

## **Improving Naval Shiphandling Training through Game Based Learning**

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### **ABSTRACT**

Currently, a gap exists between seminar style shiphandling training and higher fidelity simulations available to the U.S. Navy Surface Warfare Officer (SWO). There is currently no individually accessible, low cost, intermediate level, interactive modality, shiphandling resource which would allow SWOs to practice shiphandling skills without requiring instructor oversight. A student research team from the Naval Postgraduate School's MOVES Institute exposed newly commissioned SWO students at the Surface Warfare Officers School to basic task scenarios designed to be complementary to material covered in their introductory course of instruction utilizing VSTEP's "Ship Simulator Extremes" game. The students completed the treatment task trainer protocol utilizing a Coast Guard High Endurance Cutter model and continued with the standard introductory course curriculum where they utilized the fully immersive Conning Officer Virtual Environment (COVE) shiphandling trainer. Each student was later evaluated in COVE on his ability to maneuver a Guided Missile Destroyer, a similarly configured but larger ship, underway from a San Diego pier. The students exposed to the game based scenarios performed at a statistically significantly higher level in the categories of "Standard Commands" and "Margins of Safety Maintained," two key indicators of shiphandling proficiency, following their normal course of instruction than the control. Also of note, the novice level students encountered difficulty in unlearning the handling characteristics of one model and learning a new one through the course of their instruction. Our findings suggest that an individually accessible, game based, shiphandling task trainer with ship models matching those found in the COVE and Full Mission Bridge would benefit newly commissioned SWOs by reinforcing classroom instruction and could potentially be used by SWOs of all skill levels as a self study tool prior to participation in high level, fully immersive, and manpower intensive, naval shiphandling simulators.

### **ABOUT THE AUTHORS**

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LT Reber completed his Master's of Science in Modeling, Virtual Environments, and Simulation at the Naval Postgraduate School in 2012. He completed a Bachelor's of Science in Finance at the University of Florida in 2005.

At sea, he served as Training & Readiness Officer on USS MONTEREY (CG 61), First Lieutenant and Auxiliaries Officer on USS HOPPER (DDG 70), and as a nuclear propulsion plant operator in USS ENTERPRISE (CVN 65).

**LT Benjamin Bernard** is a Surface Warfare Officer attending the Surface Warfare Officers School Department Head course. After graduation, he will report to SWOS Department Head School for training.

LT Bernard completed his Master's of Science in Modeling, Virtual Environments, and Simulation at the Naval Postgraduate School in 2012. He completed a Bachelor's of Science in Psychology at Jacksonville University in 2005. At sea he served as Training & Readiness Officer on USS TRUXTUN (DDG 103), Auxiliaries Officer on USS PRINCETON (CG 59), and as an Electronics Technician (Submarines) on USS MAINE (SSBN 741, Blue).

**Perry McDowell** is a Research Associate at MOVES Institute at the Naval Postgraduate School in Monterey and the Executive Director for the Delta3D Game Engine Project. He has been on the faculty of the Naval Postgraduate School since 2000, where he teaches classes in Computer Graphics and Virtual Environments.

He has primarily focused his research on game based training and open source technologies. Currently, he is researching the best ways to implement game based learning into various military curricula.

Mr. McDowell is a former Naval Nuclear Power – Surface Warfare Officer, whose sea tours include USS-VIRGINIA (CGN-38), USS ELROD (FFG-55), and USS ENTERPRISE (CVN-65). He graduated with a B.S. in Naval Architecture from the U.S. Naval Academy in 1988, and an M.S. (with honors) from the Naval Postgraduate School in 1995.

**CDR Joseph Sullivan** graduated from Catholic University of America with a Bachelor of Science in Computer Science, attended Aviation Officer Candidate School, and was commissioned in 1986. He has a Ph.D. in Modeling and Simulation from the Naval Postgraduate School (2010). CDR Sullivan's operational background includes multiple tours in east and west coast Helicopter Antisubmarine (HS) squadrons. In 1998, CDR Sullivan earned a Master's of Science in Computer Science degree at the Naval Postgraduate School. CDR Sullivan has been assigned to the Naval Postgraduate School since 2001. While assigned to NPS he has filled various roles including Military Faculty, Program Officer and Principal Investigator. His research background and interests center on the application of emerging virtual environment technology to training.

