CANADIAN FORCES COLLEGE / COLLÈGE DES FORCES CANADIENNES
JCSP 35 / PCEMI 35

EXERCISE/EXERCICE New Horizons

**Maritime Simulation:
Can It Be A Sole Source Solution For Force Generation?**

By/par LCdr/capc C.A. Bursey

ABSTRACT

Simulation in training has realized benefits for military skill proficiency, operations and maintenance costs and quality of life for soldiers, airmen and women and sailors for many decades. Yet there is still a reluctance to rely solely on such extraordinary technologies to train forces preparing to deploy on operations. Navies around the world insist on sending ships to sea at great expense in order to acquire skills that could otherwise be obtained through high fidelity simulation. Whilst progress toward greater acceptance can be tracked, there is still a need for further study and improvement.

The Canadian Navy, as well as our international partners, must and will eventually progress towards a fully interconnected and simulated coalition of capabilities prior to proceeding on operations in the future. It will likely prove to be the most cost effective means of training as an alliance of maritime forces, particularly given the typically large geographical dispersion of participants on any given operation.

List of Acronyms

AAW	Anti Air Warfare
ADM Mat	Assistant Deputy Minister Materiel
ASW	Anti Submarine Warfare
BWK	Bridge Watchkeeping
CBRN	Chemical Biological Radiological and Nuclear
CCFL	Commander Canadian Fleet Atlantic
CD&E	Concept Development and Experimentation
CF	Canadian Forces
CFNOS	Canadian Forces Naval Operations School
CIWS	Close In Weapon System
CMS	Chief of Maritime Staff
CPF	Canadian Patrol Frigate
DCTF	Damage Control Training Facility
DMRS	Director of Maritime Requirements Sea
DMSS	Director Maritime Ship Support
DMTE	Director of Maritime Training and Education
DND	Department of National Defence
FST-J	Fleet Synthetic Training – Joint Exercise
GPS	Global Positioning System
HCM	HALIFAX Class Modernization
HR	High Readiness
HVU	High Value Unit
IT & E	Individual Training and Education
M&S	Modeling and simulation
MARCORD	Maritime Command Order
MIO	Maritime Interdiction Operations
MPT	Maintenance Procedural Trainer
MSHQ	Maritime Staff Headquarters
NABS	Navigation and Bridge Simulator
NASA	National Aeronautics and Space Administration
NPTT	Naval Part Task Trainer
NTASG	Naval Trainer Acquisition Sub-Group
NTS	Naval Training System
OJT	On-The-Job Training
OOW	Officers of the Watch
ORTT	Operations Room Team Trainer
OT	Operational Training
R&S	Readiness and Sustainment
RR	Reduced Readiness
SCTT	Submarine Command and Team Trainer
SE	Synthetic Environments
SECO	Synthetic Environment Coordinating Office
SOCD	Statement of Capability Deficiency
SOR	Statements of Requirement
TE	Training Establishment
USN	United States Navy

"Excellence is an art won by training and habituation. We do not act rightly because we have virtue or excellence, but we rather have those because we have acted rightly. We are what we repeatedly do. Excellence, then, is not an act but a habit."

Aristotle

INTRODUCTION

Five decades ago, astronauts of the Apollo space program practiced their mission procedures and emergency flight situations in a command module simulator, a lunar module simulator and a mission simulator in Houston, Texas. This capability helped ensure the safe arrival and departure of the astronauts without the risks associated with space travel. It permitted repetition of drills, in particular emergency procedures, without any risk to the crew or the actual spacecraft. The degree to which an organization such as the National Aeronautics and Space Administration (NASA) had, and has, exploited simulation is testament to the importance and utility of this capability. Today, similar philosophies towards modelling and simulation enable ships' bridge and operations officers, fighter pilots, tank commanders and a growing list of other operators and maintainers to learn and practice their skills with minimal to no risk to personnel or equipment.

