PAINTED SHIP UPON A PAINTED OCEAN:

Facilitation and Practical Competency Assessment of Shiphandling Skills

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I hear, I forget. I see, I remember.
I do, and I understand.
--- *Ancient Chinese Proverb*

Abstract

This paper will provide an overview of the three types of simulators employed during the Shiphandling / Seamanship course offered at the United States Merchant Marine Academy, discuss the virtues and limitations of each in the facilitation process, and provide techniques for competency assessment. Examples of the course practical training exercises and critique of each methodology will be presented. The paper will offer observations between the employment of simulation and the use of training vessels for the dissemination of practical shiphandling skills. In conclusion, the paper will confer the relevance of the use of simulators as an integral part of experiential learning and reinforce the importance of the facilitation and practical competency assessment of shiphandling using a painted ship upon a painted ocean .

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1. Introduction

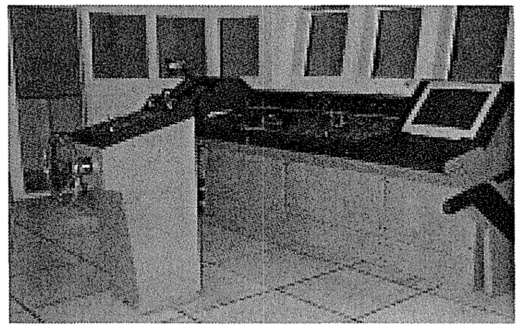
Marine simulation, when used in conjunction with other training methodologies, provides an effective mechanism for dissemination of the physics of shiphandling theory. The mariner s ability to apply the abstract concepts in real time scenarios transcends vector analysis to become the art of shiphandling. IMO/STCW addresses specific competency assessments with respect to ship officer certification. Historically, the Shiphandling/Seamanship course offered at the United States Merchant Marine Academy did not provide for evaluation of midshipmen through practical competency assessment of these mariner skills. Moreover, simulation was not traditionally used in the facilitation process to demonstrate ship behavior.

With the advent of IMO model courses and implementation of STCW competency assessment, the Shiphandling/Seamanship course offered to midshipmen at the United States Merchant Marine Academy has been redesigned to employ practical demonstration, performance evaluation, and assessment. Part-task simulators, full mission simulators, small vessels, and the training ship are used to facilitate the understanding of ship manoeuvring concepts. Because shiphandling training is fundamentally task oriented, marine simulation or actual shipboard training is requisite to the facilitation process. Practical mariner assessment of shiphandling skills, to be successfully objective and quantitative, should be executed in a controlled environment such as the simulator provides.

2. USMMA Simulators

One full mission simulator (CAORF) and two part task simulators (RADAR NMS-90 and PortSim) are currently employed at the United States Merchant Marine Academy (USMMA) for the facilitation of practical shiphandling skills.

2.1 CAORF



CAORF (Computer Aided Operations Research Facility) was installed at the USMMA in 1975. Since that time of room-sized mainframe computers, the CAORF simulator has evolved to the state of the art full mission simulator it remains today. In the summer of 2000, the simulator underwent another upgrade to the Polaris system of Norcontrol. Modern navigation units and realistic ship interactions are a part of this new system.

2.1.1 CAORF Advantages

Any full mission simulator, such as CAORF, offers a number of advantages over a part task simulator or a training vessel for the facilitation of practical shiphandling skills. By removing the instructor from the bridge of the ship, the midshipmen are afforded complete immersion in the scenario. The perceived safety net is removed and the students are allowed to carry the exercise to its ultimate outcome, whether their commands result in collision, allision, or grounding. The midshipmen are directly accountable for their bridge team decisions and are able to observe the final outcome of their actions. The process lends validity to the lesson. A statement from an instructor, such as, If we had not altered course at this point, we would have had a collision with the crossing vessel, becomes unnecessary as the team is able to observe the consequences of their choices. Newest versions of full mission simulator provide for a playback of the scenario so that a chain of error may be easily identified and followed during a debrief. Essentially, the full mission simulator allows the bridge team to fail an operation, or, stated in the positive sense, the simulator provides for maximum learning opportunity as the ship experiences a grounding or collision.

