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MARITIME TRAINING THROUGH THE USE OF SIMULATORS

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Abstract. The purpose of this paper is to call to mind the importance of adequate training for mariners due to the high level of social, economic, and environmental impacts that are possible in the event of a miscalculation on the part of the mariner. However, determining what defines the most effective training method which would ensure maximum information retention and ability is essential. This paper discusses the reasons why simulation in combination with real world cadet shipping experience is the most effective means for training. Current theories on how the mind works, several educational and learning theories which exist, along with how the mind interprets information and then stores it, are critical to developing training strategies. The Theory of Situated Cognition, the Information Processing Theory and the Cognitive Apprenticeship Method along with how they align with both Cadet Shipping and Simulator based training, solidifies both training platforms as beneficial tools for maritime based training. Although extremely beneficial, the Simulator and Cadet Shipping have several disadvantages as well. This paper will draw upon all of the previously mentioned aspects, and explain why the combination of experience as a cadet onboard a ship alongside experience in a simulator will maximize the learning retention and understanding of the student.

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STUDIES AND REFERENCES

Several references will be used including a study conducted by Tamera Reul with assistance of several Marine Transportation Professors at SUNY Maritime College, involving a survey of current students who are utilizing a simulator as well as students who have experience as a cadet on board operating vessels. Interviews of experts in the field along with several texts, documents, and outside studies from reputable organizations will also be referenced.

Recent catastrophes such as the grounding of the *Costa Concordia* and the sinking of the *MV Sewol*, have reminded the world of the extreme importance of Maritime Safety. The topic of Maritime Safety has always been a critical, yet constantly evolving, issue which has been primarily reactionary. Examples such as the sinking of the *RMS Titanic* which led to regulations being created to improve lifesaving equipment onboard vessels and the grounding of the *Exxon Valdez* which led to the Oil Pollution Act (OPA) of 1990 in the United States, show how tragic events lead to drastic changes in the standards of maritime safety. These recent catastrophes will most likely have similar outcomes, drastically rewriting the pages of both history and regulation books around the world.

Although regulations will eventually be put in place to address many of the more imposing contributing factors of these incidents, there may be another key underlying issue which impacts not only these situations, but is an issue which causes most maritime accidents to occur. In the paper, *The Human Element as a Factor in Marine Accidents*, it states that the SAFECO project (a thorough analysis of 75 separate marine accident cases) indicated "that a central result of this analysis is the paramount importance of the human factor. In fact, in the majority of cases reviewed, the incident was due to one or more of the following: Poor crew competence, lack of communication, lack of proper maintenance, lack of application of safety or other procedures, inadequate training, poor judgment of the situation, and so forth. This general conclusion also means that many of the serious accidents reviewed might have been averted if some of the above deficiencies did not exist" (Psarafitis, page 10). Most authorities in the field will agree that greatest cause of marine accidents is Human Error. Just from the few incidents mentioned earlier, Human Error stands out as a predominant issue. Human Errors led to all of these situations including errors such as departure from the passage plan, delay in the abandon ship announcement, certifying improper loading conditions, not ordering the passengers to their abandon ship stations, and traveling at an unsafe speed in restricted visibility. The unfortunate side of having vessels operated by

people is the inherent vice of Human Error. People will make mistakes, however it is also possible to make the number of mistakes made shrink significantly through the use of proper training.

As the understanding of how the mind works, learns, and utilizes information expands, the educational community's understanding of training techniques has grown and evolved significantly. Significant technological advancements, such as the advent of the Simulator, have drastically changed the landscape for maritime training. Almost every task onboard a vessel can now be replicated from how to load and discharge cargo, to how to safely navigate a congested waterway through the use of a Simulator. Many training schemes are now adopting Simulator Training as a way to earn "sea time" onboard vessels for various certificates. Although the Simulator provides countless opportunities to provide experience to the trainee (which would be otherwise impossible onboard an operating vessel), Simulators have significant drawbacks as well. Although the use of the Navigation Simulator as a training technique is extremely beneficial for training purposes, it cannot replace real world experience and must be used in conjunction with time spent onboard vessels in order to create a truly competent mariner.

