Installing And Testing New Technologies On A Maritime Training Vessel

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Abstract

The installation of new technologies; advanced, developed and being researched for use on board commercial or military vessels, on board a Maritime Training Vessel can result in very positive opportunities for the vessel, the institution , the manufacturer, and the eventual end user, but none benefits more than the student population. STATE OF MAINE has been involved in just such development, research and training for the past seven years. Our current involvement is expected to stretch into the future and we are continually on the lookout to research, procure and test new equipment and to partner with manufacturers and developers.

The enthusiasm generated amongst the students involved is exciting and our training cruises have proven to be a very effective defined time to collect data from some of the installed equipment. The recently released commercial and military versions of "LookSea" are an example of a training ship installation which allowed for an intense programming and problem solving hands on real ship trial and error involvement.

This paper details and explores the lessons learned and shares the failures as well as the successes. The knowledge garnered by the students involved whether the technology is a success or failure can equate to a well trained seafarer who can recognize the factors involved in integrating equipments. The student can equally relate to the worth of the technology in enhancing the safety of the vessel or the benefit to its performance.

New technologies are vital to our industry and preparing our student population to interact with the emerging technological advances is a key mandate.

1. Introduction

Training Ship STATE OF MAINE was delivered (the vessel is owned by the United States Department of Transportation, Maritime Administration MARAD and is on loan to the State of Maine with MMA the custodian) to Maine Maritime Academy in the spring of 1997. The ship was constructed for and delivered to the U.S. Navy in 1990 and served as a Fast Oceanographic Research Vessel until 1993 when an engine casualty effectively removed it from Navy use.

After a 3 year period of lying idle the ship was converted for use by Maine Maritime Academy as a training vessel for educating men and women to become officers in the merchant marine.

Because of the engine casualty it was necessary to completely strip the ship of her old propulsion engines and install another propulsion plant. In studies of plant types it eventually became obvious that some innovations in design could be easily accomplished while adhering to the strict budgetary restraints imposed on the project by lack of governmental agency funds.

The power plant installed is unique in a couple of ways. First, the tail shaft, intermediate shaft and propeller were modified or replaced without changing the stern tube bearing or structure. Second, the original (2) two engines, reduction gear and fixed propeller were replaced by a single used engine on the port side and an electric motor on the starboard side through the original gearbox and driving a controllable pitch propeller.

This in itself makes it a unique vessel in the world fleet today. The ship can be operated using the diesel engine dragging the electric motor and still accomplish speeds of around 16.5 knots. Alternatively the ship may be operated with the main diesel engine unclutched, all (3) three generators on line and the electric motor driving the ship via the original gearbox and controllable pitch propeller. Speed in the range of 6.5 knots is accomplished in this mode of operation.

So, we have a training ship that has a special design capable of teaching diesel mechanical propulsion along with diesel electric propulsion. The added advantage is that the electric motor adds emergency backup for the main propulsion plant enhancing the safety of the entire platform.

Lastly, this innovation in power plant design leads into our use of the training ship as a technology development platform. We have made every effort to stay up with technological innovations and, if possible, ahead of what will be the norm in ships in the immediate future, which will be the platforms our students will be sailing on after graduation.

2. Installation and testing of technology and associated applications

With the arrival of the converted training ship at Maine Maritime Academy it became very evident that insufficient funds were available to install and test new items of technology had they been commercially available. The Maritime Administration has been, and continues to be, very supportive of our independent endeavors to introduce new items to the platform for testing and teaching. Our affiliation with the Maritime Administration proves to be valuable in helping other government entities provide us with equipment and enhance our teaching technology. Some research datasets have been gathered by students, ships crew and faculty for evaluation and submittal to the sponsoring agencies, notably the Office of Naval Research, NAVSEA, DARPA, and ISOpur Corp.

As with any endeavor there have been varying levels of success with some of our projects but without a doubt even the failed projects offered a great teaching and learning experience for all

involved. For example, research into radio tagging components failed, while the concept of modular construction, and assembly using wearable computer generated instruction datasets certainly left the students with a much better understanding of the problem and invoked some interesting suggestions to fix the problem.