Generally, the use of the simulator is reserved for upperclassmen at the USMMA -- those having had some experience at sea aboard real ships. Having stood on the bridge of a ship, these midshipmen are less likely to perceive the simulator as a video game and so bestow upon it serious respect. Anyone doubting the validity of the aforementioned has not witnessed the deflated egos, shaky hands and voices, and almost tears as a watch team is debriefed following a less than stellar performance. Ship officers will remember the first time they made a solo decision, albeit minor, such as altering course for traffic. How carefully did he or she check the grease pencil rendition of the other ship s resultant RM line, check the trial maneuver on the ARPA, or replot the vessel s position? Midshipmen, and freshly minted officers, share a fear of having the conn. Simulators assuage this anxiety. Each ship master clearly remembers their first command — first maneuvering, first time they were called to the bridge at 0300, etc. This feeling of command is perhaps the most important element imparted to the marginally experienced midshipman, albeit intangible and nonquantifiable. All prior experience has probably been that of an observer — a requisite stage in the learning process. The next stage is necessarily learning by doing — the experiential environment that the simulator provides.

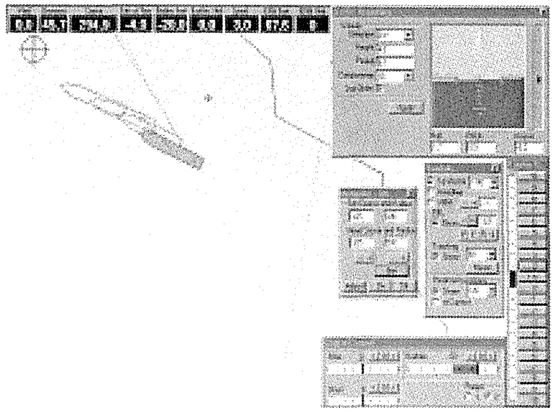
CAORF provides a number of clear advantages with respect to both qualitative and quantitative assessment of mariner skills requisite to successful shiphandling. Once developed, the same exercise may be utilized for multiple assessments. Conversely, the instructor is easily able to alter a scenario efficiently before or during a run. Traffic may be changed or other elements altered according to bridge team responses. Especially relevant to shiphandling training and assessment, the own ship model may be changed for comparison purposes. After initial scenario development, preparation time is relatively short. Shjphandling elements such as ship interaction, squat, bank cushion, suction and the resulting sheer will be easily demonstrable. Each run may be recorded and played back during a class debrief.

2.1.2 CAORF Disadvantages

Operation of the CAORF simulator is both time and labor intensive. The capstone course, Bridge Team Management, offered at the USMMA, is taught exclusively with the use of the simulator. The course is well planned with respect to both time and student to teacher ratio. One instructor and one computer operator work in tandem to operate the simulator for each bridge team of four midshipmen. Each scenario runs for approximately one hour and is followed by an extensive debrief, facilitated by same the instructor. As this course was designed for the simulator, its rendition is consistently excellent.

Conversely, the Shiphandling / Seamanship course offered at the USMMA is assigned thirty midshipmen to one instructor and one assistant. During the laboratory, a two-hour period, five midshipmen are in the simulator during a twenty to thirty minute scenario while the twenty-five others in the section stand by to rotate through the simulator. The assistant handles these twenty-five midshipmen. There is neither time nor instructor available for the debrief, which should, for optimum corroboration, be given immediately following the simulation. A brief discussion on how these challenges were allayed will be provided later in this paper.

2.2 PORTSIM®



The Marine Transportation Department of the USMMA also employs a part task simulator, PortSim, developed by SSPA Maritime Consulting of Gr teborg, Sweden. The PC based simulator presentation is bird s eye view and may be displayed in true motion, relative motion, head or north up. The ship models are based on mathematical modeling, tank model testing, and full-scale correlation; and therefore accurately describe the many vessel hydrodynamic behaviors in four degrees of freedom. A few of the features include: current and shallow water effects, bank, quay and squat effects, wind effects including lees from buildings, escort towing, eight winches for mooring, accurate underwater topography, dynamic position predictor, replay function, result file for storing of parameters.

2.2.1 PORTSIM Advantages

Part task, PC based simulation systems, such as PortSim, offer a number of advantages to full mission simulators. A first quality, interactive, multistation PC based simulator may be acquired for under $100,000.00 (USD), whereas installation of a first quality full mission simulator may easily cost $2,000,000.00 (USD). Often these simulators require major architectural alterations to existing classrooms or offices, a new wing, or dedicated building. Beyond the obvious monetary and space considerations, part task simulators offer a number of advantages to the full mission alternative.

PortSim 4.0 includes fifteen student stations and one instructor station. The system permits a section of thirty midshipmen to work in pairs during a two-hour laboratory. Alternatively, half of the class, fifteen midshipmen, may work solo. The low student to simulator ratio affords increased training time for each individual. The student necessarily makes his or her own maneuvering decision and views the direct outcome of that action. Recorded observations, outcome analysis and assessment are also individual. With respect to shiphandling facilitation, this is also important when training differing personality and learning types.