In order to be an effective instructor, one must truly understand how to effectively transfer one's own knowledge to the student and understanding how the mind processes information can greatly improve the student's retention of information. The Information Processing Theory is one explanation on how the mind accepts, interprets, and stores information. This theory compares the mind to a computer as is explained by Michael Orey in the publication, *Information Processing*, by stating that as a person receives sensory information, they hear or see something, their Sensory Register (Similar to an Input Device ie. CD) is instantaneously registered in the brain for a period of time being only about two to three seconds long, and is then immediately sent to your Short Term Memory (Similar to a CPU) to be processed. Short Term Memory is essentially where consciousness exists; where the received Sensory Input information is registered, analyzed and interpreted, lasting for about 20 seconds long. Once the item has been analyzed within the Short Term Memory, it is then sent to the Long Term Memory (Similar to a Hard Drive) where it is stored. Long Term Memory is where everything that we know or know how to do exists and is broken up into three types of memory including Declarative (facts), Procedural (procedures), and Episodic (Experiences) (Orey, 2001).

As this information is received, analyzed, and then stored as Declarative, Procedural, or Episodic information, it is important for the educator to relay the information in a way so that the information is stored in the

correct context. It would be more effective for a mechanic to learn how to repair an engine by going through the steps of repairing an engine then to simply memorize the steps from a manual. This is because the information is being stored as Episodic information after having accomplishing the task rather than Declarative information by memorizing the manual. This concept of learning information in the way the student will need to retrieve it later is known as Situated Cognition. If the student learns a piece of information through memorization, it will most readily be retrieved by the brain when asked a question. If the student learns a piece of information through accomplishing a task, the brain will most readily retrieve the needed information when presented by the same situation. The use of Cognitive Apprenticeship re-enforces the concept of Situated Cognition. As the article, *Situated Cognition and the Culture of Learning* states, "Cognitive Apprenticeship Methods try to enculturate students into authentic practices through activity and social interaction in a way similar to that evident – and evidently successful – in craft apprenticeship" (Brown, page 37). This concept of Cognitive Apprenticeship Methods, attempts to combine the traditional idea of an apprenticeship, allowing the individual to gain experience by watching a professional in the field, and combining it with cognitive training techniques, training through participating in the task. The article continues by pointing out that, "apprenticeship techniques actually reach well beyond the physical skills usually associated with apprenticeship to the kinds of cognitive skills more normally associated with conventional schooling. This extension is not as incompatible with traditional apprenticeship as it may first seem. The physical skills usually associated with apprenticeship embody important cognitive skills" (Brown, page 39). The combination of apprenticeship training with cognitive training techniques is highly effective as it not only allows the individual to gain experience by watching an expert but by also being allowed to participate in the task, makes the Cognitive Apprenticeship Method an extremely effective training technique.

Within the maritime education community, there are two opportunities which are classified as a Cognitive Apprenticeship Method. The first opportunity is Cadet Shipping and the second is Simulator based training courses. Cadet Shipping has been a training method in the maritime industry for an extremely long time and constitutes of a maritime officer candidate being placed onboard an operating vessel under the rate of cadet. As a cadet, the candidate has no true responsibilities except to learn and participate in as many operations as possible onboard the vessel. They usually work alongside one of the officers, slowly gaining experience in a real world training environment.