To set the scene in the naval context, one only has to imagine a day at sea during conventional combat where any member of a ship's company has to face the full spectrum of stressful circumstances. Over the span of a twenty-four hour period any number of dramatic and life threatening scenarios can take place. In this scenario, the ship's Officers of the Watch (OOW) navigate through thick haze or a sandstorm while escorting a High Value Unit (HVU) through a narrow channel where their most effective means of knowing where they and the HVU are, or where they are headed, is by radar and Global Positioning System (GPS). While navigating in those confined waters, a raid of small craft swarms the ship from the nearby territorial waters of an adversary, one known to harbour terrorists. Simultaneously, a shore missile battery unleashes a volley of anti-ship missiles towards the coalition warship leaving them with mere second's worth of battlespace. The same ship's helicopter that was hovering near the HVU declares an emergency and requires an immediate recovery. One of the swarming craft hits the warship, causing an explosion, and a fire ensues. The ship's damage control organization dispatches attack teams who fight to put out the fire and stop the subsequent flooding. When the fire is finally out, the HVU is safely through the channel, the coalition warship is out of harms way and then the lights come on and those OOW, weapons operators and damage control personnel put on their jackets and go home for the evening. This is the reality that simulation brings to bear. There is a plethora of other scenarios, varying in complexity and intensity which would allow sailors to acquire or maintain critical skill sets without ever having to go to sea. Simulation also provides the opportunity to generate abnormally complex situations that could never be replicated at sea without creating unduly dangerous conditions for sailors and equipment to operate. The benefits awarded by this degree of simulation are an endstate that is much desired by members of the Canadian Navy and by many other world navies.

The scenario described in the previous paragraph could very well have occurred in a Canadian Patrol Frigate (CPF); the workhorse of the Canadian fleet. Complemented by 235 officers and sailors, each ship has seven different departments each with a multitude of different occupations, and each of those occupations consisting of multiple qualification levels varying in complexity and responsibility. Most of these operator and maintainer occupations can benefit from this type of simulated scenario making this a Navy challenge writ large vice solely an independent problem for a ship and its various departments. In other words, simulation is not limited to the tactical or unit level. For example, not only can simulation benefit an individual sailor, solidifying his/her on the job performance requirements, but operational fleet commanders can equally employ simulation and battle labs to plan large scale fleet deployments and operations. The latter would allow the details of the maritime operational planning process to be rehearsed with validated courses of action and identification of potential weaknesses and vulnerabilities.

Today more than ever, the benefits of simulation are weighed heavily as a cost savings measure. In today's strained economic climate, the impact of simulation takes on greater importance, particularly in light of an upcoming HALIFAX Class [frigate] Modernization (HCM) programme as well as a revitalized Canadian shipbuilding program. The HCM programme will see nearly 25% of the fleet in dry-dock at any given time, therefore the need for innovative and cost effective training methods in the maritime environment has never been more important. The Canadian Navy needs to plan now on how to impart and maintain the appropriate skill sets for a new fleet of 2020 and beyond. This essay will demonstrate that in order to accomplish this, however, there are many challenges to overcome before a complete shift in training methodology could or should be made. A fundamental culture shift is needed amongst those that are harnessed to the belief that sea time is the best and only means to acquire the necessary experience and to be exposed to the harsh operating conditions. The current paradigm insists on the majority of training being conducted at sea.[1]

To that end, this paper will examine the advantages and disadvantages of using simulation in training to determine if it is the panacea for future force generation or if a better balance is required between simulation and training at sea.[2] It will also identify and briefly

[1] National Research Council, *Simulated Voyages: Using Simulation Technology to Train and License Mariners* (Washington: National Academy Press, 1996), 143.
[2] Force Generation in the context of the Canadian Forces is defined as the process by which forces are trained, equipped and assembled for potential operations. The process is completed once the forces are declared

describe the various Canadian Forces (CF) and Canadian Navy policies pertaining to simulation in order to demonstrate the disparity between the various levels of guidance. I contend that while simulation is an exceptional means to train sailors and prepare them to deploy on complex operations, Naval training policy makers must not discount the value of training in the actual environment in which the fleet operates. Moreover, even before that can be irrefutably accepted, a better overarching naval strategy is required on how the Navy ought to capitalize on such a limitless capability. Additional study is needed to validate the assertion that simulation could reduce training at sea as well as reduce operations and maintenance costs while maintaining proficiency and readiness of its sailors and the fleet. Although I allude to some costs associated with modelling and simulation, in the end this is not a cost benefits analysis. It is an analysis of the proven benefits and limitations of simulation, including an analysis of the disparity in the various policies. It is intended to encourage maritime staff charged with developing the future training requirements of the Navy to follow through with more in-depth research, including policy revisions.

DEFINITIONS, RESPONSIBILITIES AND POLICY

In order to better understand the complexities of the Canadian Naval Training System (NTS), it is necessary to distinguish between certain key terms commonly used, the current policy statements that drive the way in which simulation is acquired and employed in naval

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operationally ready and their command is transferred to the field. This essay however, deals specifically with the training aspect of force generation.

training and finally the responsibilities of the various agencies that deal with simulation and training.