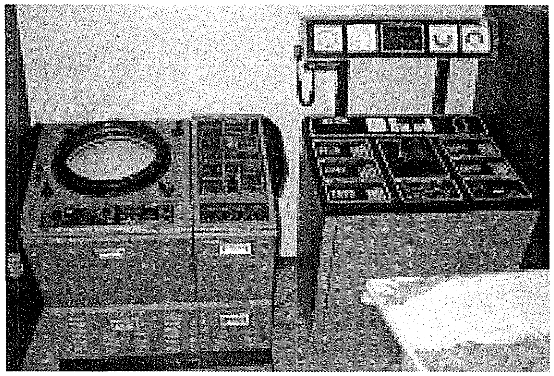
Part task simulators allow the instructor to easily develop a lesson isolating a single competency or shiphandling factor for study. Outputs such as drift angle, turning rate, set and drift provide the data for quantitative analysis during report and debrief. The bird s eye view divulges outcomes not as readily apparent from the bridge perspective of the full mission simulator. Definition and relevancy of factors such as drift angle are clearly apparent. Although a student may be able to memorize a textbook definition of terminology such as advance, transfer, tactical diameter, final diameter, the lexis is often without the marked significance revealed by a dynamic rendition. Real time maneuvers, such as the shallow water turning circle of a VLCC, are extremely time consuming. Observations of isolated tasks, such as turning circles, were challenging to the patience of even the most attentive students. The part task simulator provides for observation of maneuvers in a compressed time mode, relieving the tediousness of the real time renditions. Additionally, if adjacent monitors are programmed to execute similar tasks, those with one factor altered, the result is readily apparent. For example, while one station is programmed to have a VLCC execute a turning circle in deep water, and the adjacent station is set up to have the same VLCC execute the turning circle in shallow water. Part task simulators, such as PortSim, generally provide a wider variety of own ships, thereby increasing the potential for comparison study. For example, the same turning circle described above yields quite different results when executed with a container ship.

In the shiphandling course at the USMMA, midshipmen are asked to present results to the class as a part of the facilitation process. The part task simulator permits the midshipmen to save and play back their shiphandling experiments. The dissemination of the individuals results to the group reinforces basic concepts studied by reinforcing the individuals outcomes. Part task simulators such as PortSim provide the best venue for several practical competency assessments, as are compulsory with the recent implementation of STCW requirements. A midshipman s ability to successfully complete a shiphandling task is not dependent upon the performance of others on the bridge team or on another ship, as is the case with the current assessment methodology. Further, the assessment may be completed on a singular basis, without requirement of a watch team to execute the task. A further comparison of test beds for competency assessments is discussed in the section *Assessment of Shiphandling Skills,* later in this paper.

2.2.2 PORTSIM Disadvantages

By definition, part task simulators do not provide the immersion experience of the full mission simulator. Although PortSim is extremely effective in the isolation and dissemination of the physics of shiphandling theory, the system does not provide the command experience of the bridge. Danger of a video game mentality approach to PC based simulators is a risk when midshipmen have little bridge experience. Proper introduction of the simulator as a serious teaching tool and presentation of its utility for competency assessment should preclude this attitude. For this reason, use of the simulator should be reserved for those with some shipboard experience, such as upperclassmen, as this familiarity will lend validity to the own ship responses.

2.3 NavSim NMS-90 Norcontrol Simulator



The NavSim NMS-90 MK III Simulator is a Norcontrol part task simulation system that provides radar input in the form of several port databases. It has applicability as a shiphandling simulator through the blind bridge maneuvering of up to twelve own ships in the radar laboratory. Accurate ship model behavior is included in the system to afford students experience in ship maneuvering. The instrumentation on the own ship bridges is modeled after ship equipment to give trainees the best possible illusion of operating an actual ship. The system is interactive, i.e., each of six stations (own ships) tracks five other vessels on the screen and may maneuver as requisite to avoidance of collision.

2.3.1 NavSim NMS-90 Simulator Advantages

The radar simulator is state of the art for instruction of radar plotting, navigation, and ARPA training. It has limited but valuable use in the promulgation of shiphandling theory and practical competency assessment. Currently, it is the only simulator at the USMMA with which bank effects and ship interaction may be demonstrated. For this reason, it is used as the assessment method for the ship interaction competency required by STCW. Details of the evaluation procedure will be reviewed in the section, Assessment of Shiphandling Skills. A feature unique to the NMS-90 simulator, as compared to other simulators in use at the USMMA, is in the fact that there are essentially twelve own ships. Each of the student stations is interactive with five others, permitting realistic meeting, crossing and overtaking situations between the vessels.

