COMPILER: GNAT 3.13p  
--| DESCRIPTION: This class is an upgrade taken from Ada 95 Problem Solving and  
--| Program Design pg. 492 - 493, 2nd Edition, by Feldman & Koffmann.  
--| Specification for package to represent dates, Orig Author Michael B. Feldman  
--| The George Washing University wrote Get_Date_From_System(everything else is  
--| original work.  
--| INPUTS: Ada.Calendar  
--| OUTPUTS: Outputs based on what Functions are requested and run.  
--| Process: None to note  
--| Assumptions: N/A  
--| Warnings: None
```

--*****

WITH Ada.Calendar;

PACKAGE dates IS

TYPE Date_Type IS PRIVATE;

SUBTYPE Month_Number IS Ada.Calendar.Month_Number;

SUBTYPE Year_Number IS Ada.Calendar.Year_Number;

SUBTYPE Day_Number IS Ada.Calendar.Day_Number;

Date_Error : EXCEPTION;

--*****

--| Function: Get_Date_String_From_Number

--| Input: Month Number

--| Output: Returns String related to Inputted Number Date

--| Description: Input of a Month Number 1-12 and returns a string

--| associated with that date. Example Number One Inputted returns String

--|"January"

--*****

FUNCTION Get_Date_String_From_Number(M : IN Integer) RETURN String;

--*****

```

--| Function: Get_Date_From_System
--| Input: Year, Month, Day
--| Output: Returns a Date_Type; analogous to Ada.Calendar.Clock
--| Warnings: Date_Error if the year, month, day triple do not
--| form a valid date (Feb 30th, for example)
--| Analogous to Ada.Calendar.Time_Of
--*****
FUNCTION Get_Date_From_System RETURN Date_Type;

--*****

--| Procedure: Set_Date
--| Input: Year_Number, Month_Number, Day_Number, Date_Type
--| Output: Date_Type
--| Description: Sets Year, Month, and Day into Date_Type
--| Warnings: None
--*****
PROCEDURE Set_Date( D : IN Day_Number; M : IN Month_Number;
                   Y : IN Year_Number;
                   Dat: IN OUT Date_Type);

--*****

--| Procedure: Set_Month
--| Input: Month_Number, Date_Type
--| Output: Date_Type

```

```

--| Description: Sets Year into Date_Type
--| Warnings: None
--*****
PROCEDURE Set_Month(M : IN Month_Number; Dat : IN OUT Date_Type);

--*****

--| Procedure: Set_Day
--| Input: Day_Number, Date_Type
--| Output: Date_Type
--| Description: Sets Day into Date_Type
--| Warnings: None
--*****
PROCEDURE Set_Day(D : IN Day_Number; Dat : IN OUT Date_Type);

--*****

--| Procedure: Set_Year
--| Input: Year_Number, Date_Type
--| Output: Date_Type
--| Description: Sets Year into Date_Type
--| Warnings: None
--*****
PROCEDURE Set_Year(Y : IN Year_Number; Dat : IN OUT Date_Type);

--*****

```



```

--| Function: Get_Date
--| Input: Date_Type
--| Output: Date_Type
--| Description: Returns a Date_Type value
--| Warnings: None
--*****
FUNCTION Get_Date(D : Date_Type) RETURN Date_Type;

--*****

--| Function: Get_Month
--| Input: Date_Type
--| Output: Month_Number
--| Description: Returns a integer value
--| Warnings: None
--*****
FUNCTION Get_Month(D : Date_Type) RETURN integer;

--*****

--| Function: Get_Day
--| Input: Date_Type
--| Output: Dat_Number
--| Description: Returns a integer value
--| Warnings: None
--*****

```

```
FUNCTION Get_Day(D : Date_Type) RETURN integer;
```

```
--*****
```

```
--| Function: Get_Year
```

```
--| Input: Date_Type
```

```
--| Output: Year_Number
```

```
--| Description: Returns a integer value
```

```
--| Warnings: None
```

```
--*****
```

```
FUNCTION Get_Year(D : Date_Type) RETURN integer;
```

```
PRIVATE
```

```
TYPE Date_Type IS RECORD
```

```
    Month : Month_Number := Ada.Calendar.Month(Ada.Calendar.Clock);
```

```
    Day : Day_Number := Ada.Calendar.Day(Ada.Calendar.Clock);
```

```
    Year : Year_Number := Ada.Calendar.Year(Ada.Calendar.Clock);
```

```
END RECORD;
```

```
END dates;
```

A-2 TIME.ADS

--*****

--| FILE: Time.ads

--| AUTHOR: Joey L. Frantzen, Naval Post Graduate School

--| LAST MODIFIED: 11 September 2001

--| OPERATING ENVIRONMENT: Windows 2000(Designed to be O/S Independent)

--| COMPILER: GNAT 3.13p

--| DESCRIPTION: This class is contains all of the data types and

--| functionality to manipulate and type record Time

--| INPUTS: N/A

--| OUTPUTS: Outputs based on what Functions are requested and run.

--| Process: None to note

--| Assumptions: N/A

--| Warnings: None

--*****

PACKAGE times IS

TYPE Time_Type IS PRIVATE;

--*****

```

--| Function: Get_Time_Of_Day()
--| Input: None
--| Output: Current Time from Ada.Calendar.Clock in a Time_Type
--| Process: Finds today's Time and returns it as a record of type Time
--|
--|           Today's Time is gotten from PACKAGE Ada.Calendar
--*****
FUNCTION Get_Time_Of_Day RETURN Time_Type;

--*****

--| Procedure: Set_Time
--| Input: Hour, Minutes, Seconds, Time_Type
--| Output: Time_Type
--| Description: Sets Hour, Minutes, and Seconds into Time_Type
--| Warnings: None
--*****
PROCEDURE Set_Time(Hr : IN Integer; Min : IN Integer; Sec : IN Integer;
                  T: IN OUT Time_Type);

--*****

--| Procedure: Set_Hours
--| Input: Hour, Time_Type
--| Output: Time_Type
--| Description: Sets Hours into Time_Type
--| Warnings: None

```

--*****

PROCEDURE Set_Hours(Hr : IN Integer; T : IN OUT Time_Type);

--*****

--| Procedure: Set_Mins

--| Input: Minutes, Time_Type

--| Output: Time_Type

--| Description: Sets Mintues into Time_Type

--| Warnings: None

--*****

PROCEDURE Set_Mins(Min : IN Integer; T : IN OUT Time_Type);

--*****

--| Procedure: Set_Secs

--| Input: Seconds, Time_Type

--| Output: Time_Type

--| Description: Sets Seconds into Time_Type

--| Warnings: None

--*****

PROCEDURE Set_Secs(Sec : IN Integer; T : IN OUT Time_Type);

--*****

--| Function: Get_Time

--| Input: Time_Type

```

--| Output: Time_Type

--| Description: Returns Time_Type

--| Warnings: None

--*****

FUNCTION Get_Time(T : Time_Type) RETURN Time_Type;

--*****

--| Function: Get_Hours

--| Input: Time_Type

--| Output: Integer(Hours)

--| Description: Returns an Integer from Time_Type(Hours)

--| Warnings: None

--*****

FUNCTION Get_Hours(T: Time_Type) RETURN Integer;

--*****

--| Function: Get_Mins

--| Input: Time_Type

--| Output: Integer(Minutes)

--| Description: Returns an Integer from Time_Type(Minutes)

--| Warnings: None

--*****

FUNCTION Get_Mins(T : Time_Type) RETURN Integer;

```

--*****

--| Function: Get_Secs

--| Input: Time_Type

--| Output: Integer(Seconds)

--| Description: Returns an Integer from Time_Type(Seconds)

--| Warnings: None

--*****

FUNCTION Get_Secs(T : Time_Type) RETURN Integer;

PRIVATE

TYPE Time_Type IS RECORD

Hours : Integer RANGE 0..24 := 0;

Mins : Integer RANGE 0..59 := 0;

Secs : Integer RANGE 0..59 := 0;

END RECORD;

END times;

A-3 HIT.ADS

--*****

--| FILE: Hit.ads

--| AUTHOR: Joey L. Frantzen, Naval Post Graduate School
--| LAST MODIFIED: 11 September 2001
--| OPERATING ENVIRONMENT: Windows 2000(Designed to be O/S Independent)
--| COMPILER: GNAT 3.13p
--| DESCRIPTION: This class is contains all of the data types and
--| functionality for a specific data point(or Hit) taken from manual
--| or auto input.
--| INPUTS: N/A
--| OUTPUTS: Outputs based on what Functions are requested and run.
--| Process: None to note
--| Assumptions: N/A
--| Warnings: None

--*****

WITH lat_long;

WITH dates;

WITH times;

WITH Realnum;

WITH degrees;

WITH speeds;

WITH ownship;

PACKAGE hit IS

TYPE Hits IS PRIVATE;

--TIME PROCEDURES and FUNCTIONS *****

--*****

--| Procedure: Set_Hit_Time

--| Input: Hour, Minute, Seconds(all type Integer), Hit_Type

--| Output: Hit_Type

--| Description: Saves Hour, Minute and Seconds into Hit_Type.T_ime

--*****

PROCEDURE Set_Hit_Time(Hr : IN Integer; Min : IN Integer; Sec : IN Integer;
 H : IN OUT Hits);

--*****

--| Procedure: Set_Hit_Time

--| Input: Time_Type, Hit_Type

--| Output: Hit_Type

--| Description: Saves Time_Type into Hit_Type.T_ime

--*****

PROCEDURE Set_Hit_Time(T_ime : IN times.Time_Type; H : IN OUT Hits);

--*****

--| Procedure: Set_Hit_Hours

```

--| Input: Hours(integer), Hit_Type
--| Output: Hit_Type
--| Description: Saves Hours into Hit_Type.T_ime
__*****
PROCEDURE Set_Hit_Hours(Hr : IN Integer; H : IN OUT Hits);

__*****

--| Procedure: Set_Hit_Mins
--| Input: Minutes(integer), Hit_Type
--| Output: Hit_Type
--| Description: Saves Minutes into Hit_Type.T_ime
__*****

PROCEDURE Set_Hit_Mins(Min : IN Integer; H : IN OUT Hits);

__*****

--| Procedure: Set_Hit_Secs
--| Input: Seconds(integer), Hit_Type
--| Output: Hit_Type
--| Description: Saves Seconds into Hit_Type.T_ime
__*****

PROCEDURE Set_Hit_Secs(Sec : IN Integer; H : IN OUT Hits);

__*****

--| Function: Get_Hit_Time

```

```

--| Input: Hit_Type
--| Output: Time_Type
--| Description: Returns Hit_Type.T_ime Value of inputed Hit_Type
__*****

FUNCTION Get_Hit_Time(H : Hits) RETURN times.Time_Type;

__*****

--| Function: Get_Hit_Hours
--| Input: Hit_Type
--| Output: Integer
--| Description: Returns Integer Value(Hours) of inputed Hit_Type.T_ime
__*****

FUNCTION Get_Hit_Hours(H: Hits) RETURN Integer;

__*****

--| Function: Get_Hit_Mins
--| Input: Hit_Type
--| Output: Integer
--| Description: Returns Integer Value(Minutes) of inputed Hit_Type.T_ime
__*****

FUNCTION Get_Hit_Mins(H : Hits) RETURN Integer;

__*****

--| Function: Get_Hit_Secs

```

```

--| Input: Hit_Type
--| Output: Integer
--| Description: Returns Integer Value(Seconds) of inputed Hit_Type.T_ime
--*****
FUNCTION Get_Hit_Secs(H : Hits) RETURN Integer;

```

```

--DATE PROCEDURE and FUNCTIONS*****

```

```

--*****
--| Procedure: Set_Hit_Date
--| Input: Day_Number, Month_Number, Year_Number, Hit_Type
--| Output: Hit_Type
--| Description: Saves Day, Month and Year into Hit_Type.Dat
--*****
PROCEDURE Set_Hit_Date(D : IN dates.Day_Number; M : IN dates.Month_Number;
                      Y : IN dates.Year_Number; H: IN OUT Hits);

```

```

--*****
--| Procedure: Set_Hit_Date
--| Input: Date_Type, Hit_Type
--| Output: Hit_Type
--| Description: Saves Date_Type into Hit_Type.Dat

```

__*****

PROCEDURE Set_Hit_Date(D : IN dates.Date_Type; H: IN OUT Hits);

__*****

--| Procedure: Set_Hit_Month

--| Input: Month_Number, Hit_Type

--| Output: Hit_Type

--| Description: Saves Month into Hit_Type.Dat

__*****

PROCEDURE Set_Hit_Month(M : IN dates.Month_Number; H : IN OUT Hits);

__*****

--| Procedure: Set_Hit_Day

--| Input: Day_Number, Hit_Type

--| Output: Hit_Type

--| Description: Saves Day into Hit_Type.Dat

__*****

PROCEDURE Set_Hit_Day(D : IN dates.Day_Number; H : IN OUT Hits);

__*****

--| Procedure: Set_Hit_Year

--| Input: Year_Number, Hit_Type

--| Output: Hit_Type

--| Description: Saves Year into Hit_Type.Dat

--*****

PROCEDURE Set_Hit_Year(Y : IN dates.Year_Number; H : IN OUT Hits);

--*****

--| Function: Get_Hit_Date

--| Input: Hit_Type

--| Output: Date_Type

--| Description: Returns Hit_Type.Dat Value of inputed Hit_Type

--*****

FUNCTION Get_Hit_Date(H : Hits) RETURN dates.Date_Type;

--*****

--| Function: Get_Hit_Month

--| Input: Hit_Type

--| Output: Month_Number

--| Description: Returns Month Value of inputed Hit_Type.Dat

--*****

FUNCTION Get_Hit_Month(H : Hits) RETURN dates.Month_Number;

--*****

--| Function: Get_Hit_Day

--| Input: Hit_Type

--| Output: Day_Number

--| Description: Returns Day Value of inputed Hit_Type.Dat

--*****

FUNCTION Get_Hit_Day(H : Hits) RETURN dates.Day_Number;

--*****

--| Function: Get_Hit_Year

--| Input: Hit_Type

--| Output: Year_Number

--| Description: Returns Year Value of inputed Hit_Type.Dat

--*****

FUNCTION Get_Hit_Year(H : Hits) RETURN dates.Year_Number;

--SET and GET HIT_LATITUDE PROCEDURE and FUNCTIONS*****

--*****

--| Procedure: Set_Hit_Latitude

--| Input: Degree, Minute, Seconds, Hemisphere Sign, Hit_Type

--| Output: Hit_Type

--| Description: Saves Degree, Minute, Seconds, and Hemisphere into Hit_Type.Lat

--*****

PROCEDURE Set_Hit_Latitude(D : IN Integer; M : IN Integer; S : IN Integer;

Sign : IN Character; H: IN OUT Hits);

--*****

--| Procedure: Set_Hit_Latitude

```

--| Input: Latitude Type, Hit_Type
--| Output: Hit_Type
--| Description: Saves Latitude Type into Hit_Type.Lat
__*****
PROCEDURE Set_Hit_Latitude(Lat : IN lat_long.Latitude; H: IN OUT Hits);

__*****

--| Procedure: Set_Hit_Lat_Deg
--| Input: Degree, Hit_Type
--| Output: Hit_Type
--| Description: Saves Degree into Hit_Type.Lat
__*****
PROCEDURE Set_Hit_Lat_Deg(D : IN Integer; H : IN OUT Hits);

__*****

--| Procedure: Set_Hit_Lat_Min
--| Input: Minutes, Hit_Type
--| Output: Hit_Type
--| Description: Saves Minutes into Hit_Type.Lat
__*****
PROCEDURE Set_Hit_Lat_Min(M : IN Integer; H : IN OUT Hits);

__*****

--| Procedure: Set_Hit_Lat_Sec

```



```

--| Input: Seconds, Hit_Type
--| Output: Hit_Type
--| Description: Saves Seconds into Hit_Type.Lat
__*****

PROCEDURE Set_Hit_Lat_Sec(S : IN Integer; H : IN OUT Hits);

__*****

--| Procedure: Set_Hit_Lat_Sign
--| Input: Sign, Hit_Type
--| Output: Hit_Type
--| Description: Saves Hemisphere Sign into Hit_Type.Lat
__*****

