OMIA: MH-60R Helicopter Desktop Crew Trainer & Software Change Experimentation Tool

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***Abstract*—The US Navy's PMA-205 in conjunction with Stottler Henke Associates, Inc. (SHAI) has developed and deployed a tool that can be used for training and Software Change (SC) experimentation for the MH-60R & MH-60S helicopters, used by the US Navy, the Australian Navy, the Saudi Navy, the Danish Navy, and the Navy of India. The tool, called the Operator Machine Interface Assistant (OMIA), is primarily an expandable, easily modifiable low-cost PC-hosted desktop crew trainer in use by US and Australian Navy training squadrons, helicopter maintenance organizations, and by fleet squadrons at port, and when deployed at sea; both navies have unlimited access to OMIA. OMIA is also used for Saudi Navy training and India Navy training. OMIA provides much of the cockpit interface for the front seats of the MH-60S & MH-60R and the Sensor Operator station in the MH-60R. OMIA provides training in most aspects of flight operations except flying, this includes but is not limited to navigation operations, radio operations, emergency operations, RADAR, ISAR, ESM, FLIR, and both active and passive acoustics.**

This reality has resulted in a product that is not only valuable for training, but is also useful for SC experimentation, design, and testing. OMIA has been designed to be flexible, allowing for low-cost, rapid development since the software and crew interfaces have been constantly evolving, and OMIA has had to keep current. OMIA's flexibility has allowed SHAI to many times deploy updated versions matching the latest SC more rapidly than the weapons trainers and full-flight simulators used by the Navy.

A major user interface component is on-screen menus. A menu generation and modification tool has been developed as part of OMIA, which makes it easier for developers to move or change menu elements. Thus, OMIA can be leveraged as an innovative concept in the areas of aircraft systems and avionics development, situational awareness, and airspace awareness. For example, at the time of this writing OMIA is being enhanced with digital map capabilities to match the recent addition of the digital map to the helicopter. How best to integrate this new capability with current capabilities requires a certain level of experimentation, OMIA can be rapidly modified so the Navy can quickly change the user interface and then experiment to determine which user interface configuration is most efficient for the crew. This is just one example use case because as the helicopter continues to evolve the most efficient and effective enhancements could be made more rapidly by using OMIA to test potential user experience changes most rapidly.

This paper demonstrates not only the significant training benefit OMIA provides to the various navies that fly the MH-60S & MH-60R helicopters, but also the power of OMIA as a rapid evaluation tool for potential enhancements to the crew members workflow. OMIA allows the Navy to evolve the helicopter more efficiently, and train crew members more rapidly thanks to the same OMIA flexible rapid development tools.

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1. INTRODUCTION

The US Navy flies two similar but distinct helicopters, the MH-60S and MH-60R. Both of these helicopters utilize Lockheed-Martin's Common Cockpit design [1]. The Common Cockpit includes all the flight and mission instrumentation in both of the helicopters and enables both the pilot and co-pilot to share workload through dual flight and mission instrumentation. As can be seen in Figure 1 the pilot and copilot each have two LCD screens, one of which is the Mission Display (MD) and the other is the Flight Display (FD). The pilots interact with these displays primarily through a trackball-based pointing device (PD) and a set of bezel keys around each display. There is also a Control Display Unit (CDU) in the center console, used for operator inputs.

For over a decade the US Navy's PMA-205, in conjunction with industry, has developed, deployed, and updated a flexible, low-cost PC-hosted crew trainer for the Navy's MH-60S (Sierra) and MH-60R (Romeo) helicopters called the *Operator Machine Interface Assistant* (OMIA) [2][3].

OMIA is used by US and Australian Navy training squadrons, helicopter maintenance organizations, and by fleet squadrons at port, and when deployed at sea; both navies have unlimited access to OMIA. OMIA is also used for Saudi Navy training and India Navy training. OMIA provides much of the cockpit interface for the front seats of the MH-60S & MH-60R and the Sensor Operator station in the MH-60R. OMIA provides training in most aspects of flight operations except flying, this includes but is not limited to navigation operations, radio operations, emergency operations, RADAR, ISAR, ESM, FLIR, and both active and passive acoustics.