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### INTRODUCTION

This paper describes the work done by Reber and Bernard for their thesis which was part of their Masters of Science degrees in Modeling, Virtual Environments and Simulation at the Naval Postgraduate School. For more detail on any aspect of the work in this paper, please see the entire thesis. (Reber and Bernard, 2012)

#### Seaman's Eye

Shiphandling is one of the most important tasks for the Navy surface warfare officer (SWO). Nothing is more evident to those outside the ship than how her crew handles her in tight situations and this often sets the reputation for the ship. In order to expertly handle a ship, an officer needs a good Seaman's eye. Crenshaw writes (pg. 4)

“Seaman's eye is rather an expression of competence at sea. It is an expression connoting judgment and understanding. The captain with a reputation for Seaman's eye is one who can marshal all the information on the situation available to him, combine it with his intimate knowledge of his ship and her characteristics, and take his course of action with the judgment of the Master Mariner. This knowledge is made up of intelligence, knowledge of ship and the sea, and an understanding of the physics of shiphandling.”

As to how an officer acquires Seaman's eye, Crenshaw has an answer for that also.

“The best preparation for handling the ship, then, is a combination of a study of the principles involved and sufficient experience at sea to be able to evaluate the situation. Neither extensive experience nor theoretical understanding can stand alone. The competent shiphandler must have both.” (Crenshaw, 1974, pg. 5)

The Navy has a problem with this. As budgets are reduced, the amount of time underway decreases. Likewise, a higher percentage of that underway time is

devoted to operational missions, decreasing the amount of underway time available for training. The Navy has realized this is reducing the capabilities of personnel in all fields and senior leadership is concerned about this. Dr. Terry Allard says that the Navy will need to replace the experience lost due to less underway time through other methods of training. (Allard, 2012) However, most book training can only meet the theoretical half of Crenshaw's requirements for Seaman's eye. Now that the ability for each officer to get “sufficient experience at sea” to acquire Seaman's eye is significantly less, experience in simulations will need to replace it.

#### Creating Seaman's Eye Ashore

There are three methods that the Navy trains officers in shiphandling. The first is the traditional method of conning ships at sea or discussions with other ship's officers, which we will not cover in this paper. The second is training they receive en route to their ships; the command responsible for delivering this shiphandling training is Surface Warfare Officers' School (SWOS) in Newport, RI. The third is simulators either on their ships or ashore in home ports.

SWOS trains officers of all experience levels, from the junior-most ensign who has never been to sea to the captain preparing for major command. Most of the shiphandling simulators currently in use by SWOS fall into the category of large simulators. Since no one could say whether smaller simulators can provide effective training, the Navy has followed the rationale that the more realistic the simulator, the better the training and therefore has opted for large and highly realistic simulators.

The largest shiphandling simulators at SWOS act as full mission bridges (FMBs). Shown in Figure 1, they include bridge wings as well as have most of the equipment found on ships' bridges, such as radar repeaters, helm stations, gyro repeaters, and radio handsets. There are large screens that provide outside views, generally between 180-270° around the simulator. Normally, students or faculty act as the other members of the bridge team supporting the one student who is actually conning the ship. FMBs generally require one or more instructors to facilitate for and

evaluate the students as well as a team of operators and contractors to run the simulator, create new scenarios and behaviors, troubleshoot, and perform maintenance. This significantly limits their throughput. SWOS should have two FMBs operational for training at this paper's publication date.

Another form of shiphandling simulator the Navy uses is the Conning Officer Virtual Environment (COVE). COVE displays the world either through a head-mounted display (HMD) or three screen system. Figure 2 shows an officer using COVE wearing an HMD, with an earlier three screen configuration in the background.



**Figure 1. Navy Full Mission Bridge**

SWOS designed COVE to reduce instructor involvement and increase school house capability of supporting the training in the following tasks: basic navigation, shiphandling, seamanship, harbor and strait transits, contact management, pier and tug work, DIVTACs, ship stationing, plane guard, signals, flags, lights, and day shapes. COVE is also capable of supporting the following special evolutions: anchoring, mooring to a buoy, towing, UNREP, Man Overboard, and Engineering Casualties (NAWCTSD, 2010). Due to its purpose built scalability, COVE can support training for individuals, bridge teams, or even multiple ships interacting together. COVE interprets the trainees' verbal orders and then carries them out. COVE requires contractor support for startup, shutdown, troubleshooting, and maintenance. Instructors are typically assigned one per station for shiphandling training and evaluation of students. SWOS currently has eighteen COVE stations for training.

In large Navy ports, the Navy has placed additional training resources at the Afloat Training Groups (ATGs) for navigation seamanship and shiphandling training (NSST). These include bridge simulators,

similar to the FMBs at SWOS as well as two PC-based systems, the Kongsberg Version 1 and Version 2. Both versions emulate shipboard equipment. Both V1 and V2 are capable of supporting individual officer and bridge team training. Nearly all aspects of general seamanship and navy specific shiphandling, maneuvering, and navigational training can be effectively conducted (Meers, 2011).