PROCEDURE Set_Hit_Lat_Sign(Sign : IN Character; H : IN OUT Hits);

__*****

--| Function: Get_Hit_Latitude
--| Input: Hit_Type
--| Output: Latitude Type
--| Description: Returns Latitude Value of inputed Hit_Type.Lat
__*****

FUNCTION Get_Hit_Latitude(H : Hits) RETURN lat_long.Latitude;

__*****

--| Function: Get_Hit_Lat_Deg

```

```

--| Input: Hit_Type
--| Output: Latitude Degree(Integer)
--| Description: Returns Latitude Degree Value of inputed Hit_Type.Lat
__*****
FUNCTION Get_Hit_Lat_Deg(H : Hits) RETURN Integer;

__*****

--| Function: Get_Hit_Lat_Min
--| Input: Hit_Type
--| Output: Latitude Minute(Integer)
--| Description: Returns Latitude Minute Value of inputed Hit_Type.Lat
__*****

FUNCTION Get_Hit_Lat_Min(H : Hits) RETURN Integer;

__*****

--| Function: Get_Hit_Lat_Sec
--| Input: Hit_Type
--| Output: Latitude Seconds(Integer)
--| Description: Returns Latitude Seconds Value of inputed Hit_Type.Lat
__*****

FUNCTION Get_Hit_Lat_Sec(H : Hits) RETURN Integer;

__*****

--| Function: Get_Hit_Lat_Sign

```

```

--| Input: Hit_Type
--| Output: Latitude Hemisphere Sign(Character)
--| Description: Returns Latitude Hemisphere Sign Value of inputed Hit_Type.Lat
__*****

FUNCTION Get_Hit_Lat_Sign(H : Hits) RETURN Character;

--SET and GET HIT_LONGITUDE PROCEDURE and FUNCTIONS*****

__*****

--| Procedure: Set_Hit_Longitude
--| Input: Degree, Minute, Seconds, Hemisphere Sign, Hit_Type
--| Output: Hit_Type
--| Description: Saves Degree, Minute, Seconds, and Hemisphere into -- ----
--| Hit_Type.Lon
__*****

PROCEDURE Set_Hit_Longitude(D : IN Integer; M : IN Integer; S : IN Integer;
                           Sign : IN Character; H: IN OUT Hits);

__*****

--| Procedure: Set_Hit_Longitude
--| Input: Longitude Type, Hit_Type
--| Output: Hit_Type
--| Description: Saves Longitude Type into Hit_Type.Lat

```

__*****

```
PROCEDURE Set_Hit_Longitude(Lon : IN lat_long.Longitude;
                             H: IN OUT Hits);
```

__*****

```
--| Procedure: Set_Hit_Long_Deg
--| Input: Degree, Hit_Type
--| Output: Hit_Type
--| Description: Saves Degree into Hit_Type.Lon
```

__*****

```
PROCEDURE Set_Hit_Long_Deg(D : IN Integer; H : IN OUT Hits);
```

__*****

```
--| Procedure: Set_Hit_Long_Min
--| Input: Minute, Hit_Type
--| Output: Hit_Type
--| Description: Saves Minute into Hit_Type.Lon
```

__*****

```
PROCEDURE Set_Hit_Long_Min(M : IN Integer; H : IN OUT Hits);
```

__*****

```
--| Procedure: Set_Hit_Long_Sec
--| Input: Seconds, Hit_Type
--| Output: Hit_Type
```

```

--| Description: Saves Seconds into Hit_Type.Lon
__*****

PROCEDURE Set_Hit_Long_Sec(S : IN Integer; H : IN OUT Hits);

__*****

--| Procedure: Set_Hit_Long_Sign
--| Input: Hemisphere Sign, Hit_Type
--| Output: Hit_Type
--| Description: Saves Hemisphere Sign into Hit_Type.Lon
__*****

PROCEDURE Set_Hit_Long_Sign(Sign : IN Character; H : IN OUT Hits);

__*****

--| Function: Get_Hit_Longitude
--| Input: Hit_Type
--| Output: Longitude Type
--| Description: Returns Longitude Value of inputed Hit_Type.Lon
__*****

FUNCTION Get_Hit_Longitude(H : Hits) RETURN lat_long.Longitude;

__*****

--| Function: Get_Hit_Long_Deg
--| Input: Hit_Type
--| Output: Longitude Degree(Integer)

```

```

--| Description: Returns Longitude Degree Value of inputed Hit_Type.Lon
__*****

FUNCTION Get_Hit_Long_Deg(H : Hits) RETURN Integer;

__*****

--| Function: Get_Hit_Long_Min
--| Input: Hit_Type
--| Output: Longitude Minute(Integer)
--| Description: Returns Longitude Minute Value of inputed Hit_Type.Lon
__*****

FUNCTION Get_Hit_Long_Min(H : Hits) RETURN Integer;

__*****

--| Function: Get_Hit_Long_Sec
--| Input: Hit_Type
--| Output: Longitude Seconds(Integer)
--| Description: Returns Longitude Seconds Value of inputed Hit_Type.Lon
__*****

FUNCTION Get_Hit_Long_Sec(H : Hits) RETURN Integer;

__*****

--| Function: Get_Hit_Long_Sign
--| Input: Hit_Type
--| Output: Longitude Sign(Character)

```

```

--| Description: Returns Longitude Hemisphere Sign Value of inputed
--| Hit_Type.Lon
__*****

FUNCTION Get_Hit_Long_Sign(H : Hits) RETURN Character;

--SET and GET BEARING PROCEDURE and FUNCTIONS*****

__*****

--| Procedure: Set_Hit_Bearing
--| Input: Bearing, Hit_Type
--| Output: Hit_Type
--| Description: Sets Hit Bearing in Hit_Type to Inputed Value
__*****

PROCEDURE Set_Hit_Bearing(Bear : IN degrees.Degree; H : IN OUT Hits);

__*****

--| Function: Get_Hit_Bearing
--| Input: Hit_Type
--| Output: Bearing (Realnum.Real)
--| Description: Returns Bearing Degree Value of inputed Hit_Type
__*****

FUNCTION Get_Hit_Bearing(H : Hits) RETURN Realnum.Real;

--SET and GET RANGE PROCEDURE and FUNCTIONS*****

```

--*****

--| Procedure: Set_Hit_Range

--| Input: Range, Hit_Type

--| Output: Hit_Type

--| Description: Sets Hit Range in Hit_Type to Inputed Value

--*****

PROCEDURE Set_Hit_Range(Rng : IN Realnum.Real; H : IN OUT Hits);

--*****

--| Function: Get_Hit_Range

--| Input: Hit_Type

--| Output: Range (Realnum.Real)

--| Description: Returns Range Value of inputed Hit_Type

--*****

FUNCTION Get_Hit_Range(H : Hits) RETURN Realnum.Real;

--SET and GET OWNSHIP_CSE PROCEDURE and FUNCTIONS*****

--*****

--| Procedure: Set_Hit_OwnShip_Cse

--| Input: Course, Hit_Type

--| Output: Hit_Type

--| Description: Sets OwnShip Course into Hit_Type to Inputed Value

--*****

PROCEDURE Set_Hit_OwnShip_Cse(Course : in degrees.Degree; H : IN OUT Hits);

--*****

--| Function: Get_Hit_OwnShip_Cse

--| Input: Hit_Type

--| Output: OwnShip Course(Realnum.Real)

--| Description: Returns OwnShip Course Value of inputed Hit_Type

--*****

FUNCTION Get_Hit_OwnShip_Cse(H : Hits) RETURN Realnum.Real;

--SET and GET TARGET_CSE PROCEDURE and FUNCTIONS*****

--*****

--| Procedure: Set_Hit_Target_Cse

--| Input: Course, Hit_Type

--| Output: Hit_Type

--| Description: Sets Target Course into Hit_Type to Inputed Value

--*****

PROCEDURE Set_Hit_Target_Cse(Course : in degrees.Degree; H : IN OUT Hits);

--*****

--| Function: Get_Hit_Target_Cse

--| Input: Hit_Type

```

--| Output: Target Course(Realnum.Real)
--| Description: Returns Target Course Value of inputed Hit_Type
__*****
FUNCTION Get_Hit_Target_Cse(H : Hits) RETURN Realnum.Real;

--SET and GET OWNSHIP_SPEED PROCEDURE and FUNCTIONS*****

__*****

--| Procedure: Set_Hit_OwnShip_Speed
--| Input: Speed, Hit_Type
--| Output: Hit_Type
--| Description: Sets OwnShip Speed into Hit_Type to Inputed Value
__*****

PROCEDURE Set_Hit_OwnShip_Speed(Spd : IN speeds.Speed; H : IN OUT Hits);

__*****

--| Function: Get_Hit_OwnShip_Speed
--| Input: Hit_Type
--| Output: OwnShip Speed(Realnum.Real)
--| Description: Returns OwnShip Speed Value of inputed Hit_Type
__*****

FUNCTION Get_Hit_OwnShip_Speed(H : Hits) RETURN Realnum.Real;

--SET and GET HIT COUNTER PROCEDURE and FUNCTIONS*****

```

--*****

--| Procedure: Set_Hit_Counter

--| Input: Counter, Hit_Type

--| Output: Hit_Type

--| Description: Sets Counter into Hit_Type to Inputed Value

--*****

PROCEDURE Set_Hit_Counter(Counter : IN integer; H : IN OUT Hits);

--*****

--| Function: Get_Hit_Counter

--| Input: Hit_Type

--| Output: Hit Counter(Integer)

--| Description: Returns Hit Counter Value of inputed Hit_Type

--*****

FUNCTION Get_Hit_Counter(H : Hits) RETURN integer;

--SET and GET TARGET_SPEED PROCEDURE and FUNCTIONS*****

--*****

--| Procedure: Set_Hit_Target_Speed

--| Input: Target Speed, Hit_Type

--| Output: Hit_Type

```

--| Description: Sets Target Speed into Hit_Type to Inputed Value
__*****

PROCEDURE Set_Hit_Target_Speed(Spd : IN speeds.Speed; H : IN OUT Hits);

__*****

--| Function: Get_Hit_Target_Speed

--| Input: Hit_Type

--| Output: Target Speed(Realnum.Real)

--| Description: Returns Hit Target Speed Value of inputed Hit_Type
__*****

FUNCTION Get_Hit_Target_Speed(H : Hits) RETURN Realnum.Real;

__*****

--| Procedure: Calc_Hit_Target_Angle

--| Input: Hit_Type

--| Output: None

--| Description: Calculates Target Angle based on inputed Hit current Bearing
--| and Course. Once it calculates Target Angle the algorithm then saves it
--| into Hit.Target_Angle
__*****

PROCEDURE Calc_Hit_Target_Angle(H : IN OUT Hits);

__*****

--| Procedure: Set_Hit_Target_Angle

```

```

--| Input: Target Angle, Hit_Type
--| Output: Hit_Type
--| Description: Sets Target Angle into Hit_Type to Inputed Value
--*****
PROCEDURE Set_Hit_Target_Angle(Target_Angle : IN degrees.Degree;
                               H : IN OUT Hits);

--*****

--| Function: Get_Hit_Target_Angle
--| Input: Hit_Type
--| Output: Target Angle(degrees.Degree)
--| Description: Returns Hit Target Angle Value of inputed Hit_Type
--*****
FUNCTION Get_Hit_Target_Angle(H : Hits) RETURN degrees.Degree;

--*****CALC_HIT_LAT_LONG*****

--*****

--| Procedure: Calc_Hit_Lat_Long
--| Input: Hit_Type
--| Output: None
--| Description: Calculates Latitude and Longitude of the inputed Hit based on
--| Bearing and Range and OwnShips Lat/Long. This Procedures calls
--| lat_long.Calc_Lat_Long procedure to calculates the new lat/long.

```

__*****

```
PROCEDURE Calc_Hit_Lat_Long (Lat1 : IN lat_long.Latitude;  
                             Long1 : IN lat_long.Longitude; H : IN OUT Hits);
```

PRIVATE

TYPE Hits IS RECORD

```
    Bear: degrees.Degree := 0.0;  
    Rng : Realnum.Real := 0.0; --Stored in Yards  
    Lat : lat_long.Latitude;  
    Lon : lat_long.Longitude;  
    Dat : dates.Date_Type := dates.Get_Date_From_System;  
    T_ime: times.Time_Type := times.Get_Time_Of_Day;  
    Target_Cse : degrees.Degree := 0.0;  
    OwnShip_Cse : degrees.Degree := 0.0;  
    Target_Speed : speeds.Speed := 0.0;  
    OwnShip_Speed : speeds.Speed := 0.0;  
    Target_Angle : degrees.Degree := 0.0;  
    Hit_Counter : integer := 0;
```

END RECORD;

END hit;

A-4 REALNUM.ADS

```
--*****  
  
--| File : realnum.ads  
  
--| Purpose : This file defines a Real type that has precision of digits 12.  
  
--| This also uses the Generic Elementary Functions for all Real Types  
  
--*****
```

```
WITH Ada.Numerics.Generic_Elementary_Functions;
```

```
WITH Ada.Numerics;
```

```
USE Ada.Numerics;
```

```
PACKAGE Realnum IS
```

```
TYPE Real IS DIGITS 12;
```

```
PACKAGE Real_Functions IS
```

```
    NEW Generic_Elementary_Functions(Real);
```

```
END Realnum;
```

A-5 SPEEDS.ADS

```
--*****  
  
--| File : speeds.ads  
  
--| Purpose : This file defines a type Speed that is of Realnum.Real with digits  
  
--| 1 precision and a range of 0.0 to 1000.0 knots
```

--*****

WITH Realnum; USE Realnum;

PACKAGE speeds IS

SUBTYPE Speed IS Real DIGITS 1 RANGE 0.0..1000.0;

-- Max speed set to 1000.0 Knots;

-- this is designed this way because our program is designed to track

-- surface/subsurface contacts, and possibly helicopters. This upper range is

-- set because a user could input a wrong bearing that causes the speed

-- calculated to go outside normal reasonable knots.

END speeds;

A-6 DEGREES.ADS

--*****

--| File : degrees.ads

--| Purpose : This file defines a type Degree that is of Realnum.Real type with

--| a precision of digits one and range of 0.0 to 359.9

--*****

WITH Realnum; USE Realnum;

PACKAGE degrees IS

SUBTYPE Degree IS Real DIGITS 1 RANGE 0.0..359.9;

END degrees;

A-7 OWNSHIP.ADS

--*****

--| FILE: ownship.ads

--| AUTHOR: Joey L. Frantzen, Naval Post Graduate School

--| LAST MODIFIED: 11 September 2001

--| OPERATING ENVIRONMENT: Windows 2000(Designed to be O/S Independent)

--| COMPILER: GNAT 3.13p

--| DESCRIPTION: This class is contains all of the data types and

--| functionality for your ownship.

--| INPUTS: N/A

--| OUTPUTS: Outputs based on what Functions are requested and run.

--| Process: None to note

--| Assumptions: N/A

--| Warnings: None

--*****

WITH lat_long;

WITH degrees;

```
WITH speeds;
WITH Utilities;
WITH file_io;
WITH historical_io;
WITH times;
WITH Ada.Strings.Fixed;
```

```
PACKAGE ownship is
```

```
--*****
```

```
--| Procedure: Init_OwnShip
```

```
--| Input: OS Number, OS Id, OS Course, OS Speed, Latitude, Longitude
```

```
--| Output: None
```

```
--| Description: Initializes and sets all inputed values into Ownship record
```

```
--*****
```

```
PROCEDURE Init_OwnShip(OS_Number : IN integer; OS_Id : IN String;
```

```
OS_Cse : IN degrees.Degree; OS_Speed : IN speeds.Speed;
```

```
Lat1 : IN lat_long.Latitude; Long1 : IN lat_long.Longitude);
```

```
--Eventually LAT/LONG will be pulled from either Manual/GPS entry
```

```
--For now will pass in manually
```

```
--*****
```

```
--| Function: Reset_OwnShip
```

```

--| Input: None

--| Output: Boolean

--| Description: Resets all inputted values into Ownship record(Zero's Out)
--*****
FUNCTION Reset_Ownship RETURN Boolean;

--*****

--| Procedure: Set_OwnShip_Number

--| Input: Integer

--| Output: None

--| Description: Sets Ownship Number into Ownship record Ownship_Number
--*****

PROCEDURE Set_OwnShip_Number(OS_Number : IN integer);