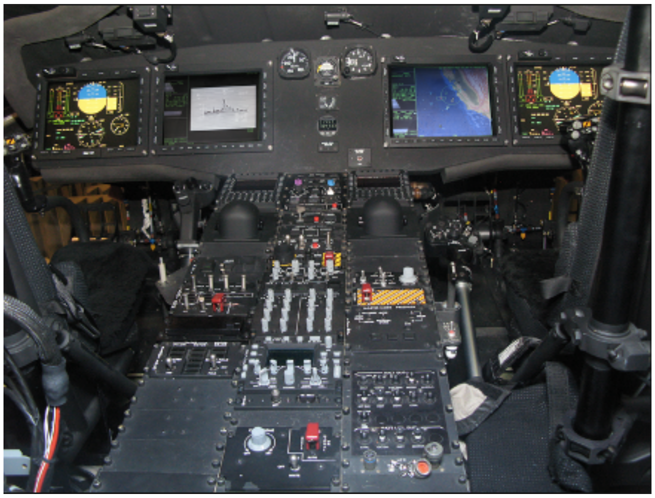


Figure 1. MH-60 Common Cockpit

The purpose of this paper is to discuss:

1. OMIA as a training tool and design decisions that have allowed OMIA to be easily modified to rapidly meet changing requirements due to updates to the helicopter's software configuration; and
2. The unanticipated no-cost benefits that have come out of the deployment of the training device as a Software Change Experimentation tool.

The core of OMIA (Figure 2) is a standalone Java program that operates under any standard Windows, Linux or Macintosh computer that is installed with a Java Runtime Environment (JRE); it is also compatible with Navy/Marine Corps Intranet (NMCI) computers. The standalone OMIA provides an introduction to the Common Cockpit, including the Mission Display (Figure 3), the Flight Display (Figure 4), the Control Display Unit (CDU) (Figure 5), and several helicopter control panels. A major benefit of the standalone core OMIA trainer that the Navy requires, is that the application uses no external licensing, and therefore it can be distributed freely to anyone in the US Navy via compact disc or the Web. In addition, the core system also supports a number of optional extensions to meet other training needs.

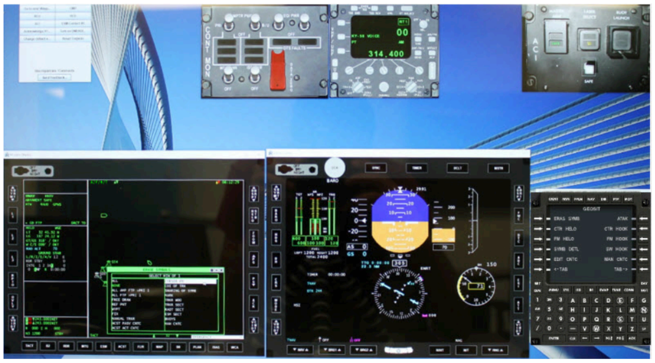


Figure 2. OMIA Part-Task Trainer (PTT)

The core OMIA program is used to teach Navy crewmembers how to operate both the Sierra and Romeo versions of the helicopter. That is, OMIA provides training in most aspects of flight operations except flying, this includes but is not limited to navigation operations, radio operations, emergency operations, RADAR, ISAR, ESM, FLIR, and both active and passive acoustics. A different executable is created for each configuration. Presently there are two for the MH-60S (armed and non-armed) and two for the MH-60R (pilot and sensor operator). In addition, the user can also run in standalone mode (the default) or in network configuration. In a network configuration, one operator can be the pilot and another operator can be the co-pilot or sensor operator. In this scenario, both operators will see the same world, including changes made by each other.