As part of the pre-deployment work-up cycle, every ship has an annual allotment of up to 100 hours of professionally mentored shiphandling simulator training. This includes one formal course plus up to an additional 32 hours of special evolutions training (SET). The commanding officer of each ship has great leeway in determining the content of the SET sessions based upon what she thinks her personnel will need for future planned ship operations. (Commander, COMNAVSURFOR INSTRUCTION 3505.1A, 2010).



**Figure 2. An Officer Training in COVE**

### **Shrinking the Size of Simulators**

Like SWOS and ATG, many other organizations in the military already use simulators to replace actual field or at-sea training in many areas, and leaders expect to expand simulator use to other areas. However, like SWOS' shiphandling simulations, many of these simulators are very large and expensive and require a significant amount of contractor support in order to operate. This makes them fairly expensive as well as limits the number of students they can train, commonly referred to as throughput. As the military's budgets continue to shrink, it is no longer using such large simulators exclusively, even though they might produce the best training. Col. Tony Krogh, head of the National Simulations Center (NSC) at Fort Leavenworth said of the Army's moving away from exclusive use of large, expensive simulations to a mixed menu of large and small simulators, "We are

telling commanders that this is not necessarily a better way to train, but it is more affordable.” (Peck, 2012)

Both FMB and COVE are high level trainers. There is currently no readily accessible, low cost, intermediate level, interactive, shiphandling resource to fill the existing gap between seminar-style shiphandling training and the higher fidelity simulations currently available to Navy officers. Such a system would be a desktop based simulator, similar to commercial games. The authors believed that such a system could provide valuable training and either reduce the amount of time students need to spend in the larger simulators or to improve their capabilities before they begin training in the larger simulators. This will allow them to practice the more advanced skills that require the higher fidelity of the larger simulators, resulting in a better trained officer without increasing the amount of time in either COVE or the FMB. Such a system of tiered trainers would be similar to aviation simulators, which range from simple desktop simulators through non-motion simulators up to full motion simulators.

The difficulty of implementing such a system of tiered trainers, however, is that rarely do trainer designers have anything more than a gut feeling from their experience as to what can be trained in the cheaper system and what requires the higher fidelity trainer to deliver effective instruction. SME input does not normally help this, since SMEs do not necessarily fully understand the capabilities and limitations of different systems. We cover this further in the conclusion.

### **Initial Shiphandling Training**

Most SWO officers report directly to their first ship after receiving some sort of shiphandling training through their commissioning source. United States Naval Academy (USNA) midshipmen train in watercraft and high quality shiphandling simulations. Both USNA and Naval Reserve Officers Training Corps (NROTC) midshipmen participate in four weeks of summer cruise training, where they likely stand watch on the bridge as a conning officer. However, officers commissioned via Seaman to Admiral-21, Officer Candidate's School and direct commissioning programs such as Limited Duty Officers and Chief Warrant Officers don't receive these same opportunities. As a result, most show up to their first assignment significantly behind their peers in shiphandling training.

To address this problem, officers commissioned from these sources may report to SWOS or ATG for the Surface Warfare Officer Introduction (SWOI) course before reporting to their ships. This three-week course

of instruction exposes students to, among other topics, seamanship and shiphandling instruction, including four sessions in the COVE.

### **RESEARCH GOALS**

As mentioned earlier, generally nothing exists other than the gut feel of either the subject matter expert or the trainer designer as to what tasks can be trained effectively in smaller simulators. Determining this was the crux of our research. We set out to examine whether adding a desktop simulator can improve shiphandling training. Although we believe such a simulation can be effective in training SWOS in a wide range of shiphandling abilities, such an investigation would be far beyond the extent of a master's thesis. Thus, we decided to begin investigating at the simplest level: can a desktop shiphandling simulation effectively train neophyte officers with almost no previous experience, allowing them to perform better at the end of their training?

Specifically, we elected to look at two slightly different areas. The first was the improvement in proficiency in issuing standard commands. More basic than the skills Crenshaw mentioned regarding Seaman's eye, standard commands are the domain specific operational language of shiphandlers. The second area is the ability of students to safely maneuver a ship through a complex task environment in the COVE following exposure to task trainer scenarios in a commercially available shiphandling game.

For several reasons, we decided to look initially at these very basic areas using newly commissioned ensigns attending SWOI at SWOS. The first is that each member of this group had very similar experience levels in shiphandling. Had we decided to look at officers who had previously served at sea, there would have been a significant difference between experience levels which would have confounded our results. Table 1 shows that none of the subjects had any previous military shiphandling experience, and only two of the eleven had recreational experience. The second reason is that SWOS runs SWOI approximately every six weeks and we could get access to enough classes to have sufficient subjects for statistical relevance. Finally, the faculty at SWOS was extremely willing to allow us access to its classes and evaluate their performance, which served as our evaluation criteria.