--*****

--| Function: Get_OwnShip_Number

--| Input: None

--| Output: Integer

--| Description: Gets Ownship Number info from Ownship record Ownship_Number
--*****

FUNCTION Get_OwnShip_Number RETURN integer;

--*****

--| Procedure: Set_OwnShip_Id

```

```

--| Input: String

--| Output: None

--| Description: Sets Ownship Number into Ownship record Ownship_Id
--*****

PROCEDURE Set_OwnShip_Id(OS_Id : IN String);

--*****

--| Function: Get_OwnShip_Id

--| Input: None

--| Output: String

--| Description: Gets Ownship Id info from Ownship record Ownship_Id
--*****

FUNCTION Get_OwnShip_Id RETURN string;

--*****

--| Procedure: Set_OwnShip_Cse

--| Input: Course (degrees.degree)

--| Output: None

--| Description: Sets Ownship Course into Ownship record Ownship_Cse
--*****

PROCEDURE Set_OwnShip_Cse(OS_Cse : IN degrees.Degree);

--*****

--| Function: Get_OwnShip_Cse

```

```

--| Input: None

--| Output: degrees.Degree(Course)

--| Description: Gets Ownship Course info from Ownship record Ownship_Cse
__*****

FUNCTION Get_OwnShip_Cse RETURN degrees.Degree;

__*****

--| Procedure: Set_OwnShip_Speed

--| Input: Speed (speeds.Speed)

--| Output: None

--| Description: Sets Ownship Speed into Ownship record Ownship_Speed
__*****

PROCEDURE Set_OwnShip_Speed(OS_Speed : IN speeds.Speed);

__*****

--| Function: Get_OwnShip_Speed

--| Input: None

--| Output: speeds.Speed(Speed)

--| Description: Gets Ownship Speed info from Ownship record Ownship_Speed
__*****

FUNCTION Get_OwnShip_Speed RETURN speeds.Speed;

__*****

--| Procedure: Set_OwnShip_Lat

```

```

--| Input: Degrees, Minutes, Seconds, Hemisphere Sign

--| Output: None

--| Description: Sets Ownship Latitude into Ownship record Ownship_Lat
__*****

PROCEDURE Set_OwnShip_Lat(D : IN lat_long.Lat_Degree; M: IN lat_long.Min_utes;
                        S : IN lat_long.Sec_onds; Sign : IN Character);

__*****

--| Function: Get_OwnShip_Lat

--| Input: None

--| Output: lat_long.Latitude

--| Description: Gets Ownship Latitude info from Ownship record Ownship_Lat
__*****

FUNCTION Get_OwnShip_Lat RETURN lat_long.Latitude;

__*****

--| Procedure: Set_OwnShip_Long

--| Input: Degrees, Minutes, Seconds, Hemisphere Sign

--| Output: None

--| Description: Sets Ownship Longitude into Ownship record Ownship_Lon
__*****

PROCEDURE Set_OwnShip_Long(D : IN lat_long.Long_Degree;
                          M : IN lat_long.Min_utes;
                          S : IN lat_long.Sec_onds; Sign : IN Character);

```

```

--*****
--| Function: Get_OwnShip_Long
--| Input: None
--| Output: lat_long.Longitude
--| Description: Gets Ownship Longitude info from Ownship record Ownship_Lon
--*****
FUNCTION Get_OwnShip_Long RETURN lat_long.Longitude;

```

```

--*****
--| Procedure: Load_OwnShip_Data
--| Input: OwnShip_Data Type
--| Output: None
--| Description: Sets Ownship Data Type info into Ownship record
--*****
PROCEDURE Load_Ownship_Data(Ownship_Data : IN file_io.OS_Data_Type);

```

```

TYPE own_ship IS RECORD

    OwnShip_Number : integer := 0; --Set to Hull Number/Associated Number

    OwnShip_Ident : String(1..20) := Utilities.Get_Default_String;
                                --max length is 20 characters

    OwnShip_Cse : degrees.Degree := 0.0;

    OwnShip_Speed : speeds.Speed := 0.0; --Expressed in Knots

    Lat : lat_long.Latitude;

```

```
    Lon : lat_long.Longitude;
END RECORD;
OS_Data : file_io.OS_Data_Type;
File_Saved : Boolean;
OWNSHIP_CONST : CONSTANT integer := 1;
Ship_Data : historical_io.Historical_Data_Type(OWNSHIP_CONST);
Own_Ship_Info : own_ship;
END ownship;
```

A-8 TRACKS.ADS

```
--*****
--| FILE: tracks.ads
--| AUTHOR: Joey L. Frantzen, Naval Post Graduate School
--| LAST MODIFIED: 14 September 2001
--| OPERATING ENVIRONMENT: Windows 2000(Designed to be O/S Independent)
--| COMPILER: GNAT 3.13p
--| DESCRIPTION: This class is contains all of the data types and
--| functionality for a specific track and an array of tracks that contains a
--| link list of hits associated with that track.
--| INPUTS: N/A
--| OUTPUTS: Outputs based on what Functions are requested and run.
--| Process: None to note
--| Assumptions: N/A
--| Warnings: None
```


__*****

WITH hit;
WITH times;
WITH dates;
WITH Realnum;
WITH degrees;
WITH speeds;
WITH ownship;
WITH lat_long;
WITH Utilities;
WITH file_io;
WITH historical_io;
WITH Ada.Strings;
WITH Ada.Strings.Fixed;
WITH Ada.Unchecked_Deallocation;
WITH Gdk.Color;

PACKAGE tracks IS

Number_Of_Tracks : integer := Utilities.LAST_TRACK_SLOT -
Utilities.BEGIN_TRACK_SLOT;

```

SUBTYPE Active_Index IS integer RANGE 1..Number_Of_Tracks;
--Maintains sorted List of all tracks that are active

TYPE Active_Track_List_Array IS ARRAY (Active_Index) OF integer;

TYPE List_Hit_Type; --Declaration of List_Hit_Type is promise for full
--declaration in follow on code.

TYPE List_Hit_Pointer_Type IS ACCESS List_Hit_Type; --Delcares Type pointer to
--List_Hit_Type

TYPE List_Hit_Type IS
    RECORD
        H : hit.Hits;
        Next : List_Hit_Pointer_Type := NULL;
        Prev : List_Hit_Pointer_Type := NULL;
    END RECORD;

--*****
--| Procedure: Clear_Active_Track_List
--| Input: None
--| Output: None
--| Description: Sets all values in Active_Track_List to Zero.
--*****

PROCEDURE Clear_Active_Track_List;

```

--*****

--| Function: Get_Active_Track_List

--| Input: None

--| Output: Active Track List Array

--| Description: Returns Active_Track_List.

--*****

FUNCTION Get_Active_Track_List RETURN Active_Track_List_Array;

--*****

--| Procedure: Get_A_New_Track_Number

--| Input: None

--| Output: Track Number and Boolean(Can_Make_Track)

--| Description: Cycles through the Track_List Array and finds first available

--| track Number. If on the first cycle track array is full, then runs

--| Purge_Old_Tracks. The algorithm will then run through the track array a

--| second time and find the first available slot. If on the second cycle

--| there are no track numbers available, returns LAST_TRACK_SLOT Number and

--| Boolean set to FALSE(Meaning NO TRACKS AVAILABLE).

--*****

PROCEDURE Get_A_New_Track_Number(Track_Num : OUT
Utilities.Track_Number_Range;

 Can_Make_Track : OUT Boolean);

--*****

--| Procedure: Add_Track
--| Input: Track_Number, Track_Id, Bearing, Range, Track Scale
--| Output: None
--| Description: Checks if Track_Number IN is Available, if Available then
--| stores inputted data into Track Number slot of Track List Array. If Track
--| Num in is not available, algorithm finds a available then saves data into
--| next available track slot. Add_Track also calls Add_A_Hit, which builds a
--| new Hit with the bearing and range entered and puts it at the Head of
--| Hit_List. Additionally Saves Hit and Track Data into the Lastest and
--| Historical datafiles.

--*****

```
PROCEDURE Add_Track(Track_Num : IN Utilities.Track_Number_Range;  
                   Track_Id : IN String;  
                   Bear : IN degrees.Degree; Rng : IN Realnum.Real;  
                   T_Scale : IN integer; Track_Color : Gdk.Color.Gdk_Color);
```

--*****

--| Procedure: Add_Track_Hit
--| Input: Track_Number, Bearing, Range, Track Scale
--| Output: None
--| Description: Stores Track Scale into Track_Num and Adds a New Hit to
--| Hit_List for associated Track Number via Add_A_Hit Procedure. Additionally
--| Saves Hit and Track Data into the Lastest and Historical datafiles.

--*****

```
PROCEDURE Add_Track_Hit(Track_Num : IN Utilities.Track_Number_Range;
                        Bear : IN degrees.Degree;
                        Rng : IN Realnum.Real; T_Scale : IN integer);
```

--*****

```
--| Procedure: Set_Purge_Time
--| Input: Old_Time
--| Output: None
--| Description: Sets variable Purge_Time to inputed integer Old_Time. Old
--| Time represents the purge time in hours(1..12) and is the range of hours.
--| If the integer is not within the Purge_Time Range then Purge Time does not
--| change. Purge_Old_Tracks is run whenever Purge_Time is changed to a
--| smaller value.
```

--*****

```
PROCEDURE Set_Purge_Time(New_Time : IN integer);
```

--*****

```
--| Procedure: Purge_Old_Tracks
--| Input: None
--| Output: None - At least, no return values
--| Description: Cycles through the Track_List Array and checks to see last hit
--| update for each track. If the last hit on that track is older then the set
--| Oldest Time then Purges this track from the array and resets the track data
```

```
--| to Zero point.  
--*****
```

```
PROCEDURE Purge_Old_Tracks;
```

```
--*****
```

```
--| Procedure: Change_Track_Number  
--| Input: Request Track Number, Current Track Number  
--| Output: Boolean representing if Requested Track Number was free.  
--| Description: Algorithm has two cases. Case 1, the requested track number is  
--| free and then current Track number is moved into requested track number  
--| slot. Current Slot is then cleared. Track Free is Returned TRUE. Case 2,  
--| Requested Track Number is not free. In this case, Track Info in Requested  
--| Slot moved into first available slot. Then Current Track Number is moved  
--| into wanted slot, and current slot is cleared. Track Free is returned True.  
--| If in both cases there are NO free slots, Purge_Old_Tracks is executed and  
--| both cases are tried again. If again, there are no free slots, then Track  
--| Free is returned false. Historical and Latest File Database are updated  
--| after each change.
```

```
--*****
```

```
PROCEDURE Change_Track_Number( Wanted_Track_Number : IN
```

```
    Utilities.Track_Number_Range;  
    Current_Track_Number : IN  
    Utilities.Track_Number_Range;
```

Track_Num_Free : OUT Boolean);

--*****

--| Procedure: Set_Track_Cse_And_Speed
--| Input: Track Number, Course, Speed
--| Output: None
--| Description: Saves Track Course and Speed into the Last Hit Target_Course
--| and Speed variables, then Calls Calculate Target Angle in the Hit Class,
--| Saves the Hit into the latest and historical databases. Then saves course
--| and speed in Track and saves target angle in track. Then the algorithm
--| saves the updated Track in Latest and historical databases.

--*****

PROCEDURE Set_Track_Cse_And_Speed(Track_Num : IN

 Utilities.Track_Number_Range;
 Course : IN degrees.Degree;
 Spd : IN Realnum.Real);

--*****

--| Procedure: Set_Track_Id
--| Input: Track Number, String(Track Id)
--| Output: None
--| Description: Saves Track Id into the Track Number variable called Track_Id.
--| Saves the New Track Information into the latest and historical database
--| files.

__*****

```
PROCEDURE Set_Track_Id(Track_Num : IN Utilities.Track_Number_Range;
                      Track_Id : IN String);
```

__*****

```
--| Procedure: Set_Track_Scale
--| Input: Track Number, Scale(Integer)
--| Output: None
--| Description: Saves Track Scale into the Track Number variable called
--| Track_Scale. Algorithm Checks if Track Scale has been set, if not then
--| saves inputed Track Scale If Track Scale already set, then does a
--| comparison and saves the Track Scale whose value is greater. I.E. If I go
--| from a 5:1 to 10:1 Scale then Track Scale is 10:1 overall. Saves the Track
--| Information into the latest and historical database files.
```

__*****

```
PROCEDURE Set_Track_Scale(Track_Num : IN Utilities.Track_Number_Range;
                          Scale : IN integer);
```

__*****

```
--| Procedure: Set_Track_Color
--| Input: Track Number, Track_Color(Gdk.Color.Gdk_Color)
--| Output: None
--| Description: Saves Track Color into the Track Number variable called
```


--| Track_Color. Saves the New Track Information into the latest and historical
--| database files.

__*****

```
PROCEDURE Set_Track_Color(Track_Num : IN Utilities.Track_Number_Range;  
                          Track_Color : IN Gdk.Color.Gdk_Color);
```

__*****

--| Procedure: Set_Track_CPA
--| Input: Track Number, Bearing, Time, and Range
--| Output: None
--| Description: Saves CPA Bearing, Time and Range into the associated Track
--| Number variables. Verifies CPA Range vs. Closest CPA Track Number Range,
--| if less then current closest CPA, then sets Closests_CPA_Track_Number to
--| Track_Num. Saves the New Track Information into the latest and historical
--| database files.

__*****

```
PROCEDURE Set_Track_CPA(Track_Num : IN Utilities.Track_Number_Range;  
                       Bearing : IN Utilities.My_Degree;  
                       T_ime : IN integer; Rng : IN Realnum.Real);
```

__*****

--| Procedure: Set_Track_CPA_Bearing
--| Input: Track Number, Bearing
--| Output: None

```

--| Description: Saves CPA Bearing into the associated Track Number CPA_Bearing
--| variable. Saves the New Track Information into the latest and historical
--| database files.
__*****

PROCEDURE Set_Track_CPA_Bearing(Track_Num : IN
    Utilities.Track_Number_Range;
    Bearing : IN Utilities.My_Degree);

__*****

--| Procedure: Set_Track_CPA_Time
--| Input: Track Number, Time
--| Output: None
--| Description: Saves CPA Time into the associated Track Number CPA_Time
--| variable. Saves the New Track Information into the latest and historical
--| database files.
__*****

PROCEDURE Set_Track_CPA_Time(Track_Num : IN Utilities.Track_Number_Range;
    T_ime : IN integer);

__*****

--| Procedure: Set_Track_CPA_Range
--| Input: Track Number, Range
--| Output: None
--| Description: Saves CPA Range into the associated Track Number CPA_Range

```

--| variable. Saves the New Track Information into the latest and historical
--| database files.

__*****

```
PROCEDURE Set_Track_CPA_Range(Track_Num : IN Utilities.Track_Number_Range;  
                               Rng : IN Realnum.Real);
```

__*****

--| Procedure: Set_Track_CPA_Faired
--| Input: Track Number, Boolean
--| Output: None
--| Description: Saves CPA Boolean Faired into the associated Track Number
--| CPA_Is_Faired variable. Saves the New Track Information into the latest
--| and historical database files.

__*****

```
PROCEDURE Set_Track_CPA_Faired(Track_Num : IN Utilities.Track_Number_Range;  
                               Faired : IN boolean);
```

__*****

--| Function: Get_Purge_Time
--| Input: None
--| Output: integer(represents Purge time in hours)
--| Description: Returns Purge_Time variable which represents time late in
--| hours that Purge_Tracks drops tracks that last hit was greater than or

```

--| equal to Purge_Time.
--*****
FUNCTION Get_Purge_Time RETURN integer;

--*****

--| Function: Get_Track_Cse
--| Input: Track Number
--| Output: degrees.Degree(represents Track Course in Degrees)
--| Description: Returns Track Course associated with Track Number entered.
--*****

FUNCTION Get_Track_Cse(Track_Num : IN Utilities.Track_Number_Range)
    RETURN degrees.Degree;

--*****

--| Function: Get_Track_Speed
--| Input: Track Number
--| Output: Realnum.Real(represents Track Speed in Realnum.Real)
--| Description: Returns Track Speed associated with Track Number entered.
--*****

FUNCTION Get_Track_Speed(Track_Num : IN Utilities.Track_Number_Range)
    RETURN Realnum.Real;