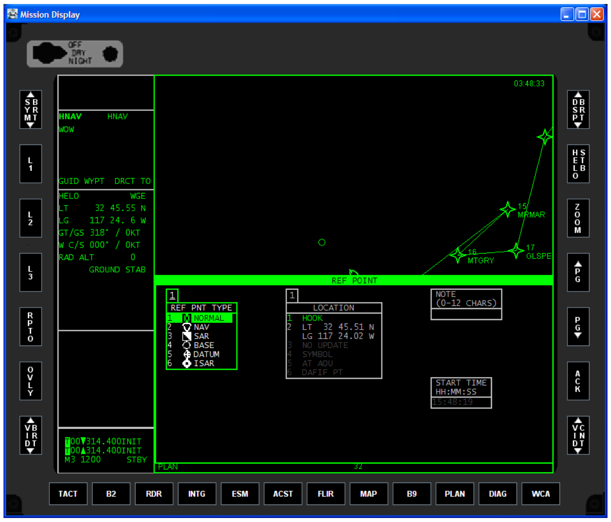


Figure 3. OMIA Mission Display with Menu Visible

The architecture is designed to allow the OMIA trainer to automatically configure itself during the startup process to deliver the most optimum training environment possible. This includes the ability to sense when multiple monitors are connected, and/or presence of a touch screen display. OMIA is able to detect if optional hardware is installed and will work correctly with new hardware automatically. The simplest example is multiple monitors: by attaching two displays, the Mission Display, shown in Figure 3, and the Flight Display, shown in Figure 4, can be displayed on separate monitors, with one of the monitors also displaying the Center Console panels. The bezel keys on the flight display and mission display may be operated using finger pushes on a touch screen in order to emulate the ergonomics of the actual helicopter more accurately. OMIA can support a third screen, which can be a touch screen and used for Center Console panels and placed horizontally so that the user can push the buttons in a way more similar to how it is done in the aircraft instead of using the mouse.

OMIA has the ability to integrate with a third-party flight simulator. Every time OMIA starts it checks to see if a compatible flight simulator (e.g., Flight Gear) is already running. If it is running, OMIA attaches itself to the flight simulator and then gets its position, speed and other flight information from the flight simulator.

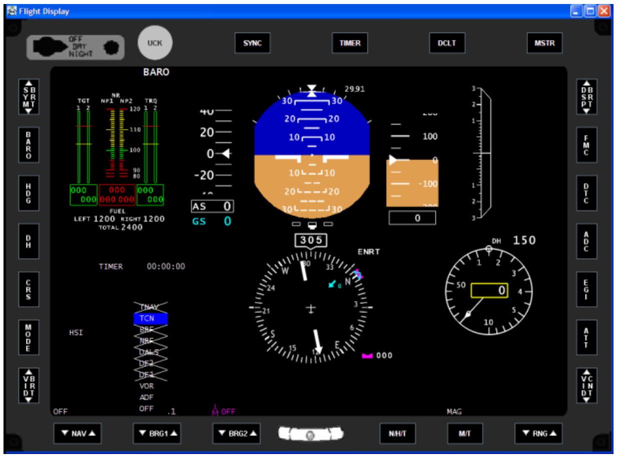


Figure 4. OMIA Flight Display

In this configuration, the user is able to have the external view be completely generated by the flight simulator. While the Flight Display, Mission Display and all of the other panels are still being used from the core OMIA. However, any other information such as ground speed, latitude/longitude location, or motion is all taken from the flight simulator. This is very beneficial if a user wishes to fly or see the terrain while navigating a search and rescue pattern. As one navigates, the helicopter may be guided along the search and rescue pattern on the Mission Display, and as search and rescue points are reached or captured the pattern will update appropriately. When using a flight simulator, other hardware can be used if desired, such as a joystick; or a head mounted display with head tracking may be added to improve the means for emulating the full field of view. Flying can be performed solely using a joystick, or a joystick and a separate control for the collective, and/or COTS pedals can be added.