We opted to evaluate the subjects in a fifth COVE session after they had completed the four sessions that are normally part of SWOI. Ideally, we would have looked for differences in shiphandling at sea, since that is the ultimate goal of any such training, but that was

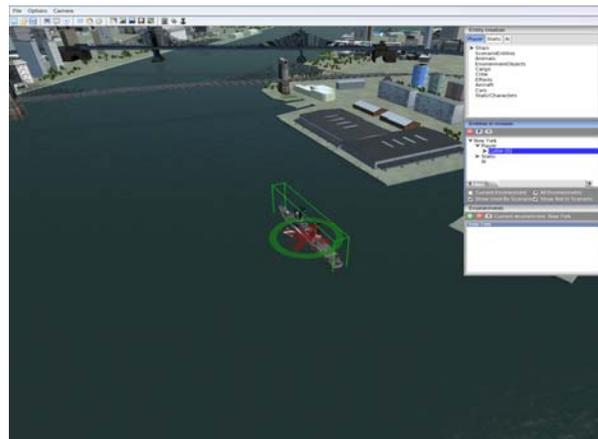
	Yes	No	N/A		None	1-10 hours	> 10 hours
Do you play video games on computers (e.g. PC/MAC)?	5	6		What amount of time have you spent playing any video game on a computer in the last six months (non-console, Xbox, PS3)?	6	2	3
Percent	45%	55%	0%	Percent	55%	18%	27%
Have you ever played simulation video games on your computer?	6	5	0				
Percent	55%	45%	0%		None	Recreational	Military/Commercial
If the answer to the previous question is "Yes", have any of the computer simulations been related to naval or commercial shipping?	0	6	5	What level of shiphandling experience do you have (e.g. recreational, military, commercial)?	9	2	0
Percent	0%	55%	45%	Percent	82%	18%	0%
	None	Hours	Days		Yes	No	
What amount of time have you spent playing simulations other than those related to question 3? (e.g. hours, days, weeks, months, etc.)	7	2	2	Do you have sailing experience?	2	9	0
Percent	64%	18%	18%	Percent	18%	82%	0%

**Table 1. Summary Test Group Demographic Data**

not an option due to far too many confounding variables. Instead, the subjects had an extra fifth session, where the same instructor evaluated all the subjects in conning the same pier landing in San Diego harbor.

**Desktop Trainer**

The research team searched extensively for available COTS game-based shiphandling software to use in this study. After compiling a list of candidates, the team decided to evaluate the three games that seemed best for the study: Ship Simulator Extremes (SSE) by VSTEP, Ports of Call Simulator 3D II, and Virtual Sailor. We evaluated these three on the criteria of ease of use, graphics, manipulation of camera viewpoint, robust mission editor, apparent physics, environmental effects, and variety of ports available for use. Based upon these criteria, SSE stood out against the rest due to above average scores in all criteria and having an extremely comprehensive mission editor required to create customized scenarios for participants. Figure 3 shows the SSE mission editor, while figure 4 shows the game environment.



**Figure 3. SSE Mission Editor**

**Research Questions**

1. Do SWOI students who use a semi-immersive, voice interactive, shiphandling game to practice standard commands covered in classroom lecture, prior to using the COVE, perform at a higher

level than those not currently using shiphandling games?

2. Do SWOI course students who use semi-immersive, voice interactive, shiphandling games to practice tasks covered in classroom shiphandling theory, prior to using the COVE, perform at a higher level than those not currently using shiphandling games? In which assessment categories will they perform better?



**Figure 4. SSE Game Environment**

## THE STUDY

We developed four prototype task trainer scenarios using SSE. The team then exposed a sample population of ensigns over the period of two evenings to the task scenarios. The ensigns then completed their normal SWOI course, after which an instructor evaluated them in a standardized pier side shiphandling scenario. After the evaluation, the team analyzed the data, identified trends and explained the results.