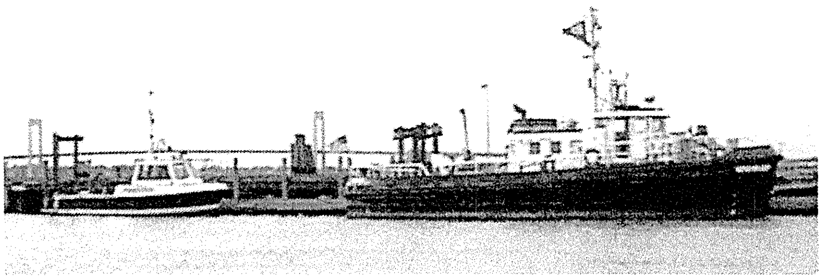
2.3.2 NavSim NMS-90 Simulator Disadvantages

The radar simulator stations are essentially blind bridges, with electronic equipment including an echo sounder, helm, bow thruster, engine controls, and VHF radio. During the exercise, the midshipmen determine the ship s position by radar and plot same. Given that there is no visual output excepting the radar screen, the midshipmen do not gain the benefit of visual orientation. Much of effective shiphandling is executed in response to visual orientation; consequently, the sense of immersion is deficient. Although the shiphandling exercise developed specifies that the ship is in dense fog, the midshipmen do not maintain the sense that they are conning a real vessel as with a full mission simulator such as CAORF.

3. USMMA Training Vessels

The USMMA Department of Waterfront Activities maintains several vessels for midshipman training. The vessels utilized specifically for shiphandling practice are described in the following subsections.

3.1 Small Boats: POSEIDON and GROWLER



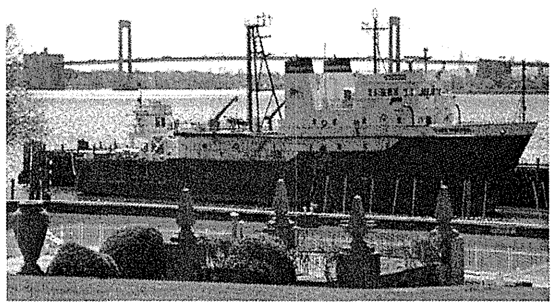
3.1.1 POSEIDON

The *Poseidon* is a thirty-two foot former U.S. Coast Guard fireboat. The vessel has twin Caterpillar 3208 high speed diesel engines, 200 SHP each. She has two small unbalanced spade rudders. She has a wheel and throttle control of the engines in a small wheelhouse. The open deck can accommodate ten midshipmen for training purposes. The *Poseidon* is easily maneuverable and is best for demonstration of twin-screw shiphandling techniques. Her rudders are fairly ineffective at slow speeds and when going astern.

3.1.2 GROWLER

The *Growler* is a sixty-five foot former U.S. Coast Guard ice breaking yard tug — 5 _ foot draft and 74 ton displacement. She is single screw (60 inch diameter, 39 inch pitch), with a maximum speed of 10.5 knots. Her main engine is Caterpillar D375, 400 SHP at 1250 RPM. The control of the engine is from the pilot house. She has a single large balanced rudder. Although her pilot house is small for instructional purposes, she can accommodate forty passengers or sleep seven on short voyages. The bow is unconventional in that it possesses a sharp break and dead rise in the keel line for ice breaking purposes. The hull is fitted with rub rails and a resilient bumper at the sides, useful to student drivers. The *Growler* is very responsive to both rudder and screw, and is the best vessel in the USMMA fleet for demonstrating single screw maneuvering.