When the cadet first joins the ship, they are usually instructed to watch all operations and are not allowed to partake in much of the operation; however, over time the cadet will improve and will slowly partake in a larger percentage of the operation, possibly taking part in the full responsibilities of a maritime officer onboard the vessel. In addition to the apprenticeship nature of Cadet Shipping, it involves a substantial amount of Situated Cognition training due to most training institutions involving some form of an academic project which the student is required to accomplish while onboard the vessel. These academic projects tend to have a substantial number of questions and assignments related several topics which the student will need to know as a maritime officer. This academic project is intended to guide the student's learning, ensuring they cover the key learning points required of the experience. Chief Mate Andrew Colleran, explained in a personal interview some of the benefits of Cadet Shipping by stating, "Positively, absolutely, and unequivocally a great positive in cadet training is having the experience onboard a commercial vessel. Pro's - the Cadet is exposed first hand to life onboard a vessel, the Cadet has to learn how to keep a work schedule, the Cadet begins to grasp responsibility of the job at hand, and the Cadet learns critical work and communication skills. They are able to work with bridge, deck, cargo and mooring equipment under supervision of ships officers" (Colleran, 2015). The combination of real world training and the academic project makes Cadet Shipping an outstanding example of a Cognitive Apprenticeship Method.

Cadet Shipping has been the only true Cognitive Apprenticeship Method available to the maritime education community until recent technological advancements brought about the development of the Training Simulator. This new piece of technology allows the instructor to be able to place the student in almost any situation that a maritime officer might experience in the field. This allows the student to gain experience with situations that they would most likely never experience with Cadet Shipping. It also completely removes the factor of extreme consequences if the student makes a mistake, allowing the student to accomplish which would have been impossible onboard an operating vessel. As Chief Mate Elspeth Hannaford stated in an interview, "the importance of repetition must be stressed... there is peace of mind in knowing that after it has been pressed x number of times, it never has to be pressed again, because the cadet being evaluated is now familiar enough with a procedure that they do not need to be reset" (Hannaford, 2015). The student is allowed to make the critical mistakes and learn from them. If the student ever experiences a similar situation in the field, this previous experience will be quick-

ly registered, allowing the individual to make the best decision since this training experience has been stored as an Episodic Memory. When combining this Situated Cognition training technique with a structured lesson plan, the Simulator can also present itself as being the perfect platform for utilizing the Cognitive Apprenticeship Method as Captain Keith Wagner, mentioned in an interview, "Simulator training is a great tool for learning, improving, and evaluating. It's a safe environment where individuals can test their abilities without consequences" (Wagner, 2015). The Simulator allows the student to focus on the training aspect of the lesson rather than on the consequences of what might happen if the student were to make a mistake. The student can also have as many practice attempts as is needed until the student has fully mastered whatever task is necessary.

Although both the Cadet Shipping and Simulator training opportunities both constitute as excellent examples of Cognitive Apprenticeship Methods, there are several underlying issues, or gaps in training, which both platforms present. For the Cadet Shipping training opportunity, the institution which is responsible for the overall training of the student, such as a maritime academy, has extremely little control of the level or type of experiences the student may obtain. As Professor Anthony Palmiotti stated in an interview, "Cadets onboard commercial vessels get to see the real world in action, both the good and the bad. If treated correctly onboard they can learn to put theory into practice at many levels. However, poor Mates/Master can create a negative experience" (Palmiotti, 2015). Most students who partake in Cadet Shipping return with good experience, stating that they learned a great deal and that the experience was critical to their learning experience. Unfortunately, there are also a large number of students who return stating that they did not learn very much and were treated extremely poorly by the crew. As Chief Mate Drew Colleran stated in an interview, "The student is away from family in a dangerous environment as someone with very limited skills and knowledge. In some cases they might not be treated as 'crew' and are neglected in terms of training. Without proper supervision and leadership, cadet training can take a backseat to vessel operations, there by the cadet loses out" (Colleran, 2015). As most Officers onboard vessels are not primarily instructors and the operations and safety of the vessel comes before training, a student may find that they are neglected training wise during their time onboard a vessel. In addition to the possibility of not having Officers onboard who offer a good training experience, there is also the possibility that the vessel does not conduct all of the operations which the training institution wishes the student to experience. Chief Mate Elspeth

Hannaford explained some of these issues in an interview by stating that, "finding appropriate billets such as a cadet that wants to sail deep sea could end up on an inland tug. Getting placed on a vessel that is in dry dock for extended periods of time can also create significant training issues" (Hannaford, 2015). There are a limited number of vessels which are willing to take on students as cadets and it is difficult placing a large number onboard the correct vessels which will provide the appropriate opportunities for the student.