Table 1 below delineates the particulars of some of our projects to date, and the involvement of students, crew and faculty. In a university environment there are many opportunities to involve faculty and students with training ship platform initiatives which pique the curiosity, stimulate the interests and reward the individuals involved with a sense of pride and knowledge that they are at the leading edge of implementation in their field.

Table 1. Projects

Project	Description	Student involvement	Crew involvement	Faculty involvement
RF tagging	DARPA[1] initiative for radio tagging components in the weapons handling design of CVX	Students located and assembled 'mock" weapons	Crew developed storage plan, and infrastructure	none
ISOpur Filter	Lube oil purification using coalescing and filtering technology.	Students helped install on multiple equipments. They operated and logged data	Designated and supervised operation, installation and data analysis and submittal	Oversight and instruction in the classroom
Augmented reality Navigational Aid	"LookSea" augmented reality overlay of a real time video picture.	Involved in wearing of original headset and operation of subsequent models	Design, comment and implementation assistance to developer.	Use and comment as a teaching tool. Possible integration with simulation
WiFi, WAP & WEBCAM technology aboard ship	Self developed for training ship specific use of 250+ terminals. Bridge and Engine room WebCams.	Installation of switches. Use at all times when living aboard.	Continuous development, trial and installation along with every day use.	Every day use when aboard
WiFi connection to shoreside	No direct cable connect yet allows shoreside integration to a LAN	Local MMA intranet as well as internet	Local MMA intranet as well as internet	Shoreside access to ship server

[1] DARPA; Defense Advanced Research Projects Agency

networks	when at a port	portal.	portal.	
Bridge technologies	Integration and power requirements and design. Research into auto equipment redundancy switchover and system UPS design	Users	Users, designers, installers, implementers.	Users
Generator, breaker, metering wireless data transmission	New meters installed to store and wirelessly transmit data to ship's computers for load trending	Installation of meters and WAP's	Design, Installation and Implementation of meters and data downloads	Direct oversight and installation assistance. End point for data collected.
Marine Fuel Cell	ONR[2] funded fuel cell academic training course	none	Joint course development with faculty geared to shipboard training	Develop Marine operations course
Marine Fuel Cell	NAVSEA[3] shipboard test of unit	None yet	Ship platform integration study underway	Joint platform development with ship crew

All of the above projects have made a noticeable impact on the way our students view technology. An interesting comment from a student was "Now I see why you keep stressing the basics. It enables me to realize when I am getting misleading or false information from my technology." So right this student was! In this particular case a stalled display had been giving static information for about nine minutes before the student had the gut feeling all was not right and figured out what the problem was.

3. Project descriptions

For the purpose of this paper I will describe our involvement with the first three items in table 1 which will give a representative look at our projects and allow a better understanding of the "value added" by Maine Maritime Academy, its students, faculty and the crew of the training ship.

3.1. RF Tagging

MMA (Maine Maritime Academy) , TSSOM (Training ship STATE OF MAINE) was

[2] ONR, Office of Naval Research
[3] NAVSEA, Naval Sea Systems Command

approached by Technology Systems Inc to partner in an effort to research designs and implementation of radio frequency tagging of weapons system components. This effort was part of a study sponsored by DARPA which revolved around the design of the weapons system for the next generation of aircraft carrier.

Our effort involved designating several storerooms aboard the training ship to receive radio location antennas that were directionally stable and sensitive to distance. A mock weapon (one of our torpedo shaped oceanographic departments towed 'fish") which was disassembled into (6) six component parts each of which were radio tagged and then distributed to the storerooms. A central assembly area was designated and the entire system was networked with computers. Students involved in the project planning were designated to don a "wearable" computer which alerted them to the specific type of weapon that was to be assembled and led them to the storeroom with the proper component. They would retrieve the component; take it to the assembly area and go on to retrieve the remaining components. Finally the computer would instruct them on the sequence of assembly.