--*****

--| Function: Get_Track_Id

```

```

--| Input: Track Number
--| Output: String(represents Track Id in String)
--| Description: Returns Track Id associated with Track Number entered.
--*****
FUNCTION Get_Track_Id(Track_Num : IN Utilities.Track_Number_Range) RETURN
    String;

--*****

--| Function: Get_Track_Scale
--| Input: Track Number
--| Output: integer(represents Track Scale in integer)
--| Description: Returns Track Scale associated with Track Number entered.
--*****
FUNCTION Get_Track_Scale(Track_Num : IN Utilities.Track_Number_Range)
    RETURN integer;

--*****

--| Function: Get_Track_Color
--| Input: Track Number
--| Output: Gdk.Color.Gdk_Color(represents Track Color)
--| Description: Returns Track Color associated with Track Number entered.
--*****
FUNCTION Get_Track_Color(Track_Num : IN Utilities.Track_Number_Range)
    RETURN Gdk.Color.Gdk_Color;

```

--*****

--| Function: Get_Track_Last_Hit_Lat

--| Input: Track Number

--| Output: lat_long.Latitude(represents Tracks Last Latitude Coordinate)

--| Description: Returns Track Latitude(of last Hit) associated with Track

--| Number entered.

--*****

FUNCTION Get_Track_Last_Hit_Lat(Track_Num : IN Utilities.Track_Number_Range)

 RETURN lat_long.Latitude;

--*****

--| Function: Get_Track_Last_Hit_Long

--| Input: Track Number

--| Output: lat_long.Longitude(Represents Tracks Last Longitude Coordinate)

--| Description: Returns Track Longitude(of last Hit) associated with Track

--| Number entered.

--*****

FUNCTION Get_Track_Last_Hit_Long(Track_Num : IN

 Utilities.Track_Number_Range) RETURN lat_long.Longitude;

--*****

--| Function: Get_Track_CPA_Bearing

--| Input: Track Number

```

--| Output: Utilities.My_Degree(represents Track CPA in Degrees)
--| Description: Returns Track CPA Bearing associated with Track Number
--| entered.
--*****
FUNCTION Get_Track_CPA_Bearing(Track_Num : IN Utilities.Track_Number_Range)
    RETURN Utilities.My_Degree;

--*****

--| Function: Get_Track_CPA_Time
--| Input: Track Number
--| Output: Integer(represents Track CPA in Time(1230)
--| Description: Returns Track CPA Time associated with Track Number entered.
--*****
FUNCTION Get_Track_CPA_Time(Track_Num : IN Utilities.Track_Number_Range)
    RETURN integer;

--*****

--| Function: Get_Track_CPA_Range
--| Input: Track Number
--| Output: Realnum.Real(represents Track CPA in Range
--| Description: Returns Track CPA Range associated with Track Number entered.
--*****
FUNCTION Get_Track_CPA_Range(Track_Num : IN Utilities.Track_Number_Range)
    RETURN Realnum.Real;

```

```

--*****
--| Function: Get_Track_CPA_Faired
--| Input: Track Number
--| Output: boolean (represents Track CPA Faired status)
--| Description: Returns Track CPA Faired variable associated with Track Number
--| entered.

```

```

--*****
FUNCTION Get_Track_CPA_Faired(Track_Num : IN Utilities.Track_Number_Range)
    RETURN boolean;

```

```

--*****
--| Procedure: Get_CPA_Info
--| Input: Track Number
--| Output: Last Hit Bearing, Range, and Time and Second to Last Hit Bearing,
--| Range, and Time. Returns Scale that the Track Should be plotted in.

```

```

--*****
PROCEDURE Get_CPA_Info(Track_Num : IN Utilities.Track_Number_Range;
    First_Bearing : IN OUT degrees.Degree;
    Second_Bearing : IN OUT degrees.Degree;
    First_Range : IN OUT Realnum.Real;
    Second_Range : IN OUT Realnum.Real;
    First_Time : IN OUT times.Time_Type;
    Second_Time : IN OUT times.Time_Type;

```


Scale : IN OUT integer);

--*****

--| Procedure: Get_Hit_Counter

--| Input: Track Number

--| Output: Hit_Counter

--| Description: Returns Hit Counter, which represents number of Hits a track

--| has entered.

--*****

FUNCTION Get_Hit_Counter(Track_Num : IN Utilities.Track_Number_Range)

 RETURN integer;

--*****

--| Procedure: Recalc_All_Track_CPAs

--| Input: None

--| Output: None

--| Description: This Procedure has not been implemented yet.

--*****

PROCEDURE Recalc_All_Track_CPAs;

--*****

--| Procedure: Get_Faired_Track_Info

--| Input: Track Number

--| Output: First Bearing, Last Bearing, First Range, Last Range, First Time,

```

--| Last Time. Description: Receives a Track number and gets the First and Last
--| Hit and returns the Bearing, Range, and Time of each of the hits.
_*****

PROCEDURE Get_Faired_Track_Info(Track_Num : IN
    Utilities.Track_Number_Range;
        Bearing1 : OUT Utilities.My_Degree;
        Bearing2 : OUT Utilities.My_Degree;
        Range1 : OUT Realnum.Real;
        Range2 : OUT Realnum.Real;
        Time1 : OUT times.Time_Type;
        Time2 : OUT times.Time_Type);
_*****

--| Procedure: Get_Last_Track_Bearing_Range
--| Input: Track Number
--| Output: Bearing, Range of Track Number
--| Description: Procedure Returns the values of Last Bearing and Range so that
--| Mboard can load values into the list.
_*****

PROCEDURE Get_Last_Track_Bearing_Range(Track_Num : IN
    Utilities.Track_Number_Range;
        Bearing : OUT Utilities.My_Degree;
        Rng : OUT Realnum.Real);
_*****

```

```

--| Procedure: Get_Track_Info
--| Input: Track Number
--| Output: Bearing, Range, Course, Speed, and Target Angle of Track Number
--| Description: Procedure Returns the values of Bearing, Range, Course, Speed,
--| and Target Angle of specified track number so Mboard can load values into
--| the list.
__*****

PROCEDURE Get_Track_Info(Track_Num : IN Utilities.Track_Number_Range;
                        Brg : OUT Utilities.My_Degree; Rng : OUT Realnum.Real;
                        Cse : OUT Utilities.My_Degree;
                        Speed : OUT speeds.Speed;
                        Target_Angle : OUT Utilities.My_Degree);

__*****

--| Function: Drop_Track
--| Input: Track Number
--| Output: Boolean(represents whether track was successfully dropped or not
--| Description: Calls Clear_Track_Data which resets and clears all track and
--| associated Hit data. Also removes track and associated Hits from Latest
--| Database File. Checks if Track Number is equal to Closest_CPA_Track_Number
--| then recalculates it.
__*****

FUNCTION Drop_Track(Track_Num : IN Utilities.Track_Number_Range) RETURN
                        Boolean;

```

--*****

--| Function: Command_Data_Reset

--| Input: None

--| Output: None

--| Description: Clears Track and Hit Information from Resident Memory, i.e.

--| resets the database. Clears the Latest database files for Tracks, Hits,

--| and Ownship.

--*****

FUNCTION Command_Data_Reset RETURN Boolean;

--*****

--| Function: Load_Last_Saved_Data

--| Input: None

--| Output: Boolean

--| Description: Loads the Latest Database for Tracks, Hits, and Ownship into

--| the Memory.

--*****

FUNCTION Load_Last_Saved_Data RETURN Boolean;

--*****

--| Function: Get_Track_Hit_List

--| Input: Track Number

--| Output: List_Hit_Pointer_Type

```

--| Description: Returns the Head Pointer of Hit_List for the associated Track
--| Number.
--*****

FUNCTION Get_Track_Hit_List(Track_Num : IN Utilities.Track_Number_Range)
    RETURN List_Hit_Pointer_Type;

--*****

--| Function: Get_Closest_CPA_Track_Number
--| Input: None
--| Output: Track Number
--| Description: Returns the Track Number of the Track with the Closest CPA.
--*****

FUNCTION Get_Closest_CPA_Track_Number RETURN
    Utilities.Track_Number_Range;

--*****

--| Function: Get_Number_Of_Active_Tracks
--| Input: None
--| Output: Number of Active Tracks
--| Description: Returns the Number of Active Tracks.
--*****

FUNCTION Get_Number_Of_Active_Tracks RETURN integer;

PRIVATE

```

```

TYPE Track_Type IS RECORD

    Track_Number : Utilities.Track_Number_Range := Utilities.LAST_TRACK_SLOT;

--Intialize All Records Track_Number

    Track_Id : String(1..20) := Utilities.Get_Default_String;

--max length is 20 characters

    Track_Cse : degrees.Degree := 0.0;    -- average/faired Course of Track

    Track_Speed : Realnum.Real := 0.0;    -- average/faired Speed of Track

    Target_Angle : degrees.Degree := 0.0;

    Track_Scale : integer := 0;

    Track_Color : Gdk.Color.Gdk_Color := Gdk.Color.Null_Color;

--have to change later to right type

    CPA_Bearing : Utilities.My_Degree := 0;

    CPA_Range : Realnum.Real := 0.0;

    CPA_Time : integer := 0;

    CPA_Is_Faired : boolean := FALSE;

--bit setting on whether CPA Values are faired values

    Hit_List : List_Hit_Pointer_Type;

    Hit_Counter : integer := 0;

END RECORD;

--Defines the Upper and Lower Limites for Purge Time settings

BOTTOM_OLD_TIME : CONSTANT integer := 1;

TOP_OLD_TIME : CONSTANT integer := 12;

```

```
--Represents the Time in hours when Purge_Tracks will delete any tracks
--older then this set time. Default is 12 hours
Purge_Time : integer RANGE BOTTOM_OLD_TIME..TOP_OLD_TIME := 12;
```

```
TYPE Track_Array IS ARRAY (Utilities.Track_Number_Range) OF Track_Type;
```

```
--Holds records of Track_Type and maintains all info on Tracks
```

```
Track_List : Track_Array;
```

```
--Maintains sorted List of all tracks that are active
```

```
Active_Track_List : Active_Track_List_Array := ( others => 0 );
```

```
--Maintains total number of active tracks
```

```
Number_Of_Active_Tracks : integer := 0;
```

```
--Variable holds temporary Track data for saving to File Database
```

```
Track_Data : file_io.Track_Data_Type;
```

```
--Variable holds tempoary Hit data for saving to File Database
```

```
Hit_Data : file_io.Hit_Data_Type;
```

```
--Constant sets the Historical Database Type to contain Track Info
```

```
TRACK_CONST : CONSTANT integer := 2;
```

```

--Constant sets teh Historical Database Type to contain Hit Info
HIT_CONST : CONSTANT integer := 3;

--Variable holds tempoary Track data for saving to Historical Database
Track_Hist_Data : historical_io.Historical_Data_Type(TRACK_CONST);

--Variable holds tempoary Hit data for saving to Historical Database
Hit_Hist_Data : historical_io.Historical_Data_Type(HIT_CONST);

Track_Saved : Boolean;
Hit_Saved : Boolean;

--Represents the track number that has the
--current closest CPA value in yards.

Closest_CPA_Track_Number : Utilities.Track_Number_Range :=
Utilities.LAST_TRACK_SLOT;

END tracks;

```

A-9 FILE_IO.ADS

```

--*****
--| FILE: file_io.ads
--| AUTHOR: Joey L. Frantzen, Naval Post Graduate School
--| LAST MODIFIED: 12 September 2001

```


--| OPERATING ENVIRONMENT: Windows 2000(Designed to be O/S Independent)

--| COMPILER: GNAT 3.13p

--| DESCRIPTION: This class is contains all of the data types and

--| functionality allowing to save a database for crash recovery, restart

--| recovery, or error recovery from a datebase that holds all current

--| information.

--| INPUTS: Based on specific functions and procedures are called.

--| OUTPUTS: Based on what functions and procedures are called.

--| Process: None to note

--| Assumptions: N/A

--| Warnings: None

--*****

WITH utilities;

WITH speeds;

WITH degrees;

WITH Realnum;

WITH lat_long;

WITH times;

WITH dates;

WITH GNAT.IO_Aux;

WITH Gdk.Color;

WITH Ada.Direct_IO;

```
PACKAGE file_io IS
```

```
-- record type represents all pertinent data for ownship and is used in file
```

```
-- io operations
```

```
TYPE OS_Data_Type IS RECORD
```

```
OwnShip_Number : integer := 99; --Set to Hull Number/Associated Number
```

```
OwnShip_Ident : String(1..20) := Utilities.Get_Default_String;
```

```
                --max length is 20 characters
```

```
OwnShip_Cse : degrees.Degree := 0.0;
```

```
OwnShip_Speed : speeds.Speed := 0.0; --Expressed in Knots
```

```
Lat : lat_long.Latitude;
```

```
Lon : lat_long.Longitude;
```

```
END RECORD;
```

```
-- record type represents all pertinent data for Hit type and is used in file
```

```
-- io operations
```

```
TYPE Hit_Data_Type IS
```

```
RECORD
```

```
Track_Number : Utilities.Track_Number_Range := Utilities.LAST_TRACK_SLOT;
```

```
Bear: degrees.Degree := 0.0;
```

```
    Rng : Realnum.Real := 0.0; --Stored in Yards
```

```
    Lat : lat_long.Latitude;
```

```
    Lon : lat_long.Longitude;
```

```

Dat : dates.Date_Type;
T_ime: times.Time_Type;
Target_Cse : degrees.Degree := 0.0;
OwnShip_Cse : degrees.Degree := 0.0;
Target_Speed : speeds.Speed := 0.0;
OwnShip_Speed : speeds.Speed := 0.0;
Target_Angle : degrees.Degree := 0.0;

Hit_Counter : integer := 0;

END RECORD;

```

--record represents all pertinent data for track type and is used in file io

--operations

TYPE Track_Data_Type IS

RECORD

Track_Number : Utilities.Track_Number_Range :=Utilities.LAST_TRACK_SLOT;

--Intialize All Records Track_Number

Track_Id : String(1..20) := Utilities.Get_Default_String; --max length is

--20 characters

Track_Cse : degrees.Degree := 0.0; -- Course of Track

Track_Speed : Realnum.Real := 0.0; -- Speed of Track

Target_Angle : degrees.Degree := 0.0;

Track_Scale : integer := 0;

```

Track_Color : Gdk.Color.Gdk_Color := Gdk.Color.Null_Color;

CPA_Bearing : Utilities.My_Degree := 0;

CPA_Range : Realnum.Real := 0.0;

CPA_Time : integer := 0;

CPA_Is_Faired : boolean := FALSE;

Hit_Counter : integer := 0;

END RECORD;

__*****

--| Function: Save_Last_OwnShip_State
--| Input: OS_Date Type
--| Output: Boolean
--| Description: This is a Latest(Last State) recovery file. Saves the Last
--| updated information about ownship into file called ownship_data.db If the
--| file does not exist then the algorithm creates the file and saves the data.