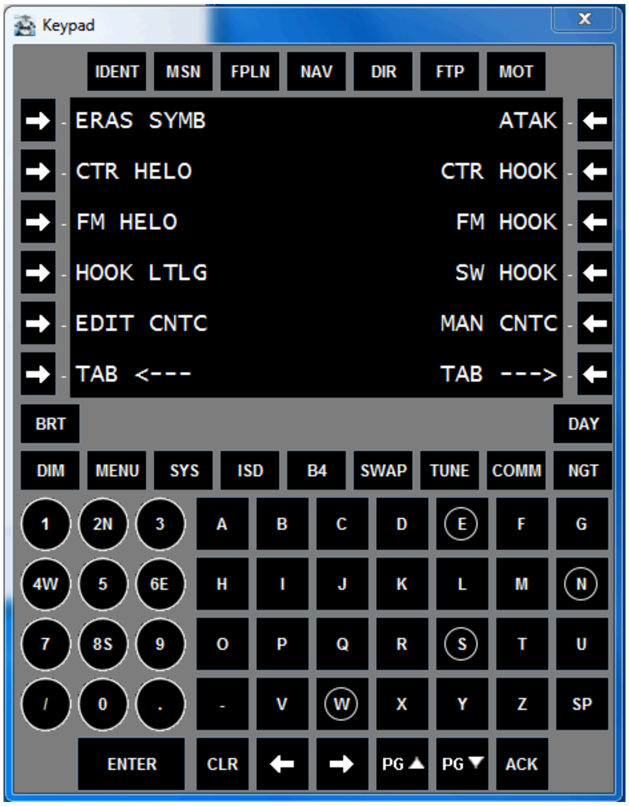


Figure 5. Control Display Unit (CDU)

2. Java as OMIA's Development Language

There were three main factors that drove the decision to write OMIA in Java.
1) A language that supported the design for evolving requirements was necessary because the Common Cockpit continues to evolve. Java provides support for rapid GUI development and there are many other GUI related tools, many Opensource, available in Java. Even though the MH-60S and MH-60R both use the Common Cockpit, the helicopters have different capabilities and missions, thus many operations are different on the two platforms. OMIA supports these differences. Since this process is continual, we need a flexible language for this task. Advances in the Java language and tools have proven this a great choice for rapid modification.

2) One of OMIA's main goals has always been its accessibility by computers on both land and at sea. The default computer configuration in the Navy, NMCI (Navy/Marine Corps Intranet), have restricted access, however, with a Java version, NMCI compatibility is provided as the required Java Runtime Environment is already installed on the NMCI machines.

3) Portability to other platforms (e.g., Linux). The Navy requested a Linux version of OMIA in 2009 as part of an acoustic systems trainer (ATS) enhancement. The fact that OMIA was written in Java allowed this requirement to be rapidly completed.

3. MenuBuilder / KeyBuilder

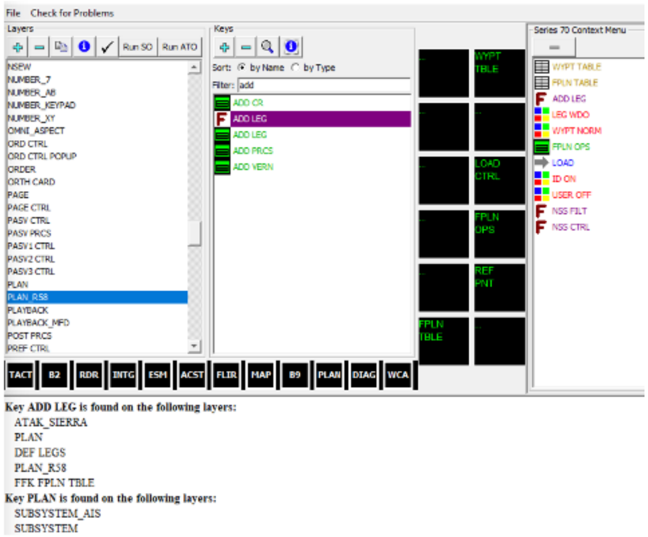
A major user interface component is on-screen menus and the corresponding keys on the Control Display Unit (CDU). To increase the development speed to create or modify menus as the software is updated in the helicopter a menu & key generation and modification tool has been developed: MenuBuilder / KeyBuilder. MenuBuilder / KeyBuilder makes it easier for non-developers (and developers) to move or change menu elements. Thus, OMIA can be leveraged as an innovative concept in the areas of aircraft systems and avionics development, situational awareness, and airspace awareness.