Although the Simulator has much more control over the training opportunities available for the student, it also has significant drawbacks as a training platform as well. The most significant of these drawbacks includes the fact that it is a simulator; it is not an actual vessel and a sense of realism and fear of consequences is a critical lesson in itself. As Chief Mate James Rogin pointed out in an interview, "There are negatives with simulator training as well such as over reliance on electronics, and a lack of real life consequences, ie. 'I ran aground in the simulator and nothing happened'" (Rogin, 2015). The students become accustomed to pressing the reset button and lose the critical fear factor which is associated with difficult operations. If the student has never had the opportunity to attempt a task in a high pressure situation, then their Episodic Memory will have a more difficult time recalling the important information because of the differences between the circumstances.

Both Cadet Shipping and Simulator based training have excellent benefits for training purposes as they both present an exceptional platform for Cognitive Apprenticeship Method training. However, they both provide significant gaps in their training abilities as well. Fortunately, the portions which are lacking in Cadet Shipping can be obtained through use of the Simulator or vice-versa. Because of this, utilizing both opportunities presents the most efficient training for maritime education purposes. Captain Keith Wagner explained in an interview, "There must be a balance of lecture, simulation, and life experience (e.g. cadet shipping). This mix provides the cadet with knowledge, a chance to put this knowledge into practice with no consequences, and finally the opportunity to bring the skills and experience gained into the workforce" (Wagner, 2015). In order to test this concept, Chief Mate Tamera Reul with the assistance of several other professors conducted a study involving students in Simulator based courses at the State University of New York Maritime College. The study consisted of students filling out a one page survey, indicating how much they had learned during the course and what aspect of the course they felt was the most effective aspect towards their learning. The students surveyed were either in their third (Junior) or fourth year (Senior) at the college and were partaking in either the

Bridge Resource Management course or the Electronic Navigation and Voyage Planning course. Both courses utilize the Simulator to practice the use of the navigation equipment and making navigational decisions from the navigation equipment onboard a vessel. At the State University of New York Maritime College, students either spend all three summers completing their cadet training experience on the school's training vessel or they may participate in Cadet Shipping on their second summer with the first and third summer onboard the school training vessel. The training vessel training program does not allow many opportunities for the students to utilize the navigational equipment until their third summer training cruise. Students who participate in the Cadet Shipping training program tend to have a high use of the navigation equipment during their Cadet Shipping experience. The students surveyed had not participated in their third summer training cruise meaning that those who participated in training vessel only cadet experience had no navigation equipment training from a Cadet Shipping experience and those who had participated in the Cadet Shipping training program had a high level of Cadet Shipping experience with the navigation equipment. When the students were asked what contributed the most to their knowledge and understanding of the navigation equipment (lecture, simulation exercises, cadet shipping experience, or other previous knowledge) the majority of students selected the simulation exercises. However, when the student's answers were divided between those who had participated in a Cadet Shipping experience from those who only participated in the school training vessel cruises a distinct difference in the answers arose. Those who had only Training Vessel experience indicated an overwhelming 81% which believed that the simulation exercises contributed the most to their understanding and knowledge. On the other hand, those who had participated in a Cadet Shipping experience indicated 52% which believed that Cadet Shipping experience contributed the most and 37% which believed that the simulation exercises contributed the most. The most likely reason for this difference is that those who had participated in the school training vessel only, did not have Cadet Shipping experience to compare their growth of knowledge with the simulator towards, making simulator training the most significant contributor to their understanding. The students who had Cadet Shipping experience tended to value the experience they had gained onboard the vessels greatly but they also valued the training opportunities which the simulator had presented to them as well. Although there was this difference of opinion in what contributed the most, both groups of students indicated significant growth of understanding throughout the span of the Simulator based course and felt well prepared for the responsibilities of a

Third Officer onboard a vessel due to all training received.