__*****

FUNCTION Save_Last_OwnShip_State(Ownship_Data : IN OS_Data_Type) RETURN
    Boolean;

__*****

--| Procedure: Save_Last_Track_State
--| Input: Track_Date Type
--| Output: Boolean
--| Description: This is a Latest(Last State) recovery file. Saves the Last

```

```

--| updated information about each Track into file called track_data.db If the
--| file does not exist then the algorithm creates the file and saves the data.
__*****
PROCEDURE Save_Last_Track_State(Track_Data : IN OUT Track_Data_Type;
                                Track_Saved : OUT Boolean);

__*****

--| Procedure: Save_Last_Hit_State
--| Input: Hit_Date Type
--| Output: Boolean
--| Description: This is a Latest(Last State) recovery file. Saves the Last
--| updated information about each Hit into file called hit_data.db If the file
--| does not exist then the algorithm creates the file and saves the data.
__*****
PROCEDURE Save_Last_Hit_State(Hit_Data : IN OUT Hit_Data_Type;
                              Hit_Saved : OUT Boolean);

__*****

--| Function: Save_Two_Hit_Track_Numbers
--| Input: Wanted Track Number, Current Track Number
--| Output: Boolean
--| Description: This procedure takes two track numbers, one that the user
--| wants to change the track number two, and the previous used track number.
--| This procedure cycles through the Hit database and changes the the hits

```

--| with the current track track number to associate with the wanted track
--| number.

__*****

FUNCTION Swap_Two_Hit_Track_Numbers(Wanted : IN

 Utilities.Track_Number_Range;

 Current : IN Utilities.Track_Number_Range)

 RETURN Boolean;

__*****

--| Function: Save_Three_Hit_Track_Numbers

--| Input: Wanted Track Number, Current Track Number, New Track Number

--| Output: Boolean

--| Description: This procedure takes three track numbers, one that the user

--| wants to change the track number too, and the previous used track number,

--| and the new track number. This procedure cycles through the Hit database

--| and changes the the hits to the associatede track numbers.

__*****

FUNCTION Swap_Three_Hit_Track_Numbers(Wanted : IN

 Utilities.Track_Number_Range;

 Current : IN Utilities.Track_Number_Range;

 New_Track : IN Utilities.Track_Number_Range)

 RETURN Boolean;

__*****

--| Function: Drop_Track_From_Track_State

--| Input: Track Number
--| Output: Boolean
--| Description: This procedure deletes inputed track number from the
--| Latest(Last State). This is done by overwriting the index number(track
--| number) position with a null value.

--*****

```
FUNCTION Drop_Track_From_Track_State(Track_Num : IN  
                                     Utilities.Track_Number_Range) RETURN Boolean;
```

--*****

--| Function: Drop_All_Track_Hits_From_Hit_State
--| Input: Track Number
--| Output: Boolean
--| Description: This procedure deletes all hits associated with inputed track
--| number from the Latest(Last State). This is done by overwriting the hits
--| associated with index number(track number) with a null value.

--*****

```
FUNCTION Drop_All_Track_Hits_From_Hit_State(Track_Num : IN  
                                             Utilities.Track_Number_Range) RETURN Boolean;
```

--*****

--| Function: Delete_OS_Latest_Files
--| Input: None
--| Output: Boolean

```

--| Description: This procedure deletes all Latest files Ownship_database.db,
--| track_database.db, and hit_database.db
--| *****
FUNCTION Delete_Latest_Files RETURN Boolean;

--| *****

--| Function: Get_Ownship_Data_From_File
--| Input: None
--| Output: OS_Data_Type
--| Description: This procedure returns the OS_Data_Type stored in Ownship
--| database. This function accesses ownship_database.db to retrieve the
--| information.
--| *****
FUNCTION Get_Ownship_Data_From_File RETURN OS_Data_Type;

--| *****

--| True: Get_All_Saved_Tracks
--| Input: Index
--| Output: Track_Data_Type, Index, and Boolean
--| Description: This procedure returns the Track_Data_Type stored in Track
--| T database. he procedure will cycle through the complete database track by
--| track as each sequential call is made. Once all tracks are loaded the
--| Loaded boolean is returned with value True.
--| *****

```



```

PROCEDURE Get_All_Saved_Tracks(Track_Data : OUT Track_Data_Type;
                               Index : IN OUT Utilities.Track_Number_Range;
                               Loaded : OUT Boolean; File_Exists : OUT Boolean);

--*****

--| True: Get_All_Saved_Hits
--| Input: Index
--| Output: Hit_Data_Type, Index, and Boolean
--| Description: This procedure returns the Hit_Data_Type stored in Hit
--| database. The procedure will cycle through the complete database hit by Hit
--| as each sequential call is made. Once all tracks are loaded the Loaded
--| boolean is returned with value True.

--*****

PROCEDURE Get_All_Saved_Hits(Hit_Data : OUT Hit_Data_Type;
                              Index : IN OUT integer;
                              Loaded : OUT Boolean);

END file_io;

```

A-10 HISTORICAL_IO.ADS

```

--*****

--| FILE: historical_io.adb
--| AUTHOR: Joey L. Frantzen, Naval Post Graduate School & Kenneth L.
--| Ehresman(Sentry Line).

```

```

--| LAST MODIFIED: 12 September 2001
--| OPERATING ENVIRONMENT: Windows 2000(Designed to be O/S Independent)
--| COMPILER: GNAT 3.13p
--| DESCRIPTION: This class is contains all of the data types and
--| functionality allowing to save a database for historical playback or
--| display, this is a historical database by day, each new day there is a new.
--| file created or auto input.
--| Due to Ada's limited ability to do file io, delete, etc. There is one date
--| type that exists based upon what the user case is, ownship data, track data,
--| or hit data. There is also a Sentry case, that is saved into the historical
--| file prior to each historical save, allowing the customer to read the
--| sentry, determine the data tructure (next) and then reading the data
--| structure, etc.
--| INPUTS: Based on specific functions and procedures are called.
--| OUTPUTS: Based on what functions and procedures are called.
--| Process: None to note
--| Assumptions: N/A
--| Warnings: None

```

```

__*****

```

```

WITH utilities;

```

```

WITH speeds;

```

```

WITH degrees;

```

```

WITH Realnum;

```

```

WITH lat_long;

```

WITH times;

WITH dates;

WITH GNAT.IO_Aux;

WITH Gdk.Color;

WITH Ada.Sequential_IO;

PACKAGE historical_io IS

TYPE Historical_Data_Type(In_Use : integer := 1) IS

RECORD

CASE In_Use IS

WHEN 1 =>

Time_Stamp : times.Time_Type := times.Get_Time_Of_Day;

OwnShip_Number : integer := 99; --Set to Hull Number/Associated Number

OwnShip_Ident : String(1..20) := Utilities.Get_Default_String; --max
length is 20 character

OwnShip_Cse : degrees.Degree := 0.0;

OwnShip_Speed : speeds.Speed := 0.0; --Expressed in Knots

OwnShip_Lat : lat_long.Latitude;

OwnShip_Lon : lat_long.Longitude;

WHEN 2 =>

Track_Number : Utilities.Track_Number_Range :=

Utilities.LAST_TRACK_SLOT; --Intialize All Records Track_Number

Track_Id : String(1..20) := Utilities.Get_Default_String; --max length is
20 characters

```

Track_Cse : degrees.Degree := 0.0;    -- Course of Track
Track_Speed : Realnum.Real := 0.0;    -- Speed of Track
Track_Target_Angle : degrees.Degree := 0.0;
Track_Scale : integer := 0;
Track_Color : Gdk.Color.Gdk_Color := Gdk.Color.Null_Color;
CPA_Bearing : Utilities.My_Degree := 0;
CPA_Range : Realnum.Real := 0.0;
CPA_Time : integer := 0;
CPA_Is_Faired : boolean := FALSE;
Track_Hit_Counter : integer := 0;

WHEN 3 =>

Hit_Counter : integer := 0;

Hit_Track_Number : Utilities.Track_Number_Range :=
    Utilities.LAST_TRACK_SLOT;

Bear: degrees.Degree := 0.0;

Rng : Realnum.Real := 0.0; --Stored in Yards

Hit_Lat : lat_long.Latitude;

Hit_Lon : lat_long.Longitude;

Dat : dates.Date_Type;

T_time: times.Time_Type;

Target_Cse : degrees.Degree := 0.0;

Hit_OwnShip_Cse : degrees.Degree := 0.0;

Target_Speed : speeds.Speed := 0.0;

Hit_OwnShip_Speed : speeds.Speed := 0.0;

```

```

        Hit_Target_Angle : degrees.Degree := 0.0;

    WHEN 4 =>

        Sentry : integer := 0; --Great and Many thanks go out to Ken Ehresman.

    WHEN OTHERS =>

        NULL;

    END CASE;

END RECORD;

--*****

--| Procedure: New_Day_Change_File_Name
--| Input: None
--| Output: None
--| Description: This procedure retrieves the current system date, converts the
--| date into a string, for example 08/08/2001 is converted into 20010808.db
--| and this is saved into the Historical File Name variable.
--*****

PROCEDURE New_Day_Change_File_Name;

--*****

--| Function: Save_Data_To_File
--| Input: Historical Data Type
--| Output: Boolean
--| Description: This is a historical data file. Saves the historical data

```

```

--| information based on what case it is. Case 1, 2, 3 are data types for
--| ownship, tracks, and hits.The data is saved in a file based on the date
--| i.e. 20010808.db is for Aug 8 2001
--*****
FUNCTION Save_Data_To_File(Data_In : IN Historical_Data_Type;
                           Data_Case : IN integer) RETURN Boolean;

PRIVATE

    --stores the current date based off the system clock
    Current_Date : integer := 0;

    --stores the current file name for the historical database
    Historical_File_Name : String(1..12) := "2001hist.db ";

END historical_io;

```

A-11 LAT_LONG.ADS

```

--*****
--| FILE: lat_long.ads
--| AUTHOR: Joey L. Frantzen, Naval Post Graduate School
--| LAST MODIFIED: 11 September 2001
--| OPERATING ENVIRONMENT: Windows 2000(Designed to be O/S Independent)
--| COMPILER: GNAT 3.13p
--| DESCRIPTION: This Class defines a Latitude and Longitude type and

```

```

--| contains all of the fuctions and procedures to calculate a new
--| latitude and longitude when given a point that is at a specific bearing
--| and range. This class also handles computing distance between two
--| given latitude and longitude coordinates. This class contains functions
--| to convert between Kilometers, Yards, and Nautical Miles. This Class
--| also contains two functions that call the Gps Class and retrieve a latitude
--| and longitude.
--| INPUTS: Ada.Numerics, Realnum.Real
--| OUTPUTS: Outputs based on user request and data input
--| Process: None to note
--| Assumptions: N/A
--| Warnings: None
--*****

```

```

WITH Ada.Numerics;
WITH Realnum;                               USE Realnum;

```

```

    USE TYPE Realnum.Real;

```

```

PACKAGE lat_long IS

```

```

    --Best Math Set Constant Declarations

```

```

RADIAN: CONSTANT Realnum.Real := 180.0/ Ada.Numerics.Pi;  --Ada.Numerics.Pi
== 3.14159_26535_89793_23846_26433_83279_50288_41971_69399_37511

TWO_PI: CONSTANT Realnum.Real := 2.0 * Ada.Numerics.Pi;    --Two Pi

DEG_TO_RADIAN: CONSTANT Realnum.Real := Ada.Numerics.Pi/180.0;  --Deg to
Radian

RADIAN_TO_DEG: CONSTANT Realnum.Real := 180.0/Ada.Numerics.Pi;  --Radian
to Deg

FETH: CONSTANT Realnum.Real := 0.335_28106_6474E-2; --Flatting Constant(about
1/298)

RE: CONSTANT Realnum.Real := 6378.137;          --Radius Earth at Equator=Semi-
Major Axis

ESQ: CONSTANT Realnum.Real := 2.0 * FETH - (FETH * FETH);

A: CONSTANT Realnum.Real := 1000.0 * RE;

TOL: CONSTANT Realnum.Real := 5.0E-15;

SUBTYPE Min_utes IS integer RANGE 0..59;

SUBTYPE Sec_onds IS integer RANGE 0..59;

SUBTYPE Lat_Degree IS integer RANGE 0..90;

SUBTYPE Long_Degree IS integer RANGE 0..180;

TYPE Latitude IS private;

TYPE Longitude IS private;

--*****

```



```

--| Function: Get_NM_From_Yards(Realnum.Real)
--| Input: Yards
--| Output: Nautical Miles
--| Description: Algorithm converts Yards to Nautical Miles is taken from
--| pg. 7 of Piloting and Dead Reckoning 3rd Ed written by
--| H.H. Shufeldt, CAPT, USNR (Ret.).
--| This standard was accepted as Official by the United States in 1959.
--*****
FUNCTION Get_NM_From_Yards(Yard1 : Realnum.Real) RETURN Realnum.Real;
--*****
--| Function: Get_Yards_From_NM(Realnum.Real)
--| Input: Nautical Miles
--| Ouput: Yards
--| Description: Algorithm to convert Nautical Miles to Yards is taken from
--| pg. 7 of Piloting and Dead Reckoning 3rd Ed written by
--| H.H. Shufeldt, CAPT, USNR (Ret.). This standard was
--| This Standard was accepted as Official by the United States in 1959.
--*****
FUNCTION Get_Yards_From_NM(Nat1 : Realnum.Real) RETURN Realnum.Real;
--*****
--| Function: Get_NM_From_KM(Realnum.Real)
--| Input: Kilometers

```

```

--| Output: Nautical Miles;
--| Description: Algorithm to convert Kilometers to Nautical Miles is taken from
--| pg. 7 of Piloting and Dead Reckoning 3rd Ed written by
--| H.H. Shufeldt, CAPT, USNR (Ret.). This standard was
--| This Standard was accepted as Official by the United States in 1959.
--*****
FUNCTION Get_NM_From_KM(Kilo : Realnum.Real) RETURN Realnum.Real;

--*****

--| Function: Get_Yards_From_KM(Realnum.Real)
--| Input: Kilometers
--| Output: Yards
--| Discription: Algorithm to convert Kilometers to Yards is taken from
--| pg. 7 of Piloting and Dead Reckoning 3rd Ed written by
--| H.H. Shufeldt, CAPT, USNR (Ret.). This standard was
--| This Standard was accepted as Official by the United States in 1959.
--*****
FUNCTION Get_Yards_From_KM(Kilo : Realnum.Real) RETURN Realnum.Real;

--*****

--| Function: Get_KM_From_Yards(Realnum.Real)
--| Input: Yards
--| Output: Kilometers
--| Description: Algorithm to convert Yards to KM is taken from

```

```

--| pg. 7 of Piloting and Dead Reckoning 3rd Ed written by
--| H.H. Shufeldt, CAPT, USNR (Ret.). This standard was
--| This Standard was accepted as Official by the United States in 1959.
--*****
FUNCTION Get_KM_From_Yards(Yard1 : Realnum.Real) RETURN Realnum.Real;

--*****

--| Function: Get_KM_From_NM(Realnum.Real)
--| Input: Nautical Miles
--| Output: Kilometers
--| Description: Algorithm to convert Nautical Miles to Kilometers is taken from
--| pg. 7 of Piloting and Dead Reckoning 3rd Ed written by
--| H.H. Shufeldt, CAPT, USNR (Ret.). This standard was
--| This Standard was accepted as Official by the United States in 1959.
--*****
FUNCTION Get_KM_From_NM(Nat1 : Realnum.Real) RETURN Realnum.Real;

--*****

--| Function: Lat_To_Degrees
--| Input: Latitude
--| Output: Degrees(0..360)
--| Description: Convert Latitude Type to Degrees
--*****
FUNCTION Lat_To_Degrees(Lat1: Latitude) RETURN Realnum.Real;

```

--*****

--| Function: Long_To_Degrees

--| Input: Longitude

--| Output: Degrees(0..360)

--| Description: Convert Longitude Type to Degrees

--*****

FUNCTION Long_To_Degrees(Long1: Longitude) RETURN Realnum.Real;

--*****

--| Function: Degrees_To_Lat

--| Input: Degrees(0..360)

--| Output: Latitude

--| Description: Convert Degrees to Latitude Type

--*****

FUNCTION Degrees_To_Lat(Deg: Realnum.Real) RETURN Latitude;

--*****

--| Function: Degrees_To_Long

--| Input: Degrees(0..360)

--| Output: Longitude

--| Description: Convert Degrees to Longitude Type

--*****

FUNCTION Degrees_To_Long(Deg: Realnum.Real) RETURN Longitude;

--*****

--| Function: calc_lat_long

--| Input: Latitude, Longitude, Bearing, Range(in Yards)

--| Output: Latitude, Longitude, Bearing

--| Description: All Values are Realnum.Real which has 12 digits of precision

--| Algorithm takes a Bearing and Distance from a known Latitude & Longitude

--| and computes new Latitude and Longitude, Back Bearing. This Algorithm is

--| from Professor John Clynch, Naval Postgraduate school. Original program was

--| written in Fortran and converted to Ada Code. Professor John Clynch stated

--| that this Algorithm has been reviewed and approved by the USGS.

--*****

PROCEDURE calc_lat_long (Lat1: IN Latitude; Long1: IN Longitude;

Bearing1: IN Realnum.Real;

Range1: IN Realnum.Real; Lat2: OUT Latitude;

Long2: OUT Longitude;

Bearing2: OUT Realnum.Real);

--*****

--| Function: calc_bearing_dist

--| Input: Latitude, Longitude, Latitude, Longitude

--| Output: Bearing, Bearing, Range(in Yards)