For example, at the time of this writing OMIA is being enhanced with digital map capabilities to match the recent addition of the digital map to the helicopter. How best to integrate this new capability with current capabilities requires a certain level of experimentation, OMIA can be rapidly modified so the Navy can quickly change the user interface and then experiment to determine which user interface configuration is most efficient / effective for the crew. This is just one example use case because as the helicopter continues to evolve the most efficient and effective enhancements could be made more rapidly by using OMIA to test potential user experience changes most rapidly.

The MenuBuilder / KeyBuilder provides a graphical tool for developing and modifying menus and the keys on the CDU, see Figure 6. The second pane provides a list of items that can be used to modify the current selection. That is, there is a Filter option, so one can find the subset of existing items to choose from. For example, if one types ‘add’ in the Filter box, then only items with ‘add’ in their name will be included in the list.

The third pane shows the corresponding keys of the two columns of keys found on the CDU. The user can simply drag the menu item onto the key of interest and the key will update.

The fourth pane shows the corresponding menu, with the menu contents shown in the order presented. To re-order a menu item, simply drag it to the location desired. To delete an item, select the item and then hot the minus ‘-‘ at the top of the pane. To add an item simply drag the menu item from the second pane into the menu list at the location in the menu desired.



Sort: ● by Name ○ by Type

Filter: add

Key ADD LEG is found on the following layers:
ATAK_SIERRA
PLAN
DEF LEGS
PLAN_R58
FFK FPLN TBLE
Key PLAN is found on the following layers:
SUBSYSTEM_AIS
SUBSYSTEM

Figure 6. MenuBuilder / KeyBuilder User Interface

When modifications are completed, the author can save out this key / menu information, so that the next time the program is *compiled* the key & menu changes will take effect.

4. Enhancing the Crew Learning Experience

OMIA is much more than the Flight Display, Mission Display, CDU, and the other items described above. The MH-60S & MH-60R have other major systems that can be trained OMIA.

Center Console Panels

As can be seen in Figure 1, there are many panels in the Center Console. OMIA emulates some of these, since these are used less frequently, they are not all shown on screen at all times. There is a Control Panels window where the user can select which panel(s) to display, see Figure 7. The CMP panel is shown in Figure 8, this panel is used for controlling the power to the computers and EGIs. The RCU panel is shown is shown in Figure 9, this panel is used for emergency radio communications.