Military training, and the complexity of the language used, can be difficult to comprehend even for those routinely involved. In the context of the Canadian Navy, there are varying levels of training from the individual sailor up to and including the collective fleet and its responsible staff.[3] At the very base level, the term Individual Training and Education (IT & E) reflects the core occupation training required to ensure sailors are capable and safe to perform the fundamental tasks expected of them from apprentice to supervisory levels.[4] When these officers and sailors join or rejoin the fleet their training falls under an overarching category that is known as Operational Training (OT), which includes the sailors' On-The-Job Training (OJT) and more team-oriented training referred to as Collective Training.[5] There is sometimes ambiguity as to what training falls into which category, i.e. IT & E or OT. It becomes important to resolve this uncertainty because under current policy different organizations are responsible for different training categories which in turn translate into different training budgets, competing requirements for simulation assets as well as conflicting views on what organization is responsible for the training aspect of force generation.

This leads to the importance of understanding the various policies that deal with modeling and simulation (M&S) and subsequent management of acquired systems, or more appropriately, the lack of clear policy, direction or guidance regarding the integration of

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[3] Department of National Defence, *Maritime Command Orders 9-47: Maritime Command Individual Training and Education Policy* (Ottawa: DND Canada, 2008), 2.

[4] Individual Training and Education (IT & E) means all instruction provided to Canadian Forces (CF) members that provide the skills required to perform assigned duties (training) as well as exercise sound judgement (education), which generally results in a formal qualification.

[5] Operational Training (OT) means the training that is required to achieve operational readiness. It includes team training to form groups of individuals and units into effective operational teams, and refresher training to maintain those skills. On-The-Job Training (OJT) is typically delivered at sea in ships after students have completed shore training. Collective Training (team training) is that portion of OT required to achieve effective operational teams. It includes sub-team, team and all-unit training as well as training amongst two or more units.

simulation into the NTS as will be explained below. According to current NTS policy, Training Establishments (TE) are "encouraged to maximize the use of simulators, synthetic trainers and re-configurable display technology within the NTS, where cost-effective to do so."[6] A similar policy states that:

> "The Canadian Navy will incorporate modeling and simulation as an integral part of all of its decision-making processes including those related to maritime operations, training, [Concept Development and Experimentation (CD&E)], research and development, and simulation-based acquisition."[7]

Further CF policy states:

> "The DND and the CF are committed to M&S as a primary enabling technology necessary to effectively meet Departmental objectives in an affordable, reusable and interoperable context within the DND, the CF, and with allied countries. The use of M&S, including Synthetic Environments (SEs), shall be undertaken to merge the real and virtual worlds in ways that empower leaders to visualize the future, analyze decision alternatives and prepare for domestic and coalition operations throughout the spectrum of conflict."[8]

What ought to be clear to the reader is that terms and expressions such as 'encouraged', 'incorporat[ing] modeling and simulation' or 'committed' are nebulous lexicons that should be more explicit and direct. These policies are not even controlled by organizations with the same chain of command and consequently naval policies do not necessarily represent the operational, or even strategic, interpretation of the more high level strategic CF policy.

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[6] Department of National Defence, *Maritime Command Orders 9-47: Maritime Command Individual Training and Education Policy* (Ottawa: DND Canada, 2008), 24.
[7] Department of National Defence, *Maritime Command Orders 80-1: Maritime Command Modelling and Simulation Policy* (Ottawa: DND Canada, 2008), 2.
[8] Department of National Defence, *Defence Administrative Orders and Directives 8008-0: Modelling and Simulation* (Ottawa: DND Canada, 2003), 2.

The final policy and process that is important as the necessary background in understanding naval simulation requirements is the Maritime Command Order (MARCORD) regarding Readiness and Sustainment (R&S), particularly in regards to training. Canadian naval ships transition from what is referred to as Reduced Readiness (RR) to a High Readiness (HR) state through a series of phases that include various certifications, inspections, and training. A comprehensive cycle for Canadian frigates and destroyers – as it varies for each class of ship – may take as long as 40 sea days to complete the necessary trials and training.[9] The detailed listing of training tasks to fully fulfil the R&S requirements amounts to over 350 training events that affect either a whole ship's company, individual departments or just sections of a specific department.[10] While many of these can be achieved through simulation, it has not been fully examined if training tasks which have traditionally been conducted at sea can also be conducting in a simulator, thus reducing the required time at sea.