3.2 Training Ship: T/V KINGS POINTER



The *T/V Kings Pointer* (ex *USNS Contender*) is a former U.S. Naval TAGOS class ocean surveillance vessel. She has a 224 foot length overall, 43 foot beam, 15 foot design draft, and has a displacement of 1,914 tons. She is diesel electric; the four main engines are Caterpillar D398TA, 970 HP, the four main generators are Kato 600 Kw, 600 VAC, 3 phase, and the two main propulsion motors are General Electric 800 HP. Her twin screws are inboard turning, 4 bladed, 8 foot diameter, 8_ foot pitch. The two rudders are semi balanced spade with a deflection of 0°°— 45°. She also has a bow thruster: 4 bladed, fixed pitch, 48 inch tunnel, 550 HP Harbormaster. The *Kings Pointer* requires a Master, a Chief Engineer, and an Able Seaman for crew on short voyages (under 12 hours), and a Master, three Mates, three A.Bs, a Chief Engineer, and an Assistant Engineer and thee QMEDs for longer voyages. She may carry a maximum of 115 persons on short voyages and 30 total aboard on extended voyages. She is limited by her draft to sailing on the high tides, which occur diurnally at Kings Point, where she is berthed. The *Kings Pointer* makes three extended voyages each year, during the fall, spring, and summer holidays. In addition, she frequently makes short weekend voyages to nearby ports and overnight cruises to nowhere for plebe orientation on Long Island Sound. The *Kings Pointer* is the best training platform for practical watchstanding and shiphandling at the USMMA, but time, cost, weather, manning, and berthing limitations somewhat restrict her use. A very short training voyage, one commencing two hours before high tide and returning two hours after high tide, burns about 280 gallons of fuel. Even a short voyage is disruptive to the daily class schedule, especially when it must be organized around the tidal cycle rather than the academic day. During a recent term, a single planned four hour voyage for shiphandling and navigation practice had to be rescheduled four times owing to weather considerations. Longer voyages, those spanning one full tidal cycle, are often executed overnight. These trips consume about 840 gallons of fuel, require meals, and usually require additional officers and crew. One twelve-hour trip costs roughly $2500.00 (USD). The ten-day voyages, taken three times yearly, cost roughly $25,000.00 (USD) per voyage.

3.3 Advantages of Using Vessels for Shiphandling Training and Assessment

When a person learns to ride a bicycle, the process is first by observation then by emulation. Rarely is the neophyte cyclist cognizant of the physics of gyroscopic inertia required to successfully balance on two wheels. Some of the best ship handlers in the world have little formal education. These fishermen and supply boat captains cannot explain transverse thrust or Bernoulli s Principle, yet all can handle a vessel adeptly. They have mastered the art of shiphandling.

Experiential learning is the process of learning through doing initially, then studying the theory subsequently. As an example of experiential learning, this Master Mariner handled vessels beginning with small boats at the age of six. The physics and theory of shiphandling were not conveyed until years later during academy advanced seamanship courses. Small craft training aboard boats most directly emulates the experiential learning process. On the small boats, the midshipman must handle the vessel and can directly see and feel her responses to each maneuver. He or she learns empirically — through direct observation followed by trial and error. Most significantly, the student experiences the responsibility of a real conn, with all of the feelings of fear and accomplishment that ensue. On the larger vessel, the *T/V Kings Pointer*, ship characteristics such as advance, slow response time of engine, continued swing after the command amidships, and heel of the vessel after she is put hard over lend validity to instruction. As the midshipmen learn by doing, the validation through class briefings becomes exponential.

3.4 Disadvantages of Using Vessels for Shiphandling Training and Assessment

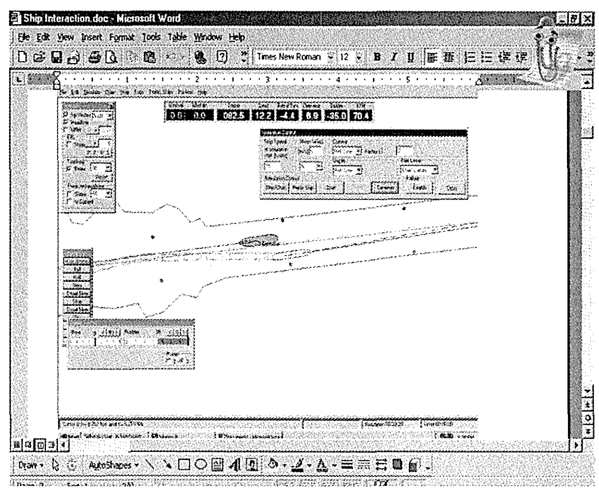
Ultimately, the objective of a practical shiphandling course is mastery of those skills aboard a real craft. Using a simulator for dissemination of shiphandling skills, however, has a number of marked advantages over the use of small boats for the same purpose. The cost analysis of deploying the training vessel *Kings Pointer* has already been reviewed. Although she is the most expensive, the smaller vessels have fuel and maintenance considerations as well. Operation of all of the vessels is weather dependent, with wind, tide, precipitation, ice, and temperature of significance. All of the vessels are time and labor intensive with respect to the hands on training opportunities. In the case of the *Kings Pointer*, often the midshipmen necessarily miss other classes to sail aboard. In a recent term, over one hundred midshipmen were registered for the shiphandling course at the USMMA. Provision of quality time for each student at the conn of the ship would have been time prohibitive. Moreover, use of the vessels for assessment is not only time prohibitive but possibly dangerous. The midshipmen are tested for shiphandling competency. For example, would a prudent mariner place a possibly incompetent student at the conn of a vessel to determine skill in compensating for narrow channel interaction an assessment required by required by STCW? Further, there are numerous uncontrollable factors, such as weather or oncoming traffic. Such major factors not under control of the examiner might also serve to undermine the validity and reliability of the assessment mechanism.