```

--| Description: All Values are Realnum.Real which has 12 digits of precision
--| Algorithm takes a two known Latitude & Longitude's and
--| computes a fwd and back bearing, and Range. This Algorithm was take from
--| Professor John Clynych, Naval Postgraduate school. Original program was
--| written in Fortran and converted to Ada Code. Professor John Clynych stated
--| that this Algorithm has been reviewed and approved by the USGS.
--*****
PROCEDURE calc_bearing_dist (Lat1: IN Latitude; Long1: IN Longitude;
                             Lat2: IN Latitude;
                             Long2: IN Longitude; Bearing1: OUT Realnum.Real;
                             Bearing2: OUT Realnum.Real;
                             Range1: OUT Realnum.Real);

--SET and GET LATITUDE PROCEDURE and FUNCTIONS*****

--*****

--| Procedure: Set_Latitude
--| Input: Degree, Minutes, Seconds : Integers; Latitude
--| Output: Latitude
--| Description: Sets Degrees, Minutes, and Seconds into Latitude Type
--| Warnings: None
--*****

PROCEDURE Set_Latitude(D : IN Integer; M : IN Integer; S : IN Integer;

```

Sign : IN Character; Lat: IN OUT Latitude);

__*****

--| Procedure: Set_Lat_Deg
--| Input: Degree: Integer; Latitude
--| Output: Latitude
--| Description: Sets Degrees into Latitude Type
--| Warnings: None

__*****

PROCEDURE Set_Lat_Deg(D : IN Integer; Lat : IN OUT Latitude);

__*****

--| Procedure: Set_Lat_Min
--| Input: Minutes: Integer; Latitude
--| Output: Latitude
--| Description: Sets Minutes into Latitude Type
--| Warnings: None

__*****

PROCEDURE Set_Lat_Min(M : IN Integer; Lat : IN OUT Latitude);

__*****

--| Procedure: Set_Lat_Secs
--| Input: Seconds: Integer; Latitude
--| Output: Latitude

--| Description: Sets Seconds into Latitude Type

--| Warnings: None

--*****

PROCEDURE Set_Lat_Sec(S : IN Integer; Lat : IN OUT Latitude);

--*****

--| Procedure: Set_Lat_Sign

--| Input: Sign: Character; Latitude

--| Output: Latitude

--| Description: Sets Sign into Latitude Type

--| Warnings: None

--*****

PROCEDURE Set_Lat_Sign(Sign : IN Character; Lat : IN OUT Latitude);

--*****

--| Function: Get_Latitude

--| Input: Latitude

--| Output: Latitude

--| Description: Returns Latitude Type

--| Warnings: None

--*****

FUNCTION Get_Latitude(Lat : Latitude) RETURN Latitude;

--*****

--| Function: Get_Lat_Deg

--| Input: Latitude

--| Output: Integer(Degrees)

--| Description: Returns Integer Type

--| Warnings: None

--*****

FUNCTION Get_Lat_Deg(Lat : Latitude) RETURN Integer;

--*****

--| Function: Get_Lat_Min

--| Input: Latitude

--| Output: Integer(Minutes)

--| Description: Returns Integer Type

--| Warnings: None

--*****

FUNCTION Get_Lat_Min(Lat : Latitude) RETURN Integer;

--*****

--| Function: Get_Lat_Sec

--| Input: Latitude

--| Output: Integer(Seconds)

--| Description: Returns Integer Type

```

--| Warnings: None
--*****
FUNCTION Get_Lat_Sec(Lat : Latitude) RETURN Integer;
--*****

--| Function: Get_Lat_Sign
--| Input: Latitude
--| Output: Character(Sign)
--| Description: Returns Integer Type
--| Warnings: None
--*****

FUNCTION Get_Lat_Sign(Lat : Latitude) RETURN Character;

--SET and GET LONGITUDE PROCEDURE and FUNCTIONS*****

--*****

--| Procedure: Set_Longitude
--| Input: Degree, Minutes, Seconds : Integers; Longitude
--| Output: Longitude
--| Description: Sets Degrees, Minutes, and Seconds into Longitude Type
--| Warnings: None
--*****

PROCEDURE Set_Longitude(D : IN Integer; M : IN Integer; S : IN Integer;

```

Sign : IN Character; Lon: IN OUT Longitude);

--*****

--| Procedure: Set_Long_Deg
--| Input: Degree: Integer; Longitude
--| Output: Longitude
--| Description: Sets Degrees into Longitude Type
--| Warnings: None

--*****

PROCEDURE Set_Long_Deg(D : IN Integer; Lon : IN OUT Longitude);

--*****

--| Procedure: Set_Long_Min
--| Input: Minutes: Integer; Longitude
--| Output: Longitude
--| Description: Sets Minutes into Longitude Type
--| Warnings: None

--*****

PROCEDURE Set_Long_Min(M : IN Integer; Lon : IN OUT Longitude);

--*****

--| Procedure: Set_Long_Sec
--| Input: Seconds: Integer; Longitude
--| Output: Longitude

```

--| Description: Sets Seconds into Longitude Type
--| Warnings: None
--*****
PROCEDURE Set_Long_Sec(S : IN Integer; Lon : IN OUT Longitude);

--*****

--| Procedure: Set_Long_Sign
--| Input: Sign: Character; Longitude
--| Output: Longitude
--| Description: Sets Sign into Longitude Type
--| Warnings: None
--*****
PROCEDURE Set_Long_Sign(Sign : IN Character; Lon : IN OUT Longitude);

--*****

--| Function: Get_Longitude
--| Input: Longitude
--| Output: Longitude
--| Description: Returns a Longitude Type
--| Warnings: None
--*****
FUNCTION Get_Longitude(Lon : Longitude) RETURN Longitude;

--*****

```

```

--| Function: Get_Long_Deg
--| Input: Longitude
--| Output: Integer(Degree)
--| Description: Returns a Integer Type
--| Warnings: None
--*****
FUNCTION Get_Long_Deg(Lon : Longitude) RETURN Integer;

--*****

--| Function: Get_Long_Min
--| Input: Longitude
--| Output: Integer(Minute)
--| Description: Returns a Integer Type
--| Warnings: None
--*****
FUNCTION Get_Long_Min(Lon : Longitude) RETURN Integer;

--*****

--| Function: Get_Long_Sec
--| Input: Longitude
--| Output: Integer(Second)
--| Description: Returns a Integer Type
--| Warnings: None
--*****

```

```
FUNCTION Get_Long_Sec(Lon : Longitude) RETURN Integer;
```

```
--*****
```

```
--| Function: Get_Long_Sign
```

```
--| Input: Longitude
```

```
--| Output: Character(Sign)
```

```
--| Description: Returns a Character Type
```

```
--| Warnings: None
```

```
--*****
```

```
FUNCTION Get_Long_Sign(Lon : Longitude) RETURN Character;
```

```
PRIVATE
```

```
TYPE Latitude IS RECORD
```

```
  latd : Lat_Degree := 0;
```

```
  latm : Min_utes := 0;
```

```
  lats : Sec_onds := 0;
```

```
  AngleSign: Character := 'N';
```

```
END RECORD;
```

```
TYPE Longitude IS RECORD
```

```
longd : Long_Degree := 0;
longm : Min_utes := 0;
longs : Sec_onds := 0;
AngleSign : Character := 'W';
END RECORD;
```

```
END lat_long;
```

A-12 UTILITIES.ADS

```
--*****
```

```
--| FILE: Utilities.ads
--| AUTHOR: Kenneth L. Ehresman and Joey L. Frantzen, NPGS
--| LAST MODIFIED: 11 September 2001
--| OPERATING ENVIRONMENT: Windows 2000(Designed to be O/S Independent)
--| COMPILER: GNAT 3.13p
--| DESCRIPTION: This class is contains all of the data types and
--| functionality for generic general purpose procedures and functions
--| for the navigator program.
--| INPUTS: Based on specific function or procedure.
--| OUTPUTS: Outputs based on what Functions are requested and run.
--| Process: None to note
--| Assumptions: N/A
```

--| Warnings: None

--*****

WITH Realnum;

WITH Ada.Strings; USE Ada.Strings;

WITH Ada.Numerics.Generic_Elementary_Functions;

WITH Ada.Numerics; USE Ada.Numerics;

PACKAGE Utilities IS

TYPE My_Degree IS RANGE 0 .. 359;

--Defines range of track numbers allowed, 1100..2101 for total of 1000

--The last slot is never used unless it is an overflow error

LAST_TRACK_SLOT : CONSTANT INTEGER := 2101;

BEGIN_TRACK_SLOT : CONSTANT INTEGER := 1100;

SUBTYPE Track_Number_Range IS Integer RANGE 1100..LAST_TRACK_SLOT;

FUNCTION Validate_Time(T_ime : IN Realnum.Real) RETURN integer;


```
FUNCTION Get_Default_String RETURN String;
```

```
PROCEDURE Convert_String_To_Real(Temp_String : String;
```

```
Temp_Number : IN OUT Realnum.Real;
```

```
Okay : IN OUT Boolean );
```

```
FUNCTION Convert_To_Degree_String( Degree_Number : My_Degree )
```

```
RETURN String;
```

```
FUNCTION Convert_To_Hours_String( Hours : Integer ) RETURN String;
```

```
FUNCTION Convert_Track_Number_To_String( New_Track_Number : Integer )
```

```
RETURN String;
```

```
FUNCTION Convert_Integer_To_String( New_Number : Integer )
```

```
RETURN String;
```

```
FUNCTION Calculate_Scale ( Hit_Range : Realnum.Real ) RETURN Integer;
```

```
END Utilities;
```

A-13 MOBOARD.ADS

--*****

--| FILE: mboard.ads

--| AUTHOR: Kenneth L. Ehresman, Naval Post Graduate School

--| LAST MODIFIED: 1 October 2001

--| OPERATING ENVIRONMENT: LINUX & Windows 2000(Designed to be O/S Independent)

--| COMPILER: GNAT 3.13p

--| DESCRIPTION: This class draws a mboard, and provides functionality for drawing lines,

--| plotting contacts, and refreshing the mboard. It is used by other classes

--| Like CPA, Wind, etc that rely on the digitally-drawn mboard.

--| INPUTS: Function Specific

--| OUTPUTS: None

--| Process: None to note

--| Assumptions: N/A

--| Warnings: None

--*****

WITH Ada; USE Ada;

WITH Gtk; USE Gtk;

WITH Glib; USE Glib;

WITH Gdk.Color;

```

WITH Gdk.Drawable;           USE Gdk.Drawable;
WITH Gdk.Gc;                 USE Gdk.Gc;
WITH Gdk.Pixmap;
WITH Gtk.Drawing_Area;

WITH Ada.Numerics;           USE Ada.Numerics;
WITH      Ada.Numerics.Elementary_Functions;           USE
Ada.Numerics.Elementary_Functions;

WITH Degrees;
WITH Lat_Long;
WITH Realnum; USE Realnum;
WITH Sketchpad;
WITH Tracks;
WITH Utilities;

```

```

PACKAGE Mboard IS

```

```

--|*****

```

```

--| Function: Get_Current_Contact_Num

```

```

--| Input: None

```

```

--| Output: Returns the active contact Number

```

--| Preconditions: None
--| Description: See output
--| Side Effects: None

FUNCTION Get_Current_Contact_Num RETURN Integer;

--|*****

--|*****

--| Function: Get_Current_Contact_Bearing
--| Input: None
--| Output: Returns the active contact number's current bearing
--| Preconditions: None
--| Description: See output
--| Side Effects: None

FUNCTION Get_Current_Contact_Bearing RETURN Realnum.Real;

--|*****

--|*****

--| Function: Get_Current_Contact_Range
--| Input: None
--| Output: Returns the active contact number's current range in yards

--| Preconditions: None

--| Description: See output

--| Side Effects: None

FUNCTION Get_Current_Contact_Range RETURN Realnum.Real;

__* * * * *

__* * * * *

--| Function: Get_Current_Color

--| Input: None

--| Output: Returns the Mboard's current foreground drawing color

--| Preconditions: None

--| Description: See output

--| Side Effects: None

FUNCTION Get_Current_Color RETURN Gdk.Color.Gdk_Color;

__* * * * *

__* * * * *

--| Function: Get_Black_Color

--| Input: None

--| Output: Returns the Mboard's created color black

--| Preconditions: None

--| Description: See output

--| Side Effects: None

FUNCTION Get_Black_Color RETURN Gdk.Color.Gdk_Color;

__* * * * *

__* * * * *

--| Function: Get_Red_Color

--| Input: None

--| Output: Returns the Mboard's created color red

--| Preconditions: None

--| Description: See output

--| Side Effects: None

FUNCTION Get_Red_Color RETURN Gdk.Color.Gdk_Color;

__* * * * *

__* * * * *

--| Function: Get_Own_Ship_Course
--| Input: None
--| Output: Returns own ship course in true degrees as drawn in the moboard center via a speed vector
--| Preconditions: None
--| Description: See output
--| Side Effects: None

FUNCTION Get_Own_Ship_Course RETURN Utilities.My_Degree;

__* * * * *

__* * * * *

--| Function: Get_Own_Ship_Speed
--| Input: None
--| Output: Returns own ship speed in knots as drawn in the moboard center via a speed vector
--| Preconditions: None
--| Description: See output
--| Side Effects: None

FUNCTION Get_Own_Ship_Speed RETURN Realnum.Real;

__* * * * *

```
__* * * * *
--| Function: Get_Ship_XPos
--| Input: None
--| Output: Returns own ship x-pixel coordinate for the drawn speed vector, called in
CPA.Finish_Speed_Triangle
--| Preconditions: None
--| Description: See output
--| Side Effects: None
```

```
FUNCTION Get_Ship_XPos RETURN Gint;
```

```
__* * * * *
```

```
__* * * * *
```

```
--| Function: Get_Ship_YPos
--| Input: None
--| Output: Returns own ship y-pixel coordinate for the drawn speed vector, called in
CPA.Finish_Speed_Triangle
--| Preconditions: None
--| Description: See output
--| Side Effects: None
```