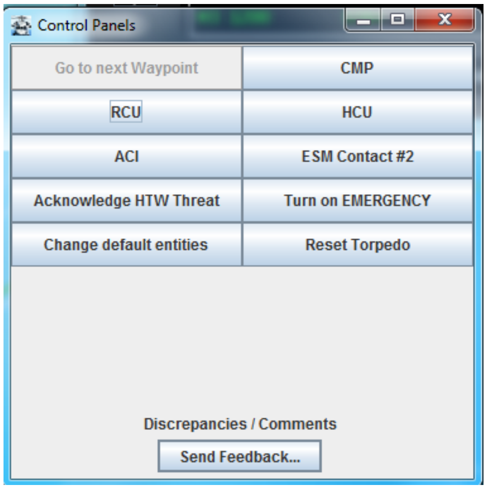


Figure 7. OMIA GUI to Select Options

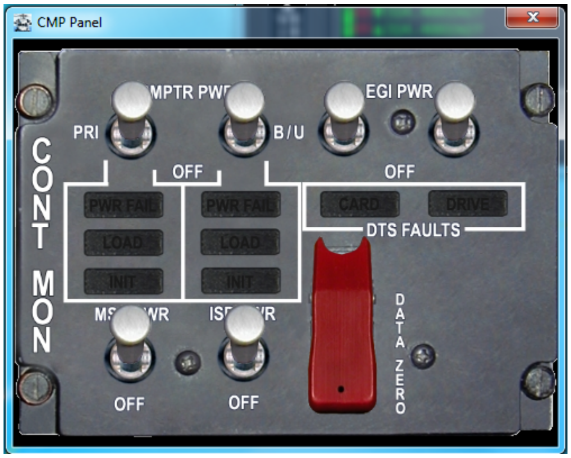


Figure 8. CMP Panel

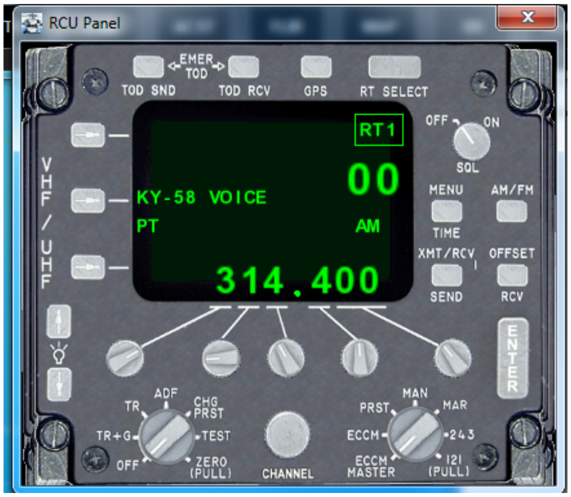


Figure 9. RCU Panel

Forward Looking InfraRed (FLIR)

One such system found on the MH-60R and some the MH-60S helicopters is the Forward Looking InfraRed (FLIR) system. The FLIR user mainly controls the FLIR operations via a Hand-Control Unit (HCU), as shown in Figure 10. The Navy has developed a portable HCU hardware facsimile that can be connected to OMIA via USB, see Figure 11. In addition, if the hardware in not available, there is an option to bring up a window that provides a software emulation of the FLIR HCU, see Figure 12.

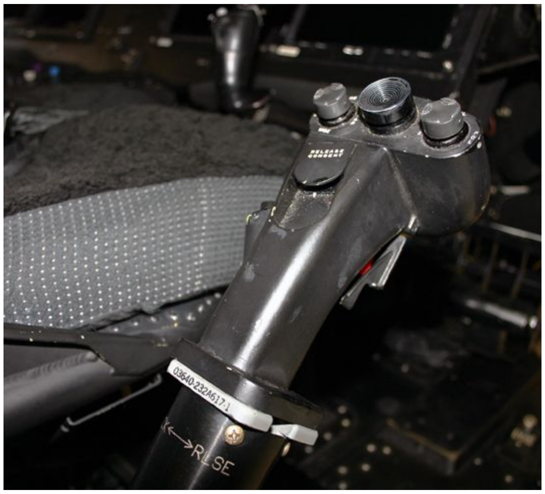


Figure 10. FLIR Hand Control Unit (HCU)

OMIA reacts the same way to the HCU hardware as it does to the presence/absence of other hardware units; when OMIA starts up it checks whether a FLIR HCU hardware is attached. If it is attached, the software will read input from it, if it is not detected, then the software equivalent is available.

The hardware FLIR HCU teaches both the tactile feedback and muscle memory of a physical hand control unit, in addition to the all the training available with just the software FLIR HCU. Due to the modular design of the OMIA software, adding support for the USB HCU input device required relatively little development effort.