4. Assessment of Shiphandling Skills

The 1995 Amendments to the Standards of Training and Competency of Watchkeepers (STCW 95) mandate performance based competency assessment. Performance measures are observable actions or consequences of those actions that can be recorded or quantified. Performance based testing may be successfully accomplished through simulation or ship operations. The 1997 report, *Mariner Qualifications and Training — Performance Based Test Development*, affirms that simulators provide a convenient, cost effective, and consistent means of controlling the operational conditions under which competencies may be demonstrated (McCallum, et. al., 1997). The report emphasizes that successful assessment testing must be both reliable and valid. Reliable tests are defined as those that yield consistent results when repeated — the environment which a simulator provides. Please refer to the example Portsim Turning Circles Laboratory and corresponding competency assessment in the Appendix of this paper.

With respect to shiphandling competency, STCW 1995 (STCW TABLE A-II/1, Specification of minimum standard of competence for officers in charge of a navigational watch on ships of 500 gross tons or more.) specifies that a mariner demonstrate a knowledge of squat, shallow water and similar effects in maneuvering a ship. Historically, Testing for this competency assessment was accomplished using the NMS-90 simulator in the radar laboratory. The midshipmen were assigned to ships meeting in a narrow channel. To accomplish the assessment objective, the two ships were required to successfully meet in the channel. To demonstrate proficiency, the midshipmen were required to score a grade of 70 or higher according to the following quantitative assessment criteria:

retake	grounding
retake	collision
- 10 points	on wrong side of channel.



- 20 points hit buoy
- 20 points sheer

A testing limitation was revealed upon actual execution of these procedures in the NMS-90 simulator: if one team made an error, such as sheering into the oncoming vessel, both teams consequently failed the test according to the grading criteria set forth in that initial outline. A more reliable testing methodology was developed using the PortSim part task simulator: the instructor preconfigures the meeting vessels, thereby yielding more consistent testing results. The PortSim simulator was also used to generate shallow water, bank effects, wind and current in laboratory. The midshipmen are tested for competencies involving compensation for these additional externalities as is also required by STCW 95.

The second criteria outlined by the 1997 report states that a test must also be valid, i.e., related to performance in the real world. In theory, the optimum means of real world assessment would be aboard a vessel. However, as previously stated, any prudent mariner would not put their vessel in harm s way — such as meeting in a narrow channel with a cadet at the conn might exemplify. In addition, real world testing such as a vessel provides is not easily repeatable or consistent with respect to testing conditions.

4. Conclusions

. . . using the language of knowledge is no proof that they possess it. --- Aristotle, 4th Century, B.C.

The importance of experience, i.e., learning by doing, has been valued through the millennia. Aristotle believed that theory was not truly understood until a person had the ability to apply it. Lecturers of shiphandling may expound upon the physics of shiphandling theory, but the lessons will remain unlearned until reinforced by practical demonstration and emulation. Practice with real vessels would appear to be the logical solution. The actual use of vessels for shiphandling training and assessment, however, fosters a number of limitations as outlined in this paper. Moreover, the prudent mariner would not place an actual vessel in an adverse situation for the purpose of assessing cadets.

Both the part task and the full mission simulators provide a controlled learning environment for practical shiphandling training. Lesson objectives, such as turning circle comparison or shallow water interaction, may be isolated and studied without adverse effects of weather or current. As stated above, successful assessment testing must be both reliable and valid. Reliable tests are defined as those that yield consistent results when repeated — the environment which a simulator provides. The environment of a simulator is also valid, i.e., related to performance in the real world.