Combining the traditional training method of Cadet Shipping with the new and sophisticated opportunities presented with Simulator based training, creates the ultimate training platform for maritime education. Both training opportunities utilize the Cognitive Apprenticeship Method effectively which utilizes Situated Cognition to store the critical information the student will need as an Episodic Memory. As most of the information a student will need when working in the maritime industry involves the ability to recall information when accomplishing a task, being able to have the student store this information as an Episodic Memory is critical. Not only experts within the industry, but also students currently within a training program, agree that both Cadet Shipping and Simulator based training provide significant advantages and disadvantages as training platforms. Fortunately, there is enough overlap between the two training methods that all critical items can be obtained through the use of both methods. If we wish for them to succeed and prevent future catastrophes from occurring, we must effectively train students so that they are properly prepared for the important tasks they will undertake in the maritime industry which may be accomplished through the combined use of Cadet Shipping and Simulator based training.

Acknowledgements

Personal Communication and Interviews:

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Hannaford, E. Assistant Professor, Marine Transportation Department, State University of New York Maritime College. (2015, May 26). Interview Type: Email.

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Wagner, K. CEO, DP Training Solutions, LLC. (2015, May 29). Interview Type: Email.

Contributing Factors to Understanding Survey: Simulator vs. Cadet Shipping

Conducted: May 2015

Conducted by: Tamera Reul

Assisted by: Andrew Colleran, Elspeth Hannaford, Richard Fitzgerald, and Jeffery Spillane

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APPENDIX I: SAMPLE OF SURVEY CONDUCTED

Simulator Training Survey 2015

Instructor _____ Course _____

Please circle the appropriate answer

- **What navigational equipment was utilized in this course?**

RADAR	ARPA	ECDIS	GPS	AIS	Depth Sounder
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- **How much time on average was spent each week during this course in the Simulator?**

Less than 1	1-2 hours	2-3 hours	3-4 hours	4-5 hours
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- **Prior to taking the course, how knowledgeable were you about using the equipment?**

No Knowledge	Somewhat Knowledgeable	Fairly Knowledgeable	Very Knowledgeable
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- **After taking the course, how knowledgeable were you about using the equipment?**

No Knowledge	Somewhat Knowledgeable	Fairly Knowledgeable	Very Knowledgeable
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- **Have you gone out as a Cadet Observer on commercial vessels?**

Yes	/	No
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- **As a Cadet Observer, how much did you use the electronic equipment?**

RADAR:	Not at all	Occasionally	Frequently	Constantly
ECDIS:	Not at all	Occasionally	Frequently	Constantly
Depth Sounder:	Not at all	Occasionally	Frequently	Constantly
GPS:	Not at all	Occasionally	Frequently	Constantly
- **Did your experience as a Cadet improve your knowledge and understanding of the equipment?**

Yes	/	No
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Why? _____
- **In your opinion, what contributed the most to your understanding of the equipment?**

Course Lecture	Simulator Use	Cadet Experience	Other previous knowledge
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- **Is there anything specific which you believed was the most helpful to your understanding of the equipment?**
- **Is there anything specific which you believed was the least helpful to your understanding of the equipment?**
- **Do you feel this course made you more prepared to stand watch as a 3rd Mate?**

Yes	No	Somewhat
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- **Do you feel that your experience as a Cadet Observer made you more prepared to stand watch as a 3rd Mate?**

Yes	No	Somewhat	N/A
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- **What contributed the most to your understanding of the responsibilities of a 3rd Mate on Watch?**

Course Lecture	Simulator Use	Cadet Experience	Other previous knowledge
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- **What do you think would have made you more prepared to stand watch as a 3rd Mate?**