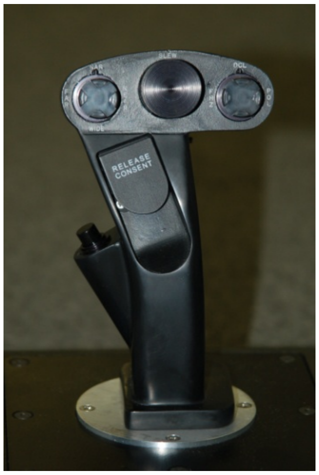


Figure 11. Low-cost HCU used for Training

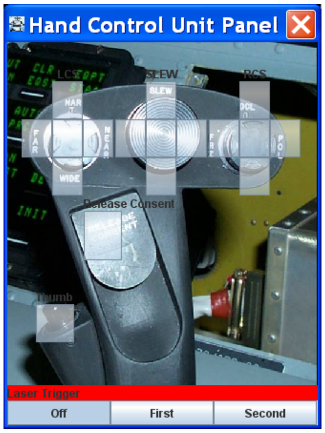


Figure 12. Simulated HCU in OMIA

An example of a FLIR, with the MH-60 overlay, as shown on a Mission Display in OMIA, is shown in Figure 13. The generation of FLIR images is a difficult task in real-time. Usually, FLIR simulators are very expensive units incorporated into multi-million-dollar simulators. For OMIA a simpler solution is created to provide a high level of learning benefit sans the cost. The FLIR implementation in OMIA uses *WorldWind*, an open-source virtual globe API supplied by NASA. Much of the learning related to FLIR concerns the operation of the FLIR menus and other operations that are part of the software overlay. Through the combination of the hardware FLIR HCU and the overlay menus and other functions with the 3D world view, a great deal of learning is facilitated. For example, users can zoom in and out, slew, adjust image polarity, cycle through camera modes, and navigate through on-screen menus.

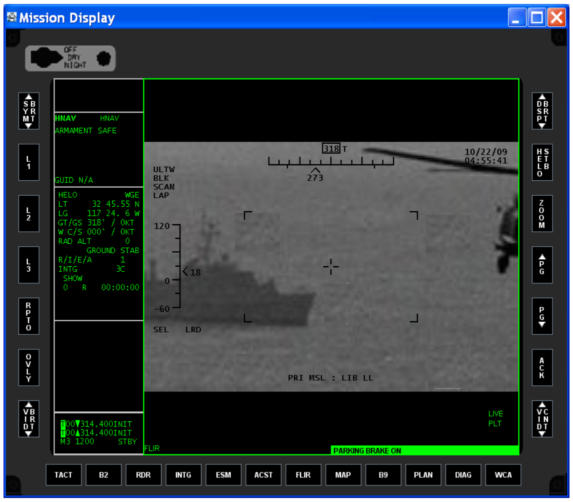


Figure 13. Screenshot of FLIR in OMIA

Acoustics

Another very important capability of the MH-60R is both passive and active acoustics. To support this there is also a version of OMIA that includes an Acoustics Trainer Simulator (ATS) enhancement, this is referred to as OMIA-ATS. This capability is mainly used by the Sensor Operator (SO) that sits at the SO station; see Figure 14. OMIA-ATS requires capabilities currently only available under Linux, so OMIA-ATS is restricted to use on Linux. This enhancement is supplied to the Navy as a complete hardware/software solution, the OMIA-ATS hardware includes a computer/laptop with an external touch screen and OMIA-ATS installed.

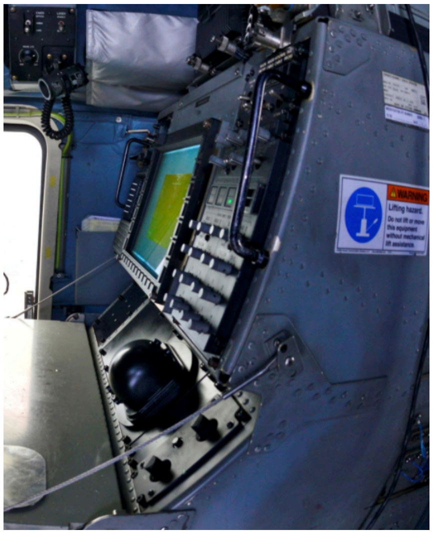


Figure 14. Sensor Operator Station

The user interface for the acoustics aspects utilizes the same menus and CDU as most of the rest of the user interface, so the interface can be quickly changed via the MenuBuilder/KeyBuilder tool described above. OMIA-ATS provides a highly capable training tool for MH-60R sonar operators. The OMIA-ATS includes, but is not limited to:

- Providing system familiarization for displays and keysets (with or without instructor support)
- Supporting independent skills review in a Training facility environment
- Preparing operators to take full advantage of TOFT training sessions
- Providing a platform for acoustic return recognition training
- Supporting independent skills review for deployed squadron personnel.