### Method

Our study employed a quasi-experimental design (Mitchell & Jolley, 2007) based on the simple experiment. The design utilized a test group and control group with the test group receiving a treatment. The treatment consisted of exposing the test group, over a two evening period, to shiphandling tasks of increasing difficulty developed in SSE. The design differs from the simple experiment in that the researchers used data from a previous study as the control group data. The research team used control group data provided by a previous study evaluating an intelligent tutoring system combined with the COVE, conducted by Naval Undersea Warfare Center and Stanford University. (Peters, Bratt, & Kirschenbaum, 2011) That study had both a control group and treatment group who ran the same scenario as our experiment. We did this in order to maximize the treatment group with the limited number of student

volunteers the research team had available due to time, resources, and SWOI class size restraints. In that study, multiple instructors assessed a control group of ten students as each conned an Arleigh Burke (DDG 51) class guided missile destroyer getting underway from a Naval Station San Diego pier with no active environmental forces in the COVE. The instructors utilized the Standard Surface Force Shiphandling Assessment created by the Center for Research on Evaluation, Standards, and Student Testing (CRESST) at UCLA. (Reber & Bernard, 2012) has this form.

The research team made three visits to SWOS to conduct preliminary fact finding, participant recruitment, and exposure of student participants to the game based task scenarios. The design focused on giving subjects a treatment, in the form of task trainer exposure, and then measuring its effect on their total learning experience by comparing their performance in the COVE San Diego scenario to subjects in the earlier study's control group.

There was no group randomization since all subjects were part of the treatment group; eleven students participated in the treatment group. Instructors utilized the CRESST assessment to collect performance data on the treatment group's ability to perform the same evolution, getting underway from a pier, on which they had evaluated the control group.

### Demographics

Participants in this experiment were volunteers from the SWOI course. Eleven volunteers, serving as the treatment group, began and completed the study. Of the eleven volunteers, all were ensigns with less than one-month service as officers. Two of the volunteers were female; nine were male. The age of the volunteers ranged between 22 years to 28. The average age was 23.4 with a standard deviation of 1.776 years.

Table 1 displays additional pre-treatment demographic data for treatment group. Demographic data for the control group is available for reference in (Peters, Bratt, & Kirschenbaum, 2011) and is similar to test group data.

### The Treatment

Each subject reported for treatment sessions on two consecutive nights. Each session consisted of a familiarization scenario followed by a task scenario. The treatments took place on two nights outside normal class after the students had received basic instructions on shiphandling and standard commands before they conducted training sessions in COVE.

All scenarios had the same basic make-up:

- The ship was in an area of New York City harbor, which was void of distracting or confusing landmarks;
- Participants were provided with printed copies of the SWOS shiphandling and standard commands lectures previously given in class, a copy of "Naval Shiphandlers Guide" (Barber, 2005) identical to the one issued by SWOS, and a SWOS COVE standard commands reference;
- Students were informed that there was a 10-knot harbor speed restriction while operating in close proximity to other moored ships;
- Participants performed the role of conning officer, or conn, aboard a Coast Guard high endurance cutter (WHEC), since the game did not have any models of Navy ships;
- The subjects gave verbal orders to control the cutter, which a researcher, acting as the helmsman, converted to input to the software.

The familiarization scenarios provided participants an opportunity to practice controlling the movement of the ship using standard commands and to acquaint themselves with the capabilities of the third person camera in the game. These scenarios were free-play; the subjects had no goals other than becoming acclimated with conning the ship in the game environment. In the first familiarization scenario, the ship started in the middle of the channel during mid-day, with the rudder centerline, the engines generating no thrust and no environmental forces affecting the ship. The starting conditions were the same for the familiarization scenario on the second day of treatment except we advanced the time of day to civil twilight in order to slightly change the scenario aesthetics and maintain participant engagement. During these sessions, the participants familiarized themselves with the ship's handling characteristics by issuing orders and assessing responses of the ship in the game.

In task scenario one, given on the first day of treatment immediately after the first familiarization scenario, participants started with the ship moored to a long straight pier with no obstructions. The subject began by reading written instructions in the scenario entitled "Captains Orders," which directed him to maneuver the ship off the pier and proceed to a berth further down the channel. Once the participant maneuvered the ship to within 100 feet of the ordered pier and below 1-knot speed over ground (SOG) the participant would order the helmsman-researcher to "Put over all lines." When the participant had accomplished the task, 30 minutes

had elapsed, or he expressed his desire to stop, the treatment would end and the participant would depart.

During the second treatment session, the subject carried out the second familiarization scenario and then began task scenario two. In scenario two, the Captain's Orders instructed the participant to pull into a berth after transiting the channel a short distance, similar to the first task scenario. However, this assigned berth had a ship moored aft and on the inboard positions of the berths on the adjacent pier. This required the participant to maneuver between two moored ships and then attempt a landing on the limited area ahead of the ship moored on the participant's starboard side. The reduced margin of error made it a significantly more challenging task than the previous night's task. Completion criteria were the same as the first task.