Shiphandling facilitation at the USMMA adheres to the model of the learning theorist David Kolb, a proponent of experiential learning. He advocates the learning is a multidimensional process, beginning from concrete experience, to observation and reflection, then to the formation of abstract concepts and generalizations, to testing implications of new concepts in new situations (Kolb, 2000) Kolb s model for experiential learning is exemplified in shiphandling methodology at the USMMA: *Concrete experience*: before the shiphandling course, the midshipmen spend several months at sea as cadets aboard merchant ships. *Observation and reflection:* the midshipmen are required to submit a comprehensive sea project with respect to their individual observations. *Formation of abstract concepts and generalizations*: shiphandling class discussions combine individual observations to shiphandling theory. *Testing of implications of new concepts in new situations*: validation of theories through practical applications using a simulator and during debrief. In closing, the ancient Chinese proverb quoted at the inception of this paper serves to reinforce the importance of the facilitation of practical shiphandling using a painted ship upon a painted ocean :

I do, and I understand.

References

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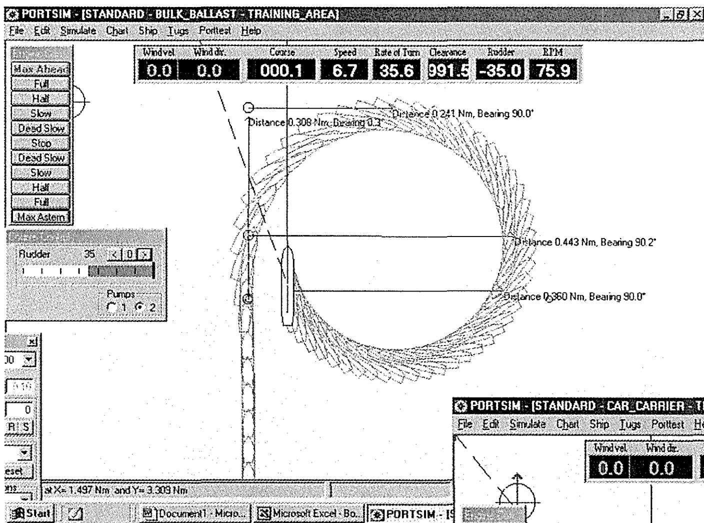
McCallum, M.C., Maloney, A.L., Sandquist, T.F., Nunnenkamp, J.M., Sandberg G.R., and Smith M.W. *Mariner Qualification and Training Performance-based Test Development.* Battelle Research Center, Seattle, 1997.

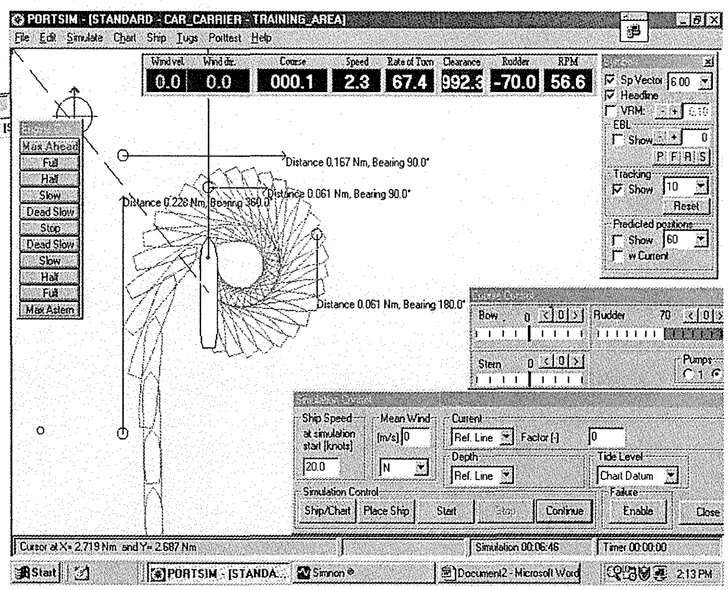
McKern R., ed. *Introduction to Aristotle.* Random House, New York, 1947.

Diagramsbelow correspond to TURNING CIRCLE LABORATORY (Appendix)



TURNING CIRCLE EXPERIMENT

3A. Shallow water



TURNING CIRCLE EXPERIMENT

3B. Deep water

APPENDIX: Example Part task Simulation Laboratory and Corresponding Competency Assessment

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PortSim Laboratory: TURNING CIRCLES

OBJECTIVE: Practical application of turning circle shiphandling theory.

ASSIGNMENT: Each team will write a report about observations made during each experiment and turn in the work by the assigned date. Each team may be required to present the results of their experiment to the class during class debrief and discussion.

INSTRUCTIONS: Utilizing the PortSim part task simulator, conduct the following experiments with given conditions: using the assigned vessels, on the grid, no wind or current, track recorder on.