A screenshot of OMIA running in the SO mode is shown in Figure 15.

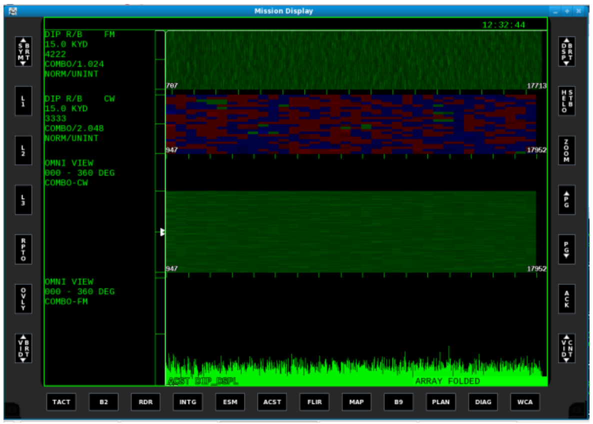


Figure 15. OMIA-ATS Running in SO Mode

The (non-ATS) OMIA benefited as much as possible from the acoustics enhancements, so OMIA allows the learner to get an introduction to acoustics operations and menus but does not allow for pinging and viewing realistic acoustic returns as OMIA-ATS does. The same output from the MenuBuilder/KeyBuilder tool is used for the acoustics portion of OMIA & OMIA-ATS.

4. Conclusion

The complexity as well as the number of the sensors under control by the crew on the MH-60S and MH-60R helicopters, pose a difficult training task for the Navy. To meet this challenge, the US Navy's PMA-205 in conjunction with industry has developed and deployed OMIA, a flexible, low-cost PC-hosted desktop crew trainer. OMIA has evolved with the changing helicopter software; with every iteration, it has become an ever more functional trainer providing greater flexibility and benefit to the Navy. OMIA demonstrates the utility of designing a flexible system that allows for quick responses to ever-changing demands. Since the software configuration of the helicopter evolves, OMIA needs to evolve also and thus development tools MenuBuilder/KeyBuilder have been developed to facilitate this evolution as rapidly as possible. OMIA program has been able to adapt to new challenges with a minimum amount of additional development. OMIA's capabilities benefits both the US Navy and the expanding list of navies throughout the world that have chosen the MH-60R or MH-60S for their own needs.

References

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[2] Richards, Robert (2007), "MH60S/R Helicopter Crew Trainer: Via a Variety of Modeling, Simulation and Visualization Technologies". *The 2007 International Conference on Modeling, Simulation and Visualization Methods (MSV).* part of The 2007 World Congress in Computer Science, Computer Engineering, & Applied Computing (WORLDCOMP), Las Vegas, Nevada, USA, June 25-28, 2007.

[3] Richards, R., J. Ludwig (2008) "Training Benefits of a Java Based Part Task Trainer", 2008 IEEE Aerospace Conference Proceedings. Big Sky, Montana.

Biography

***Robert Richards** received a Ph.D. in Mechanical Engineering from Stanford University. Dr. Richards is managing and has managed multiple projects for both commercial and government clients, including various training related projects. Dr. Richards is the Principal Scientist and Manager of Stottler Henke's OMIA Navy project to provide low-cost accessible training for MH-60S & MH-60R crewmembers. Dr. Richards has also worked on and continues to work on various projects spanning a wide range of research and application area interests, including: training system development; applying automation and artificial intelligence techniques; and intelligent planning & scheduling applications. Dr. Richards has publications in all of these domains.*

***Bart Presnell** is a software developer at Stottler Henke Associates Inc. in San Mateo, California. He has over 15 years of experience developing training systems, including projects to train teamwork in medical scenarios, healthy eating and exercise, small unit tactics, and decision making in air combat rescues. Bart is the lead software architect of OMIA. Previously Bart worked in video game development at Electronic Arts. Bart has a B.S from Brown University and M.S from the Georgia Institute of Technology.*