### **Researcher Interaction**

The research team went to great lengths to minimize any undue coaching interaction from the researchers to the participants during the treatments. Some interaction was unavoidable, to include clarification of the "Captain's Orders," clarification of illustrations in provided media, and questions asked by the participants about standard command pronunciation. The helmsman-researcher would respond to commands that were not in accordance with SWOS instruction with "Orders to the Helm" as would occur on a ship.

### **SWOS COVE Training Sessions**

Post treatment, the participants continued the SWOI course of instruction, consisting of four instructor mentored COVE sessions. These sessions introduce new officers to COVE and shiphandling in general. COVE sessions one through four consist of rudder and engine familiarization and maneuvering, man overboard procedures, underway replenishment (UNREP), and maneuvering underway from and making a pier landing, respectively.

### **Final COVE Evaluation Session**

After each volunteer finished the four standard COVE sessions in SWOI, each participated in an evaluation scenario graded by a qualified COVE instructor. The evaluation scenario protocol was the same used in the COVE ITS study, under the same conditions, same goal (getting an Arleigh Burke (DDG 51) class guided missile destroyer underway from a Naval Station San Diego pier with no active environmental forces in the COVE) to reliably compare our data with the control group data from that study. The instructor conducting the evaluation was qualified to instruct and evaluate

students in the COVE in accordance with SWOS requirements.

### DATA COLLECTION

The same qualified instructor generated the data for all treatment group participants. He used the CRESST Standard Surface Force Shiphandling Assessment utilizing the "Maneuver" category employed in the COVE ITS study. The "Maneuver" category has four areas of grading:

- Margins of Safety Maintained;
- Use of Rudder, Propulsion and Tugs;
- Anticipates and Evaluates Ship Responsiveness;
- Standard Commands.

Additionally, we computed an aggregate score from these four scores.

### ANALYSIS OF FINAL COVE EVALUATION

Even though the number of participants is fairly small, we chose an analysis method to ensure that our results still would be statistically valid and significant. We evaluated the data using the Wilcoxon Signed Rank Test. This commonly used statistical assessment produces valid findings even when the number of subjects is below the level generally required to assume a normal distribution. (Wilcoxon, 1945)

The SWOS instructor assessed the study participants on their ability to maintain proper margins of safety while maneuvering the ship through their final COVE evaluation session in accordance with standardized SWOS evaluation criteria. Table 2 displays the descriptive statistics for both groups. Unfortunately, individual participant data for the control group was not available at the time of our study due to institutional review board restrictions on the data from the initial study, so we can only compare the aggregate score but not the number of students who scored at each level.

Table 2 also displays the results of a One-Tailed Z-Test and Wilcoxon Signed Rank Test performed on the treatment data after fitting the distribution from the JMP statistical software. Researchers utilized control set mean and standard deviation as the hypothesized mean and true standard deviation.

### Analysis of Margins of Safety Maintained Scores

Eight participants performed at the "Meets Standards" level, three participants performed at the "Needs Improvement" level.

Treatment set data displayed statistical significance to the 0.0039 level, suggesting improved student performance in the "Margins of Safety Maintained" scoring category in the final COVE evaluation session. Figure 5 compares the treatment and control groups in this area.

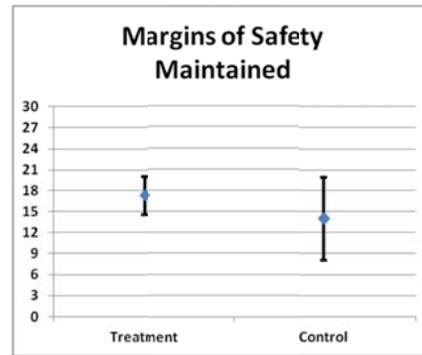


Figure 5. Comparative Means Whisker Plot of Margins of Safety Maintained Mean Scores with 95% CI

### Analysis of Use of Rudder, Propulsion and Tugs Scores

Nine participants performed at the "Meets Standards" level, two participants performed at the "Needs Improvement" level.

Treatment set data displayed no statistical significance, suggesting no discernible effect on performance in COVE through exposure to the game based protocol. Figure 7 compares the control and treatment groups.