Finally, it is important to understand the command relationships and responsibilities regarding simulation and trainers. There are many key stakeholders who are responsible for the acquisition and management of simulation in the Canadian Navy. The Director of Maritime Training and Education (DMTE) is responsible for IT & E and the management of naval trainers and training support equipment in the NTS, through the Naval Trainer Acquisition Sub-Group (NTASG).[11] The NTASG reviews Statements of Requirements (SOR) for trainers and simulators, and contributes to prioritizing trainer acquisitions.[12] Conversely, the Director of

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[9] Department of National Defence, *Maritime Command Orders 02-12: Readiness Support Programme - Ships* (Ottawa: DND Canada, 2007), 6.
[10] Department of National Defence, *CFCD 102(J): Maritime Command Combat Readiness Requirements* (Ottawa: DND Canada, 2008).
[11] DMTE is a sub-unit of Maritime Staff Headquarters (MSHQ), responsible to co-ordinate the marketing of available training capacity within naval Training Establishments (TE), including trainers, simulators and other strategic training resources.
[12] Department of National Defence, *Maritime Command Orders 9-47: Maritime Command Individual Training and Education Policy* (Ottawa: DND Canada, 2008), 24.

Maritime Requirements Sea (DMRS) is responsible for articulating the requirements for new capability for the navy, including simulators and trainers.[13] And yet another organization, the Director Maritime Ship Support (DMSS)[14], is responsible as the design authority for maritime training systems and team trainers.[15] At the joint level the Department of National Defence (DND) Synthetic Environment Coordinating Office (SECO) is responsible to establish and lead the processes for policy, standardization, management and best practices; coordinate common tools; links to other government departments and Allies; support operations in areas of common interest; and provide information transfer and training opportunities.[16]

All of these organizations interact in some forum or another and yet there is an unclear link as to who has overall responsibility for the management of simulators and trainers for the Navy and who should be responsible for generating naval simulation policy. Clear direction is needed as to which organization should be responsible for determining the trainer and simulation requirements for the Navy and what that organization's relationship should be with the DND equivalent.

CAPABILITY IN SIMULATION

[13] These requirements are established through a variety of mechanisms such as the Statement of Capability Deficiency (SOCD) dealing specifically with a simulator deficiency or as part of a separate SOR for a newly acquired system which would have an associated simulator as part of the acquisition.
[14] DMSS is a sub-unit of the Assistant Deputy Minister Materiel (ADM Mat).
[15] Department of National Defence, *Maritime Command Orders 80-1: Maritime Command Modelling and Simulation Policy* (Ottawa: DND Canada, 2008), 4.
[16] Jeff Loube, "CD&E, M&S, Synthetic Environments and Transformation," MS&T Magazine, (4/2005), 7

The government of Canada expressed a commitment in its 2009 budget on efficiency and effectiveness in how it achieves responsible spending.[17] How better for the Canadian Navy to capitalize on that commitment by creating cutting-edge ways to conduct training ashore and decrease costs at sea. Many other navies, such as the United States Navy (USN) have also recognized that the high cost of underway training, increased operational tempo and limited resources have decreased the attractiveness of underway training.[18] Organizations that monitor and routinely report on military technology cede the necessity for training with simulation. In the 2004 edition of Jane's Simulation and Training Systems, it was noted that "the more expensive the real equipment and the more severe the consequences of accidents, the greater the case for training by simulation."[19] Operators and maintainers work in a very high stress environment at sea. Replicating that environment ashore reduces risk, and expense, to personnel and materiel.

Simulation in training can vary from something as straightforward as a stand-alone personal computer running a single purpose application to a full-size modular mission simulator on a full-motion platform base. Simulators may be confined to a single laptop or interconnected over a distributed environment. They may emulate real equipment, utilize existing equipment or stimulate operational equipment. They can focus on IT&E for a very specific set of procedures or include team training for many members of a ship's company. For instance, the Naval Part Task Trainer (NPTT) is a single console (which may also be networked if, and when, required) used to concentrate on specific skills for the junior OOW. Simulators are also designed to represent, as best as possible, the actual equipment or scenarios faced at sea, with the principle variable being

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[17] Department of Finance, *Canada's Economic Action Plan: Budget 2009* (Ottawa: Public Works and Government Services Canada, 2009), 267.
[18] R.J. Yardley, *et al*, *Use of Simulation for Training in the U.S. Navy Surface Force* (Santa Monica: RAND, 2003), iii.
[19] Jane's Simulation and Training Systems 2003-2004 (Surrey: Jane's Information Group, 2009), 13.

the degree of fidelity engineered into the simulation.[20] The possibilities are endless if given the right resources. The ability of simulators to provide the right effect, at a lesser expense and a lower risk has certainly prompted exposure in both the military and private sectors.