```
FUNCTION Get_Ship_YPos RETURN Gint;
```

```
__* * * * *
```


__* * * * *

--| Procedure: Set_Contact_XPos

--| Input: New_XPos - X-pixel position of the contact, used for calculating contacts course & speed in CPA.Finish_Speed_Trinagle

--| Output: None

--| Preconditions: None

--| Description: See input

--| Side Effects: None

PROCEDURE Set_Contact_XPos(New_XPos : Gint);

__* * * * *

__* * * * *

--| Procedure: Set_Contact_YPos

--| Input: New_YPos - Y-pixel position of the contact, used for calculating contacts course & speed in CPA.Finish_Speed_Trinagle

--| Output: None

--| Preconditions: None

--| Description: See input

--| Side Effects: None

PROCEDURE Set_Contact_YPos(New_YPos : Gint);

--*****

--*****

--| Procedure: Set_Current_Color
--| Input: New_Color - the new foreground drawing color
--| Output: None
--| Preconditions: None
--| Description: sets the new foreground drawing color
--| Side Effects: None

PROCEDURE Set_Current_Color(New_Color : Gdk.Color.Gdk_Color);

--*****

--*****

--| Procedure: Set_Current_Contact_Bearing
--| Input: Temp_Bearing - the current bearing of the active contact, used in CPA
--| Output: None
--| Preconditions: None
--| Description: sets the current contact bearing
--| Side Effects: None

PROCEDURE Set_Current_Contact_Bearing(Temp_Bearing : Realnum.Real);

__* * * * *

__* * * * *

--| Procedure: Set_Current_Contact_Range
--| Input: Temp_Range - the current range of the active contact, used in CPA
--| Output: None
--| Preconditions: None
--| Description: sets the current contact range
--| Side Effects: None

PROCEDURE Set_Current_Contact_Range(Temp_Range : Realnum.Real);

__* * * * *

__* * * * *

--| Procedure: Set_Current_Contact_Num
--| Input: Temp_Num - the new contact number to be processed
--| Output: None
--| Preconditions: None
--| Description: sets the contact number to be processed
--| Side Effects: None

--| Description: sets the new own ship speed

--| Side Effects: None

PROCEDURE Set_Own_Ship_Speed(New_Speed : Realnum.Real);

__* * * * *

__* * * * *

--| Procedure: Draw_A_Line

--| Input 1 : X1_Pos - The x-pixel coordinate of the first pixel

--| Input 2 : Y1_Pos - The y-pixel coordinate of the first pixel

--| Input 3 : X2_Pos - The x-pixel coordinate of the second pixel

--| Input 4 : Y2_Pos - The y-pixel coordinate of the second pixel

--| Output: A line from one cartesian coordinate to another drawn in the current drawing color

--| Preconditions: None

--| Description: This procedure draws a line from one pixel to another

--| Side Effects: None

--| Assumptions: None

PROCEDURE Draw_A_Line(X1_Pos : Gint; Y1_Pos : Gint; X2_Pos : Gint; Y2_Pos : Gint);

__* * * * *

__* * * * *

--| Procedure: Calculate_X_Y_Pixels

--| Input 1 : Input_Bearing - the true bearing of a contact

--| Input 2 : Input_Range - the range of the contact in yards

--| Input 3 : Return_XPos - the calculated x-pixel position

Input 4 : Return_YPos - the calculated y-pixel position

--| Input 5 : The_Scale - the display scale used for ensuring the hit plots to the screen

--| Output: See description

--| Preconditions: None

--| Description: Calculates, displays and returns the X and Y Pixel coordinates of acontact given

-- the bearing and range and scale

--| Side Effects: None

--| Assumptions: None

PROCEDURE Calculate_X_Y_Pixels(Input_Bearing : Realnum.Real; Input_Range : Realnum.Real;

Return_XPos : IN OUT Gint; Return_YPos : IN OUT Gint;

The_Scale : Integer);

__* * * * *

__*****

--| Procedure: Calculate_Slope_Of_Line
--| Input 1 : M1_XPos - The X_Pixel Position of First Hit
--| Input 2 : M2_XPos - The X_Pixel Position of Second Hit
--| Input 3 : M1_YPos - The Y_Pixel Position of First Hit
--| Input 4 : M2_YPos - The Y_Pixel Position of Second Hit
--| Input 5 : X_Fact - The delta of the two X_Positions in Pixels
--| Input 6 : Y_Fact - The delta of the two Y_Positions in Pixels
--| Input 7 : Slope - The ratio of Y_Fact / X_Fact
--| Output: See description
--| Preconditions: None
--| Description: This procedure calculates the slope of a line, as well as the deltas of the
--| X and Y_Positions. Note Paramters 5, 6, and 7 are calculated and returned.
--| Side Effects: None
--| Assumptions: None

```
PROCEDURE Calculate_Slope_Of_Line( M1_XPos : Gint; M2_XPos : Gint; M1_YPos  
: Gint; M2_YPos : Gint;  
X_Fact: IN OUT Realnum.Real; Y_Fact : IN OUT  
Realnum.Real;  
Slope : IN OUT Realnum.Real );
```

__*****

__* * * * *

--| Function: Find_Distance
--| Input 1 : M1_X - the x-pixel position of the first point
--| Input 2 : M2_X - the y-pixel position of the second point
--| Input 3 : M1_Y - the y-pixel position of the first point
--| Input 4 : M2_Y - the y-pixel position of the second point
--| Output: See description
--| Preconditions: Two valid points must be passed in
--| Description: Calculates the distance between tow point in pixels
--| Side Effects: None
--| Assumptions: None

FUNCTION Find_Distance(M1_X: Realnum.Real; M2_X: Realnum.Real; M1_Y :
Realnum.Real; M2_Y: Realnum.Real) RETURN Realnum.Real;

__* * * * *

__* * * * *

--| Function: Find_DRM
--| Input 1 : Ratio - the slope of a line
--| Input 2 : Xfact - the delta of two X_Positions (Pixels)
--| Input 3 : Yfact - the delta of two Y_Positions (Pixels)

--| Input 4 : Print_It - used to determine whether or not to graphically print out the CPA

--| Output: See description

--| Preconditions: None

--| Description: Takes the slope of a line as input and returns the Direction of Relative Motion

--| Side Effects: None

--| Assumptions: None

FUNCTION Find_DRM(Ratio : Realnum.Real; Xfact: Integer; Yfact : Integer; Print_It: Boolean) RETURN Utilities.My_Degree;

__* * * * *

__* * * * *

--| Procedure: Update_Course_Speed

--| Input 1 : Course_Str - a non-empty string

--| Input 2 : Speed_Str - a non-empty string

--| Output: See description

--| Preconditions: None

--| Description: Converts the inputted strings, checks their validity, and then update both the Ownship Course and Speed Clist

--| as well as the database

--| Side Effects: None

--| Assumptions: None

PROCEDURE Update_Course_Speed(Course_Str : String; Speed_Str : String);

__* * * * *

PROCEDURE Draw_Moboard (New_Area : Sketchpad.Gtk_Sketchpad);

PROCEDURE Init(D_Width: Gint; D_Height: Gint; X_Orig : Gint; Y_Orig : Gint;

GreenGc : Gdk_GC; BlueGc : Gdk_GC; Dashed_GreenGc : Gdk_GC;

RedGC : Gdk_GC; New_Area : Sketchpad.Gtk_Sketchpad;

Red_Color : Gdk.Color.Gdk_Color; Black_Color : Gdk.Color.Gdk_Color);

PROCEDURE Replenish_Screen;

PROCEDURE Draw_All_Contacts;

__* * * * *

-- This procedure draws an arrow at the end of a vector

-- Argument 1: Vector Direction - is the direction the line is going

-- Argument 2: X_Position - is the screen X_Position to center around

-- Arguemnt 3: Y_Position - is the screen Y_Position to center around

```
PROCEDURE Draw_An_Arrow( Vector_Direction : Realnum.Real; X_Position : Gint;
Y_Position : Gint );
```

```
__*****
```

```
PROCEDURE Update_Contact( Contact_Num : String; Contact_ID: String;
Contact_Bearing : String;
```

```
Contact_Range : String; New_Contact : Boolean );
```

```
PROCEDURE Plot_A_Point( Plot_Bearing : Realnum.Real; Plot_Range :
Realnum.Real; Scale : Integer );
```

```
__*****
```

-- This procedure saves the own ship Longitude

-- Argument 1: valid longitude degrees

-- Argument 2: valid longitude minutes

-- Argument 3: valid longitude seconds

-- Argument 4: valide llongitude hemisphere

```
PROCEDURE Update_Longitude( Long_Degrees : Lat_Long.Long_Degree;
Long_Minutes : Lat_Long.Min_utes;
```

```
Long_Seconds : Lat_Long.Sec_onds; Long_Hemisphere :  
String );
```

```
--*****
```

```
--*****
```

```
-- This procedure saves the own ship Latitude  
-- Argument 1: valid latitude degrees  
-- Argument 2: valid latitude minutes  
-- Argument 3: valid latitude seconds  
-- Argument 4: valide latitude hemisphere
```

```
PROCEDURE Update_The_Latitude( Lat_Degrees : Lat_Long.Long_Degree;  
Lat_Minutes : Lat_Long.Min_utes;  
Lat_Seconds : Lat_Long.Sec_onds; Lat_Hemisphere :  
String );
```

```
--*****
```

```
PRIVATE
```

```
Current_Contact_Num : Integer;
```

```
Current_Contact_Bearing,
```

Current_Contact_Range,

Moboard_Radius : Realnum.Real;

Black,

Current_Color,

Red : Gdk.Color.Gdk_Color;

Ratio_Array : ARRAY(0..2, Utilities.My_Degree) OF Realnum.Real;

NUMBER_O_CIRCLES : CONSTANT Integer := 11;

One_Degree : Realnum.Real := Pi / 180.0;

Own_Ship_Course : Utilities.My_Degree := 0;

Own_Ship_Speed : Realnum.Real := 0.0;

Set_Up_Distance : Realnum.Real := 100_000.0;

Current_Area : Sketchpad.Gtk_Sketchpad;

Contact_XPos,

Contact_YPos,

Ship_XPos,

Ship_YPos,

Draw_Width,

```

Draw_Height,
X_Origin,
Y_Origin      : Gint;

```

```

Dashed_Green_GC,
Green_GC,
Blue_Gc,
Red_Gc : Gdk_GC;

```

```

--* * * * *

```

```

--| Procedure: Initialize_Ratio_Array

```

```

--| Input: None

```

```

--| Output: None

```

```

--| Preconditions: None

```

```

--| Description: This procedure calculates the ratio of Y over X for determining a unique
slope and value for every degree

```

```

--|           from 0 to 359 degrees. The values are stored in Ratio_Array for use in
determining which degree the slope of

```

```

--|           a line represents.

```

```

--| Side Effects: Ratio_Array values are set and calculated using a range of 100000 yards
in order to make them distinctly

```

```

--|           unique.

```

```

PROCEDURE Initialize_Ratio_Array;

```

--*****

--*****

--| Procedure: Plot_Course_Vector

--| Input 1 : Ship_Course - A Realnum.Real number representing Own Ships Course in degrees

--| Input 2 : Ship_Speed - A Realnum.Real number representing Own Ships Speed in knots

--| Output: See description

--| Preconditions: None

--| Description: Draws the course and speed vector for the ship

--| Side Effects: None

--| Assumptions: None

PROCEDURE Plot_Course_Vector(Ship_Course : Realnum.Real; Ship_Speed : Realnum.Real);

--*****

END Mboard;

A-14 CPA.ADS

--*****

--| FILE: CPA.ads

--| AUTHOR: Kenneth L. Ehresman, Naval Post Graduate School
--| LAST MODIFIED: 1 October 2001
--| OPERATING ENVIRONMENT: LINUX & Windows 2000(Designed to be O/S Independent)
--| COMPILER: GNAT 3.13p
--| DESCRIPTION: This class calculates a contact's CPA which includes:
--| CPA Time, Bearing, Range,
--| Contact Course, Speed and Target Angle
--| INPUTS: Function Specific
--| OUTPUTS: None
--| Process: None to note
--| Assumptions: N/A
--| Warnings: None

__*****

WITH Ada; USE Ada;
WITH Gtk; USE Gtk;
WITH Glib; USE Glib;

WITH Gdk.Color;
WITH Gdk.Drawable; USE Gdk.Drawable;
WITH Gdk.Gc; USE Gdk.Gc;
WITH Gdk.Pixmap;

WITH Gtk.Drawing_Area;

WITH Ada.Numerics; USE Ada.Numerics;

WITH Ada.Numerics.Elementary_Functions;USE Ada.Numerics.Elementary_Functions;

WITH Degrees;

WITH Realnum; USE Realnum;

WITH Sketchpad;

WITH Times;

WITH Tracks;

WITH Utilities;

PACKAGE cpa IS

..* * * * *

--| Function: Get_Alert_Distance

--| Input: None

--| Output: Returns the user-defined CPA alert distance

--| Preconditions: None

--| Description: See output

--| Side Effects: None

```

FUNCTION Get_Alert_Distance RETURN Realnum.Real;

--* * * * *
--* * * * *

--| Procedure: Set_Alert_Distance

--| Input: A real number, representing the new user-defined CPA alert distance

--| Output: None

--| Preconditions: None

--| Description: Sets the CPA_Alert_Distance to a new distance selected from a
ComboBox by the user

--| Side Effects: None

```

```

PROCEDURE Set_Alert_Distance( New_Distance : Realnum.Real );

--* * * * *
--* * * * *

--| Procedure: Calculate_CPA

--| Input 1 : Track_Num - The track number of the contact whose CPA is to be calculated

--| Output: The selected contacts graphically generated CPA, as well as an update to the
screen of the CPA details in

--| the Contact CPA Clist

--| Preconditions: The track number must have two Radar hits.

--| Description: This procedure uses the last two Radar hits of a contact, and graphically
draws the CPA. While drawing

--| CPA the SRM and MRM are calculated, the speed triangle is generated, and
the contact's current course,

```

```

--|           speed, and all CPA details are calculated and displayed. Upon completion
the boolean in the Sketchpad

--|           class which allows manual fairing of all bearings is set to true, thereby
enabling the user's ability to

--|           recalculated the Course, Speed and CPA of the contact using faired bearings.

--|           The contacts last two radar hits are plotted and the Measure of Relative
Motion (MRM)

--|           is calculated in yards.

--|           Next, the Direction of Relative Motion (DRM) is calculated and the slope of
the inter-

--|           connected line between the two hits is determined.

--|           A line projection using the DRM is drawn to the edge of the outer-moboard
ring, and the CPA

--|           is calculated by the closest part of this line to the Moboard's origin (center).

--|           The CPA Bearing, Time, and Range are then displayed, and the contact's
course and speed

--|           are determined by calling the procedure "Finish_Speed_Triangle"

--| Side Effects:  The current contact's CPA, course and speed are saved into the Track
Class.

--|           Sketchpad's Boolean allowing the fairing of bearings is set to True.

--| Assumptions:  None

```

```

PROCEDURE Calculate_CPA( Track_Num : Utilities.Track_Number_Range );
--* * * * *

```

```

__* * * * *
--| Procedure: Initialize
--| Input 1 : Current_Area - The double-buffered drawing area maintained in the
Sketchpad class
--| Input 2 : Current_X_Origin - The x-pixel position of the center of the drawing area
--| Input 3 : Current_Y_Origin - The y-pixel position of the center of the drawing area
--| Output: None
--| Preconditions: A current drawing area in the Sketchpad class has been instantiated.
--| Description: This procedure is passed in the double-buffered drawing area
maintained in the Sketchpad class, as well
--| as the X and Y pixel coordinated of the center of the drawing area.
--| This procedure is called from within Mboard's Init procedure
--| Side Effects: None
--| Assumptions: None

```

```

PROCEDURE Initialize( Current_Area : Sketchpad.Gtk_Sketchpad; Current_X_Origin :
Gint; Current_Y_Origin : Gint );

```

```

__* * * * *

```

```

__* * * * *

```

```

--| Procedure: Manually_Fair_Bearings
--| Input 1 : X_Pos - The x-pixel position chosen by left clicking the mouse

```

--| Input 2 : Y_Pos - The y-pixel position chosen with the mouse

--| Output: Same as Calculate CPA

--| Preconditions: A CPA for the currently selected contact must have been calculated. This will have set a boolean variable

--| in sketchpad which allows the fairing of bearings.

--| Description: This procedure is the same as calculate CPA except. It uses the original times of both the first and last RADAR

--| hit and outputs a new CPA based on user Faired bearings.

--| Side Effects: The current contact's CPA, course and speed are saved into the Track Class.

--| Sketchpad's Boolean allowing the fairing of bearings is set to False.

--| Assumptions: The SRM and MRM used are the average over the entire track's hit life

PROCEDURE Manually_Fair_Bearings(X_Pos : Gint; Y_Pos : Gint);

__* * * * *

__* * * * *

--| Procedure: Initialize_Faired_Bearing_Variables

--| Input 1 : Track_Num - The track number of the contact of Fair Bearings on

--| Input 2 : Track_Bearing1 - The contact's first bearing to be faired in degrees

--| Input 3 : Track_Range1 - The contact's first range in yards

--| Input 4 : X1_Pos - The x-pos pixel position of the first bearing

--| Input 5 : Y1_Pos - The y-pos pixel position of the first bearing

--| Input 6 : Scale - The contact's scale for plotting the points

--| Input 7 : Track_Bearing2 - The contact's second bearing to be faired in degrees

--| Input 8 : Track_Range1 - The contact's second range in yards

--| Input 9 : X1_Pos - The x-pos pixel position of the second bearing

--| Input 10 : Y1_Pos - The y-pos pixel position of the second bearing

--| Input 11 : Time1 - The time of the contact's first hit

--| Input 12 : Time2 - The time of the contact's last hit

--| Output: None

--| Preconditions: None

--| Description: This procedure initializes all the variables required to Fair a contact's bearings and

--| calculated a new CPA

--| Side Effects: None

--| Assumptions: None