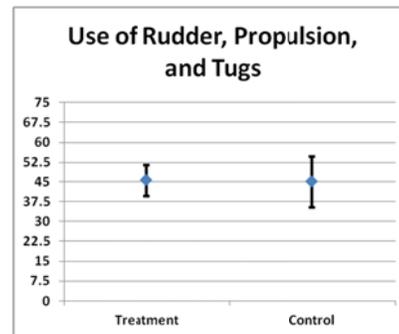


Figure 6. Comparative Whisker Plot of Use of Rudder, Propulsion, and Tugs Mean Scores w/ 95% CI

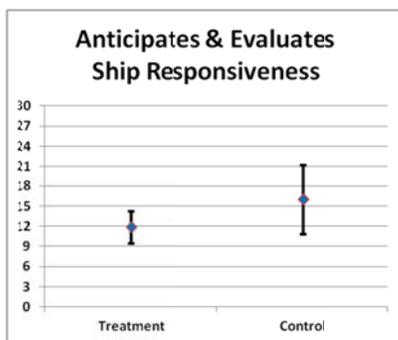
	Margins of Safety Maintained	Use of Rudder, Propulsion, and Tugs	Anticipates and Evaluates Ship Responsiveness	Standard Commands	Aggregate Maneuver					
<b>Test Mean</b>										
Hypothesized Value	14	45	16	8.5	167					
Actual Estimate	17.2727	45.4545	11.8182	10.9091	170.909					
DF	10	10	10	10	10					
Std Dev	4.67099	10.113	4.0452	2.0226	25.0817					
Sigma given	9.66	15.81	8.43	3.37	74.54					
	<b>z Test</b>	<b>Signed-Rank</b>	<b>z Test</b>	<b>Signed-Rank</b>	<b>z Test</b>	<b>Signed-Rank</b>	<b>z Test</b>	<b>Signed-Rank</b>	<b>z Test</b>	<b>Signed-Rank</b>
Test Statistic	1.1236	27	0.0954	12	-1.6453	-30	2.3709	33	0.1739	9
Prob >  z	0.2612	0.0078*	0.924	0.3408	0.0999	0.0039*	0.0177*	0.0010*	0.8619	0.4551
Prob > z	0.1306	0.0039*	0.462	0.1704	0.95	0.998	0.0089*	0.0005*	0.431	0.2275
Prob < z	0.8694	0.9961	0.538	0.8296	0.0500*	0.0020*	0.9911	0.9995	0.569	0.7725

**Table 2. Statistical Analysis of Various Evaluation Criteria**

**Analysis of Anticipates and Evaluates Ship Responsiveness Scores**

Two participants performed at the “Meets Standards” level, nine participants performed at the “Needs Improvement” level.

Treatment set data displayed a statistically significantly lower value than the control to the 0.05 and 0.002 level for the One-Tailed Z-Test and Wilcoxon Signed Rank Test respectively. This suggests that the students exposed to the game based task trainer scenarios performed at a lower level than the control group in the final COVE evaluation. Figure 7 compares the control and treatment groups.

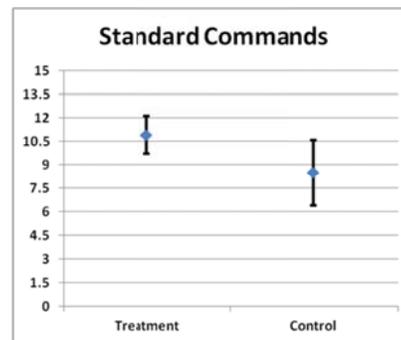


**Figure 7. Comparative Whisker Plot of Anticipates and Evaluates Ship Responsiveness Mean Scores with 95% CI**

**Analysis of Standard Commands Scores**

Two participants performed at the “Proficient” level and nine performed at the “Meets Standards” level.

Treatment set data displayed statistical significance to the 0.0089 and 0.0005 level for the One-Tailed Z-Test and Wilcoxon Signed Rank Test respectively, suggesting improved student performance in the “Standard Commands” scoring category in the final COVE evaluation session. Figure 8 compares the control and treatment groups.

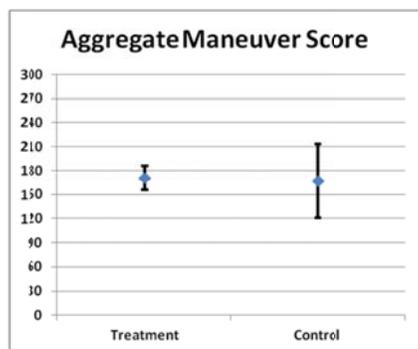


**Figure 8. Comparative Whisker Plot of Standard Commands Mean Scores with 95% CI**

**Analysis of Aggregate Maneuver Scores**

The Aggregate Maneuver Score category consists of the previous four score categories standardized to a point value of 300.

Six participants performed at the “Meets Standards” level, five participants performed at the “Needs Improvement” level. Treatment set data displayed no statistical significance, suggesting no discernible effect on student aggregate maneuver performance in COVE through exposure to the game based protocol. Figure 9 compares the control and treatment groups.