Running behind the scene in the background to this retrieval and assembly process was the fact that the computer was tracking parts usage and transmitting the data to the ship's server which in turn was preparing the order to be sent to the supply depot to replenish the expended parts. The computer was also tracking "custody" control of the items and "who" retrieved them.

Ultimately we made a video of the entire process and except for the "RF" tags the project went remarkably well. The RF tags were problematic and our conclusion was that the technology was not quite ready for deployment at the time of the testing (circa 1999, 2000). It is interesting to note that since that time the giant retailer WalMart has notified all their suppliers that every single item they sell must be equipped with radio frequency tags by December 2005.

3.2. MAG Filter

MMA & TSSOM were tasked by Bath Iron Works to install and test an ISOpur MAG filter on one of our diesel generators and to operate it during our 60 day annual cruise. System pressures were to be tracked and filter media changed as necessary. The promise was that our old oil which we would normally centrifuge would be routed through this machine and after a period of time would approach specifications better than new virgin oil. This equipment is much simpler and less difficult to run and maintain than any purifier (centrifuge).

The students and ship's crew under the direction of the manufacturers representative installed the equipment and we operated the filter for an entire cruise, drawing samples at designated times and sending data and samples back to the manufacturer.

A full report of this trial and accompanying data is available to read at the following link: http://www.isopurfluid.com/Cases/CS-MARINE-0404-0.pdf

We have now had the unit for (4) four cruises and have moved it from Generator to Generator and also have had it installed on the Main Reduction Gear case and the Stern tube. In all instances the filter worked flawlessly and in fact lived up to the promises of the manufacturer. Original oil in each unit was in need of purification and after MAG filter use cleaned up to very shiny lean looking oil which when sent out for analysis proved to be free of contaminants of any sort and in fact "better than new".

The original manufacturer has consented to let us retain the unit and we now use it as part of our ship's equipment specifically used for trouble spots that we identify in our lube oil purification processes.

Student involvement in the multiple installations has made them acutely aware of the lube oil flow through various equipments because of their intimate involvement with insuring the proper pipes are tied in to the right place on the equipment.

The filter has proven easy to operate and any of our students are now able to demonstrate the unit operations as well as explain it's function and worth to them as an operating engineer.

3.3. LookSea (Augmented Navigation)

LookSea is perhaps our most visible and rewarding development partnership to date. It started about (4) four years ago with MMA's technology partner TSI (Technology Systems Inc). At that time video gaming virtual reality headsets were the vogue and the idea was to replicate that technology for use on the bridge of a ship to assist the navigator with a heads up view of the environment surrounding him with chart data overlays of real time views. The original system included a GPS mounted helmet with wearable computer and eye piece. All entirely linked to an electronic charting system which allowed the navigational aids to be overlaid on the real picture as viewed. Bridge parallax as the person moved about the bridge was solved by precision radio tracking modules installed on the bridge and on the person.

Original 'wearable computer" and goggles on left and redesigned unit on the right.

The concept worked BUT was very cumbersome and we soon realized that wearing the unit was not the answer. In casual conversation we speculated that perhaps a fixed screen on the bridge would solve the restrictive wearing problem along with adding significantly to the safety of the bridge operations as viewed by the operator.
From that casual conversation on the bridge of training ship STATE OF MAINE, **"LookSea"** was born….

(3) basic components. Screen, Camera and Computer Server

"**LookSea™ Pro** is the most advanced electronic chart system available and can also provide a focal point for your integrated bridge system. The LookSea system takes video data from an exterior camera, converts electronic chart data into computer generated, 3D graphics and synchronizes those images with GPS and heading data to create an augmented view of your situation on a video monitor."

LookSea screen in reduced visibility

As with many items of technology, LookSea proved to be a natural addition to the bridge technology of various military vessels: minesweepers and landing craft air cushion to name a couple. These led to more robust military versions with more sophisticated "night vision" cameras and integrated to the military software that was mission designated.

The training ship has a professional version installed and during the recently completed cruise the crew and students did extensive testing of the various aspects of the equipment use and integration to our other NEMA compatible equipments signals, such as AIS. We are continuing our software upgrade tests as I write this paper.