```

PROCEDURE Initialize_Faired_Bearing_Variables( Track_Num : Integer;
Track_Bearing1 : Utilities.My_Degree;
Track_Range1 : Realnum.Real; X1_Pos : Gint; Y1_Pos : Gint;
Scale : Integer; Track_Bearing2 : Utilities.My_Degree;
Track_Range2 : Realnum.Real; X2_Pos : Gint; Y2_Pos : Gint; Time1 :
Times.Time_Type; Time2 : Times.Time_Type );
__*****

```

PRIVATE

SPEED_SCALE : CONSTANT Realnum.Real := 5.0;

NUMBER_O_CIRCLES : CONSTANT Integer := 11;

One_Degree : Realnum.Real := Pi / 180.0;

CPA_Drawing_Area : Sketchpad.Gtk_Sketchpad;

X_Origin,

Y_Origin : Gint;

CPA_Alert_Distance : Realnum.Real := 10000.0;

-- The following variables are for fairing the bearings.

Faired_First_XPos,

Faired_First_YPos,

Faired_Second_XPos,

Faired_Second_YPos : Gint;

Faired_First_Bearing,

Faired_Second_Bearing : Utilities.My_Degree;

```

    Faired_First_Range,
    Faired_Second_Range : Realnum.Real;

    Faired_Scale,
    Faired_Track_Num   : Integer;

    Faired_Time1,
    Faired_Time2      : Times.Time_Type;

```

```

_*****

```

```

--| Procedure: Calculate_SRM
--| Input 1 : MRM - Measure of Relative Motion in yards
--| Input 2 : M1_Time - Time of First Hit
--| Input 3 : M2_Time - Time of Second Hit
--| Input 4 : First_Hit_Time - Time of First Hit converted to just Hours and minutes
--| Input 5 : SRM - the Speed of Relative Motion in knots
--| Input 6 : Valid - a boolean that indicates if the calculated SRM is valid and therefore
usable
--| Output:  The SRM is calculated and returned, as well as the Boolean value Valid,
which indicates if the SRM is usable
--| Preconditions:  Two RADAR hits must be available as well as the Measure of
Relative motion. Each RADAR hit must have an

```


--| associated time, which can not be identical. Additionally, the calculated SRM must be > 0.0 knots to be valid.

--| Description: This procedure takes the measure of relative motion, measured in yards, and returns the Speed of Relative motion

--| in knots.

PROCEDURE Calculate_SRM(MRM : Realnum.Real; M1_Time : Times.Time_Type;
M2_Time : Times.Time_Type;

First_Hit_Time : IN OUT Realnum.Real; SRM : IN OUT
Realnum.Real; Valid : IN OUT Boolean);

__* * * * *

__* * * * *

--| Procedure: Finish_Speed_Triangle

--| Input 1 : SRM - the speed of relative motion in knots

--| Input 2 : DRM - the direction of relative motion in Degrees

--| Input 3 : Contact_Number - the contact number of input contact

--| Output: Graphically displayed as per Description. (Contact's Course and Speed vector as well as relative DRM)

--| Preconditions: This procedure is called by Calculate_CPA; therefore, all of Calculate_CPA's post-conditions must be met

--| Description: This procedure takes as input the speed of relative motion and direction of relative motion, which are used

--| for drawing the speed triangle, just like a regular moboard does. During procedure instantiation, the

```

--|          scale for the contact number is retrieved from the Tracks class, as well as the
X and Y pixel coordinates

--|          of own ship's speed vector (via Mboard class).

--|          The contact's course and speed are graphically drawn, then inferred from the
drawing, and saved via the Tracks

--|          class.

--| Side Effects:  The Track_Num's calculated course and speed are updated.

```

```

PROCEDURE  Finish_Speed_Triangle(  SRM    :  Realnum.Real;  DRM    :
Utilities.My_Degree; Track_Num : Utilities.Track_Number_Range );

```

```

--*****

```

```

END cpa;

```

A-15 MAINSCREEN-PKG.ADS

```

WITH Gtk.Arguments;

```

```

WITH Gtk.Widget;    USE Gtk.Widget;

```

```

WITH Gtk.Color_Selection_Dialog; USE Gtk.Color_Selection_Dialog;

```

```
WITH Gtk.Text;      USE Gtk.Text;
```

```
WITH Gtk.Window;   USE Gtk.Window;
```

```
WITH Gtk.Button;
```

```
WITH Gtk.Menu_Item;
```

```
PACKAGE Main_Screen_Pkg.Callbacks IS
```

```
Text1 : Gtk_Text;
```

```
Show_Course: Boolean := True;
```

```
Color_Done : Boolean := False;
```

```
-- The first three procedures must be instantiated, even though they will never be  
connected!
```

```
PROCEDURE      On_Cpa1_Activate(      Object      :      ACCESS  
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

PROCEDURE On_Preferences1_Activate(Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);

PROCEDURE On_Contact1_Activate(Object: ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);

PROCEDURE On_Show_Closest_Activate(Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);

PROCEDURE Put_Lat_Long_Into_Ownship_Lat_Long_Clist;

-- Manually fair the bearing to recalculate the CPA

PROCEDURE On_Manual_Fair_Activate(Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);

--The following will eventually be implemented

PROCEDURE On_Show_Cpas_Activate(Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);

PROCEDURE On_Show_Lines_Activate(Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);

PROCEDURE On_Update_Contact_Info_Activate(Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);

PROCEDURE On_Course1_Text_Changed(Object : ACCESS
Gtk_Text_Record'Class);

-- the following proceures have been implemented

```
PROCEDURE      On_Drop_Contact_Activate(      Object      :      ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

-- The next three are for creating a new contact, and responding to the submit and Cancel buttons

```
PROCEDURE      On_Create_New_Contact_Activate(      Object      :      ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE      On_New_Contact_Button_Clicked(      Object      :      ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

```
PROCEDURE      On_New_Contact_ButtonCancel_Clicked(      Object      :      ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

-- the next three are for inputting a new hit, and responding to its submit and Cancel buttons

```
PROCEDURE On_Input_New_Contact_Hit_Activate( Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE On_Input_Hit_Button_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

```
PROCEDURE On_Input_Hit_ButtonCancel_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

-- The next three are for inputting own ships course and speed

```
PROCEDURE On_Input_Course_Speed_Activate( Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE On_Course_Button_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

```
PROCEDURE On_Course_ButtonCancel_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

--The next three are for inputting own ships lat and long

```
PROCEDURE      On_Input_Lat_Long_Activate(      Object      :      ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE      On_Lat_Button_Clicked(      Object      :      ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

```
PROCEDURE      On_Lat_ButtonCancel_Clicked(      Object      :      ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

-- The next few things are for inputting a contact's color

```
PROCEDURE      On_Color_Button_Clicked(      Object      :      ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

```
PROCEDURE      On_Color_ButtonCancel_Clicked(      Object      :      ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```



```
PROCEDURE Put_Lat_Long_Into_Track_Lat_Long_Clist( Track_Number : Integer );
```

```
PROCEDURE Change_The_Contacts_Colors;
```

```
-- Process the wind options
```

```
PROCEDURE      On_Wind_Activate(      Object      :      ACCESS  
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE      On_True_Wind_Activate(      Object      :      ACCESS  
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE      On_Wind_Course_Activate(      Object      :      ACCESS  
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE      On_Wind_Button_Clicked(      Object      :      ACCESS  
Gtk.Button.Gtk_Button_Record'Class );
```

```
PROCEDURE      On_Wind_ButtonCancel_Clicked(      Object      :      ACCESS  
Gtk.Button.Gtk_Button_Record'Class );
```

```
--Process all contact purge times
```

```
PROCEDURE      On_Track_Purge_Time_Activate(      Object      :      ACCESS  
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE On_Purge_Button_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

```
PROCEDURE On_Purge_ButtonCancel_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

```
-- * * * * *
```

```
-- This procedure checks the number of currently held contacts in the database, and
deletes
```

```
-- any extraneous tracks that are being displayed in the contact_clist. In other words,
```

```
-- it keeps the screen current with tracks that are dropped by the db due to age
```

```
PROCEDURE Purge_The_Contact_Clist;
```

```
--Process the setting of the Minimum_CPA_Alert_Range
```

```
PROCEDURE On_CPA_Alert_Range_Activate( Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE On_Alert_Button_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

```
PROCEDURE On_Alert_ButtonCancel_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

```
END Main_Screen_Pkg.Callbacks;
```

A-16 MAINSCREEN-PKG-CALLBACKS.ADS

WITH Gtk.Arguments;

WITH Gtk.Widget; USE Gtk.Widget;

WITH Gtk.Color_Selection_Dialog; USE Gtk.Color_Selection_Dialog;

WITH Gtk.Text; USE Gtk.Text;

WITH Gtk.Window; USE Gtk.Window;

WITH Gtk.Button;

WITH Gtk.Menu_Item;

PACKAGE Main_Screen_Pkg.Callbacks IS

Text1 : Gtk_Text;

Show_Course: Boolean := True;

Color_Done : Boolean := False;

-- The first three procedures must be instantiated, even though they will never be connected!

```
PROCEDURE      On_Cpa1_Activate(      Object      :      ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE      On_Preferences1_Activate(      Object      :      ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE      On_Contact1_Activate(      Object:      ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class );
```

```
PROCEDURE      On_Show_Closest_Activate(      Object      :      ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE Put_Lat_Long_Into_Ownship_Lat_Long_Clist;
```

-- Manually fair the bearing to recalculate the CPA

```
PROCEDURE      On_Manual_Fair_Activate(      Object      :      ACCESS  
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

--The following will eventually be implemented

```
PROCEDURE      On_Show_Cpas_Activate(      Object      :      ACCESS  
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE      On_Show_Lines_Activate(      Object      :      ACCESS  
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE      On_Update_Contact_Info_Activate(      Object      :      ACCESS  
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE      On_Course1_Text_Changed(      Object      :      ACCESS  
Gtk_Text_Record'Class );
```

-- the following proceures have been implemented

```
PROCEDURE On_Drop_Contact_Activate( Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

-- The next three are for creating a new contact, and responding to the submit and Cancel buttons

```
PROCEDURE On_Create_New_Contact_Activate( Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE On_New_Contact_Button_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

```
PROCEDURE On_New_Contact_ButtonCancel_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

-- the next three are for inputting a new hit, and responding to its submit and Cancel buttons

```
PROCEDURE On_Input_New_Contact_Hit_Activate( Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE On_Input_Hit_Button_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

```
PROCEDURE On_Input_Hit_ButtonCancel_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

-- The next three are for inputting own ships course and speed

```
PROCEDURE On_Input_Course_Speed_Activate( Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE On_Course_Button_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

```
PROCEDURE On_Course_ButtonCancel_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

-- The next three are for inputting own ships lat and long

```
PROCEDURE On_Input_Lat_Long_Activate( Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);
```

```
PROCEDURE On_Lat_Button_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

```
PROCEDURE On_Lat_ButtonCancel_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

-- The next few things are for inputting a contact's color

```
PROCEDURE On_Color_Button_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

```
PROCEDURE On_Color_ButtonCancel_Clicked( Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class );
```

```
PROCEDURE Put_Lat_Long_Into_Track_Lat_Long_Clist( Track_Number : Integer );
```

```
PROCEDURE Change_The_Contacts_Colors;
```

-- Process the wind options

PROCEDURE On_Wind_Activate(Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);

PROCEDURE On_True_Wind_Activate(Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);

PROCEDURE On_Wind_Course_Activate(Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);

PROCEDURE On_Wind_Button_Clicked(Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class);

PROCEDURE On_Wind_ButtonCancel_Clicked(Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class);

--Process all contact purge times

PROCEDURE On_Track_Purge_Time_Activate(Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);

PROCEDURE On_Purge_Button_Clicked(Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class);

PROCEDURE On_Purge_ButtonCancel_Clicked(Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class);

--*****

-- This procedure checks the number of currently held contacts in the database, and deletes

-- any extraneous tracks that are being displayed in the contact_clist. In other words,

-- it keeps the screen current with tracks that are dropped by the db due to age

PROCEDURE Purge_The_Contact_Clist;

--Process the setting of the Minimum_CPA_Alert_Range

PROCEDURE On_CPA_Alert_Range_Activate(Object : ACCESS
Gtk.Menu_Item.Gtk_Menu_Item_Record'Class);

PROCEDURE On_Alert_Button_Clicked(Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class);

PROCEDURE On_Alert_ButtonCancel_Clicked(Object : ACCESS
Gtk.Button.Gtk_Button_Record'Class);

END Main_Screen_Pkg.Callbacks;

A-17 SKETCHPAD.ADS

WITH Glib; USE Glib;

WITH Gdk.Color;

WITH Gdk.Drawable;

WITH Gdk.Gc;

WITH Gdk.Pixmap;

WITH Gdk.Window;

WITH Gtk.Drawing_Area;

PACKAGE Sketchpad IS

Draw_Width,

Draw_Height,

X_Origin,

Y_Origin : Gint;

type Gtk_Sketchpad_Record is new

Gtk.Drawing_Area.Gtk_Drawing_Area_Record with private;

type Gtk_Sketchpad is access all Gtk_Sketchpad_Record'Class;

```
PROCEDURE Gtk_New( Drawing_Widget : Out Gtk_Sketchpad; Video_Width : Gint;
Video_Height : Gint );
```

```
PROCEDURE Initialize( Drawing_Widget : ACCESS Gtk_Sketchpad_Record'Class;
Video_Width : Gint; Video_Height : Gint );
```

```
PROCEDURE Set_Allow_CPA( Enable_CPA : Boolean );
```

```
PROCEDURE Allow_Drawing_Fairline( Allow_Drawing : Boolean );
```

```
PROCEDURE Set_Anchor_Pixels( X1_Pos : Gint; Y1_Pos : Gint );
```

```
FUNCTION Get_Allow_CPA RETURN Boolean;
```

```
FUNCTION Get_Moboard_Pixmap( Drawing_Widget : ACCESS
Gtk_Sketchpad_Record'Class ) RETURN Gdk.Drawable.Gdk_Drawable;
```

```
PRIVATE
```

```
TYPE Gtk_Sketchpad_Record IS NEW
```

```
Gtk.Drawing_Area.Gtk_Drawing_Area_Record
```

```
WITH RECORD
```

```
-- The pixmap used for double buffering
```

```
Pixmap          : Gdk.Pixmap.Gdk_Pixmap := Gdk.Pixmap.Null_Pixmap;
```

```
END RECORD;
```

```
Calculate_CPA    : Boolean := False;
```

```
Permission       : Boolean := False;
```

```
Faired_XPos_Anchor,
```

```
Faired_YPos_Anchor : Gint;
```

```
END Sketchpad;
```

A-18 WIND.ADS

```
-- Filename: wind.ads
```

```
-- Author: Ken Ehresman
```

```
-- This file is for calculating true wind, and desired wind as well as plotting their
```

```
-- solutions onto a moboard.
```

WITH Ada; USE Ada;

WITH Gtk; USE Gtk;

WITH Glib; USE Glib;

WITH Gdk.Color;

WITH Gdk.Drawable; USE Gdk.Drawable;

WITH Gdk.Gc; USE Gdk.Gc;

WITH Gdk.Pixmap;

WITH Gtk.Drawing_Area;

WITH Ada.Numerics; USE Ada.Numerics;

WITH Ada.Numerics.Elementary_Functions; USE
Ada.Numerics.Elementary_Functions;

WITH Degrees;

WITH Realnum; USE Realnum;

WITH Sketchpad;

WITH Tracks;

WITH Utilities;

PACKAGE Wind IS

PROCEDURE Calculate_True_Wind;

```

--*****

-- This procedure is called in order to initialize class variables. It is called from within
Moboard's Init procedure

```

```

PROCEDURE Initialize( Current_Area : Sketchpad.Gtk_Sketchpad; Current_X_Origin
: Gint; Current_Y_Origin : Gint );

```

```

--*****
--*****

```

```

-- This procedure is called in order calculate the True Wind from measured wind
-- Argument 1: Measured_Wind_Direction - Direction from which wind was measured
from
-- Argument 2: Measure_Wind_Speed    - Speed or measured wind
-- Argument 3: Measured_Wind_Type    - Relative or Apparant wind

```

```

PROCEDURE Calculate_True_Wind( Measured_Wind_Direction : Integer;
Measured_Wind_Speed : Integer; Relative_Wind_Type : Boolean );

```

```

--*****

```

PRIVATE

```

Wind_Drawing_Area : Sketchpad.Gtk_Sketchpad;
SPEED_SCALE : CONSTANT Realnum.Real := 5.0;
NUMBER_O_CIRCLES : CONSTANT Integer := 11;

```

One_Degree : Realnum.Real := Pi / 180.0;

X_Origin,

Y_Origin : Gint;

END Wind;

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