Just as simulators can have various levels of fidelity, simulation has diverse training applications for a multitude of occupations. Bridge Watchkeeping (BWK) officers can conduct manoeuvring drills on a full mission bridge simulator. Combat operators can conduct Anti Submarine Warfare (ASW), Anti Air Warfare (AAW) and radar plotting in an operations room simulator. Weapons maintainers can load a Phalanx Close In Weapon System (CIWS)[21] and conduct diagnostic maintenance using a maintenance procedural trainer. Furthermore, members of a ship's section base team can practice fire fighting or flood control procedures in a damage control simulator. What simulation does provide is the ability to reproduce adverse operating conditions safely; to play back and evaluate scenarios; and, to permit a more conducive learning environment with very little risk of accident or injury.[22] In fact, USN studies have shown that in certain areas of shipboard expertise very little of the training absolutely needs to be conducted at sea.[23]

Notwithstanding the negative picture painted earlier regarding flaws in DND and Canadian Navy policy, there are some areas where the effectiveness of virtual trainers in the NTS cannot be denied. The Canadian Navy employs nearly 200 stand alone virtual trainers. Some of the most well known ones are the Navigation and Bridge Simulator (NABS), the Operations Room Team Trainer (ORTT), the Submarine Command Team Trainer (SCTT), the

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[20] Regan L. Legassie, "An Examination of Trainee Reactions to the Use of Technology in Canadian Naval Occupation Training" (master's thesis, University of Calgary, 1999), 9.

[21] Phalanx CIWS is an anti-Anti-ship missile defence system using a 20 mm Vulcan Gatling gun linked to a radar system for acquiring and tracking targets.

[22] National Research Council, *Simulated Voyages: Using Simulation Technology to Train and License Mariners* (Washington: National Academy Press, 1996), 152.

[23] John F. Schank, *et al*, *Finding the Right Balance: Simulator and Live training for Navy Units* (Santa Monica, RAND, 2002), 51.

Maintenance Procedural Trainer (MPT), and the Damage Control Training Facility (DCTF). With the exception of the ORTT and the SCTT, these simulators are duplicated for both the Halifax-based and Esquimalt-based fleets. The NABS is a full mission ship handling bridge designed as the "principal delivery vehicle for all of the Navy's initial bridge officer training with the added role of performing for the Pacific fleet a similar role in OT that the Halifax-based simulator does for the Atlantic fleet.[24] Similarly, the ORTT is a full-scale reproduction of a HALIFAX class frigate operations room, located at the Canadian Forces Naval Operations School (CFNOS) in Halifax. It provides the necessary training environment to "learn, practise and enhance skills that create an effective Operations Team [using] dynamic simulation of tactical engagements to exercise the team in picture compilation, procedures, operations and the execution of tactics in a variety of realistic situations."[25] The SCTT, also located at CFNOS, provides the equivalent capability as the ORTT but for the Victoria Class submarine control room. The MPT is a network of computers in an electronic classroom which replicates various shipboard combat systems, their operation and potential fault conditions, "allowing the technician to follow fault finding procedures to identify the fault, to conduct the actions needed to rectify the fault and verify system performance."[26] Finally the DCTF is able to simulate a crashed helicopter fire, fires in 15 different virtual ship compartments, floods in two other compartments as well as structures to conduct Chemical Biological Radiological and Nuclear (CBRN) training. These simulators have proven their value time and again by precluding ships from having to manoeuvre in close quarters conditions, from firing weapons needlessly, from

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[24] Garland Hardy, "Shiphandling Simulators," M&S: Training Environment, (July/August 2005): 28; http://www.frontline-canada.com/FrontLineSecurity/pdfs/05_4_Hardy.pdf; Internet; accessed 12 February 2009.

[25] Lockheed Martin Canada, "Naval Combat Systems and Support," http://www.lockheedmartin.com/canada/corebusiness/NavalCombatSystemsSupport.html; Internet; accessed 12 February 2009.

[26] LCdr Alan Porteous and Stan Jacobson, "Naval Maintenance Procedures Trainer," M&S: Training Environment, (July/August 2005): 26; http://www.frontline-canada.com/FrontLineSecurity/pdfs/05_4_PorteousJacobson.pdf; Internet; accessed 12 February 2009.

potentially damaging expensive equipment and finally from having crews fight fires without the benefit, or arguably burden, of practical experience first.