**Figure 9. Comparative Whisker Plot of Aggregate Maneuver Mean Scores Treatment versus Control with 95% CI**

### CONCLUSIONS

The results of our data collection and analysis suggest that student volunteers performed at a statistically higher level in the category of “Standard Commands” and “Margin of Safety Maintained” than control group students did. These findings, specifically the standard command improvement, are corollary with unsolicited instructor and student feedback.

Standard command improvement was directly observable in SWOI students. Increased comprehension and execution of standard command domain knowledge was apparent during post-treatment COVE instruction by SWOI instructional staff. “Seaman’s Eye” increased during the course of the treatment according to subjects.

The category “Use of Rudder, Propulsion, and Tugs” score of the treatment group proved to be statistically indistinguishable from that of control group. In the case of “Use of Rudder, Propulsion, and Tugs,” the reason may lie in the four instructed COVE sessions. These sessions may have sufficiently transferred an equivalent level of knowledge to control group students and negated any measurable positive training effects of the treatment. Additionally, the treatment scenarios in SSE did not include tugs.

The results in the category “Anticipates and Evaluates Ship Responsiveness” surprised the research team. The treatment group performed at a significantly lower level than the control group. The research team has considered several possible causes for this. The effect of viewpoint, model acclimation, and individual model relearning time could account for the significantly lower score when compared to the control group. More study is necessary to determine the root cause of this result indicating negative training transfer.

However, if this result stands up under further analysis, it is an important finding, if not the *key* finding of the research. In deciding to use an existing game as a trainer, it is very difficult to determine whether the game will meet the training needs. The same question from a different perspective is how does an instructional designer justify the extra cost and time to build a training game from scratch? By showing that the game loses significant training value by not having the correct models and/or physics provides a vital criterion to evaluate existing COTS games or justify building a system.

We had three designers, who were both shiphandling SMEs as well as well-educated in M&S, and additional SMEs at SWOS who were all surprised by this result. Our instinct believed that the response of the USCG cutter in the game would be close enough to that of the DDG to not matter, yet it appears to do so. That bears out our belief that designers must rely on experimentation to determine what is critical rather than instinct or experience.

The “Aggregate Maneuver” score of the treatment group was statistically indistinguishable from the control group and proved to be a less accurate measure of overall student performance than previously expected. The true data trends were not evident until viewed at the individual category component level.

The game based treatment demonstrated statistically significant effects in the areas of execution of standard commands and student abilities to maintain proper margins of safety while maneuvering. The intent of the research team was not to train specific evolutions or categories, but to expose students to a voice controlled game based shiphandling simulation and determine if the exposure led to increased performance in the COVE. Although the effect of the treatment on aggregate maneuver skill was statistically indistinguishable from the control group, the research demonstrated that the specific skills of “Standard Commands” and “Margin of Safety Maintained” increased due to exposure to the game based protocol.

This research is important because it demonstrated how one desktop based shiphandling training simulation affected trainees’ performance in different areas. This is crucial in understanding the attributes that a final desktop training system must have in order to provide the necessary training.

### FUTURE WORK

This research showed that the Navy needs a good desktop simulator to train officers in shiphandling and

this research was just the first step to develop the most effective one possible. Several areas of needed research and capabilities became apparent during this study.

The first is that the surprising result of degraded performance in the area of “Anticipates and Evaluates Ship Responsiveness” needs to be investigated and understood. This is important because many people believe that shiphandling training on one type of ship should transfer well to another type, which this result seems to belie. Is the result we found incorrect? Is it due to some factor of SSE that caused negative training? Or does it only apply to the greenest of shiphandlers? We must determine the cause of this in order to ensure future training systems train correctly.

The second is that the Navy needs to experiment to determine whether it can extend these results to more experienced shiphandlers. Officers report to SWOS multiple times over the course of their careers and each time shiphandling is a large part of the curriculum. Likewise, the Navy conducts shiphandling training daily in ships and in home ports. The Navy needs to answer the question, “What properties does a desktop shiphandling simulator need to train an officer?”, and it needs to answer it at every experience level.

The remainder of the future work we recommend are features that naval shiphandling trainers require to meet fully their capabilities. The most important is to build an intelligent tutoring system for the shiphandling trainers. Such a system would greatly reduce the instructor loading for training. This currently requires one instructor to observe one student throughout the training session, which greatly limits throughput. A system that could either coach a student at critical times during an evolution or conduct an after action review with her after a session will be quite useful. Even if we accept that shiphandling is more an art than a science and there are several correct solutions to each problem, a system that did not require an instructor to constantly observe a student but alert the instructor at a session’s critical time will still improve throughput.

The last recommendation is a true voice control software interface. In this work, the researcher interpreted the voice commands of the student and entered them into the software. A true desktop system needs a voice interface.

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