I am happy to report that a cumbersome first edition piece of equipment has evolved into a sleek easily useable piece of equipment that will go a long way towards enhancing bridge safety.

3.1.1. Recent adaptation

During testing and operations aboard TSSOM the idea came up of sending the LookSea signal to the ship's local area network for possible remote site extraction. This became a reality about two thirds of he way through cruise so we were able to test and use the remote picture, for information purposes only, during the final days of this years voyage. The picture was remotely displayed in a lower passageway of the ship for any and all crew members to view. Additionally it was sent to the Engine room for display in the Engine Operating Console area of the control room. Suddenly the myriad persons in the crew, who never really saw where they were going, are now totally in the picture. Well informed as to the progress of the voyage and more importantly they can watch the ship's progress in docking and undocking. Again adding that one more layer of safety awareness should they be called on to respond to an emergency situation.

This added feature has proven to be extremely valuable to crew well being and awareness. It adds one more level to total ship integration and awareness.

4. MMA / TSSOM "Value added"

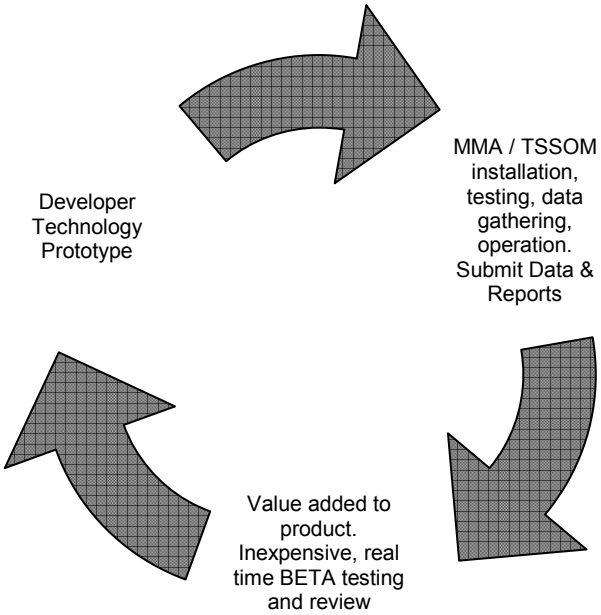
Academia, partnering with Industry, and the sponsored government research adds value to the project at significantly reduced cost to the project. Our facilities, research methodology, and foremost our student population are key to being able to make this partnership work to everyone's advantage.

Students are extremely interested in technology. They are also weaned on the visual acuity of modern childhood games and are very quick learners. They tend to bypass "operations

manuals" and often discover unusual ways to use the equipment. Some innovative and useful and others that show the need for sounder programming techniques. Regardless, that is what testing is all about and reinforces the worth of this type of testing platform and venue.

One word of caution that is applicable…."they are eager to point and click, often without first thinking". Going to sea with 200 plus students simply means you are taking 2000 button pushing fingers with you.

Figure 1. Value added cycle



5. Conclusions

Maine Maritime Academy and the Training Ship STATE OF MAINE recognize the value to *all* parties involved in an industry/academia partnership to test technology. Our technology partners have been pleased by our collaborative effort on their behalf. The longer we are involved and the more diverse the involvement the stronger our conviction is that this is a value to the institution, to the vessel and to our student population as much as it is to our partners. Whether or not the real time use of a product or idea is of current value to us, we certainly learn from our installation and testing. The seafarer of tomorrow will be surrounded by technology. Perhaps a test that he/she was involved in back in the training

ship days will prove useful in a future situation allowing instant recognition of a failed piece of equipment or system malfunction.

I firmly believe the value of this technology to our cadets is paramount and an important part of their training at a maritime university. They must learn the inherent dangers and or distractions that will arise and they must learn how to effectively deal with the situation, which is dependent on their analytical skills as well as their intuitions. Technology testing adds immeasurably to these skills.

Collaboration is an easily initiated testing method which is relatively inexpensive, and reaps great benefits to all parties involved.

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