Teams having laboratory the 1st week make right turns; midshipmen having laboratory the 2nd week make left turns.

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1. **Effect of Ship s Speed on Turning Circles**

A. High Speed

Using the assigned ship, steady the vessel on a course of 000° at full ahead [max ahead or 100% CPP]. Set the SPEED AT START in the SIMULATION CONTROLS to the maximum design speed for assigned ship. After running on a steady course for 5 cables (1/2 NM), put the rudder hard left and observe one complete turn. When heading is 000°, stop the run, measure turning circle parameters and save all data to own disc as required.

B. Slow Speed

Place own ship on a starting grid point two rows up from the bottom center of the chart. Determine slow ahead for own ship by setting an initial speed of 30% of full (max) ahead on the SPEED AT START. Steady the vessel on a course of 000° at slow ahead [30% CPP] on the EOT. Observe the speed of the vessel for 5 cables (1/2 NM) and check that she is not accelerating or slowing speed. If yes, adjust the initial speed accordingly. Once own ship is on course at slow ahead, bring the rudder hard left and observe one full turn on the grid with the track recorder on. When heading is 000°, stop the run, measure turning circle parameters and save all data to own disc as required.

2. **Effect of Engine RPM on Rudder**

Using the assigned ship in deep water, place the vessel as above and steady on a course of 000° at full ahead [100%CPP]. Set the SPEED AT START to the max ahead speed of own ship. After a run of 5 cables, give the ship hard left rudder. When the heading is 270°, stop the engines [0% pitch]. Observe the change in turning circle diameter. Measure and record all data to own disc.

3. **Effect of Water Depth on Drift Angle**

A. Shallow water

Using the assigned ship, steady the vessel on a course of 000°°at full ahead with initial speed corresponding to RPM. Set the simulation in the shallow water: determine shallow water by adding 2-3 meters to design draft. Water depth is set by clicking on fixed under depth in the simulation controls window. After a run of 5 cables, put the helm hard left and observe the complete turning circle.

B. Deep Water

Repeat the above exercise given the same parameters with the simulation in deep water: 100M.

4. **Effect of Acceleration on Turning Circle**

Using the assigned ship, begin the exercise with the vessel stopped on a heading of 000° in deep water. Put the ship on full ahead, helm hard left. Compare results to those found in 3B above.

5. **Create Own Maneuver**

Given the examples in the film, texts, and class discussion, create your own experiment to substantiate shiphandling theory. The experiment should be short and simple. Consider that the maneuver may be presented in class for discussion. DO NOT USE TUGS OR BOW THRUSTERS.

IMO/STCW Assessment Control Sheet DN460-12C

STCW Requirement	STCW TABLE A-II/1 (Specification of minimum standard of competence for officers in charge of a navigational watch on ships of 500 gross tons or more.)
STCW Function	Navigation at the operational level.
STCW Competence	Maneuver the ship.
STCW Knowledge, Understanding and Proficiency	Knowledge of the effects of deadweight, draught, trim, speed and under-keel clearance on turning circles and stopping distances.

Assessment Method	Graded practical exam in CAORF simulator or part task simulator
TRB Cross-Ref. (if applicable)	Ship maneuvering 10.1.10.1

Course/Designated Examiners	Bridge Watchstanding (DN460) / Meurn, Sandberg, Hagedorn, C. Smith

EACH OBJECTIVE MUST BE SUCCESSFULLY DEMONSTRATED

		Standard Met		
Assessment Objective	**Performance Measure/Standard**	**Pass**	**Fail**	**Date**
1. Candidate is able to recognize the effects of varying draught, trim, speed, and under-keel clearance on turning circles and stopping distances.	Test candidate shall pass a graded practical exercise using a navigation simulator under varying conditions as specified in the assessment objective and criteria. Minimum passing score: 70%			

Comments

ASSESSMENT CRITERIA:

1. Demonstrate the effects of varying water depth on turning circle diameter.
2. Demonstrate the effects of speed on turning circle diameter.
3. Demonstrate the effects of acceleration/deacceleration on turning circle characteristics.
4. Demonstrate the change in draught and UKC during a turn.
5. Demonstrate the effects of turning on speed.
6. Demonstrate the effects of varying parameters on vessel stopping distances.

A midshipman who fails the practical exercise will be allowed a retake exercise at a later time. The retake has no bearing on the midshipman s academic grade. The retake must be passed to satisfy STCW requirements.

A midshipman who fails a retake shall be referred to the Academy s Professional Review Board for further action.