One of the criticisms of these particular simulators however, is that they lack a conduit to communicate. Interconnectivity amongst multiple simulators allows an even more realistic opportunity for team training. It permits the type of scenario described in the introduction to be conducted with multiple sub-teams from one ship's company. It also provides the opportunity for command level training given the leadership that is necessary to bring all these teams together and *train as you fight*; a common dogma in any military yet one that is not always fully realized in the Canadian NTS.

Other navies however are seized on the concept of simulation over a distributed environment. The USN-led Fleet Synthetic Training – Joint (FST-J) Exercise simulates at-sea war-fighting conditions without involving ships going to sea.[27] The data, which stimulates actual shipboard equipment, is sent over various high level secure networks to provide the necessary scenario information to the participating units around the world. Capt. Mark Nesselrode, Commanding Officer Tactical Training Group Atlantic stated, "It allows us to build and fortify relationships; it allows us to identify a more cost effective and time efficient way ahead to resolve issues of regional or global stability."[28] Before the FST-J exercises, the USN would need to add an additional two to three weeks of training at sea to accomplish the same objectives. This degree of interconnectivity also brings a capability to conduct joint training at a level not seen before. Over high level network architectures, training can occur simultaneously with ships, helicopter simulators, submarine simulators, Army Battle Group simulators and the various TE. This capability was not at all lost on Admiral McFadden; soon to be the Chief of Maritime Staff

[27] Cdr Jashua Glassburn, "U.S., Coalition Forces Conduct At-Sea Training Without Leaving the Pier," http://www.navy.mil/search/display.asp?story_id=22943; Internet; Accessed 14 February 2009.
[28] Ibid.

(CMS). When he was the Commander of the Canadian Fleet Atlantic (CCFL), he participated in one of the FST-J exercises in Norfolk Virginia to assess the feasibility of this capability for Canada and execute the duties of Maritime Interdiction Operations (MIO) Commander. To say that it met his expectations would be an understatement. As he put it, "Interoperability between simulators and other units in a synthetic environment is the future of the Canadian naval training."[29]

FST-J exercises tend to be limited though to combat scenarios involving primarily weapons and sensor operators. The USN again seized upon this deficiency and built USS Trayer. Trayer is a 3/4-scale, 210 feet long replica of an Arleigh Burke-class destroyer enclosed within a 157,000-square-foot building at the USN Great Lakes Training Centre. The trainer uses simulation effects to create challenging and realistic training scenarios for recruits. Recruit divisions work through a 12-hour exercise known as Battle Stations 21 – a test of the skills and teamwork learned during their eight weeks of basic training.[30] Battle Stations 21 can emulate ship handling for Bridge watchkeepers, war fighting and weapons drills for combat operators and officers, asymmetrical threats for command team training and weapon handlers, damage control for the entire ship's company and life preserving for Bridge teams and boat handlers, to name only a few of the important tasks.[31] Trayer even simulates the movement of the ocean by housing the ship in a sufficiently-sized pool with a wave machine to provide the ocean-like roll, pitch and yaw.[32]

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[29] Virginia Beaton, "CFMWC Participates in Fleet Synthetic Training," Trident (July 9, 2007); 3; http://www.tridentnews.ca/PDFArchives/July9_2007.pdf; Internet; Accessed 14 February 2009.
[30] Bill Couch and Scott A. Thornbloom, "Battle Stations 21 Trainer Commissioned at RTC Great Lakes," http://www.navy.mil/search/display.asp?story_id=30434; Internet; accessed 16 February 2009.
[31] Margaret Roth, "Navy's New Battle Stations 21: The Ultimate Final Exam," Sea Power (Dec 2003); http://findarticles.com/p/articles/mi_qa3738/is_200312/ai_n9321061; Internet; accessed 16 February 2009.
[32] Don Doherty, "Navy's New High-tech Trainer to Create Realistic Sea Battle Experience," http://www.readjobscope.com/archives/spring%202006/b020601.htm; Internet; accessed 16 February 2009.

The technology exists to create synthetic environments for training that are so realistic that there is minimum risk to being able to provide initial qualification training or to prevent skill fade later on. What will remain to be seen is whether or not the military leadership is willing to develop the procurement and sustainment strategies to build upon a robust simulation capability and commit the necessary resources to bring such a strategy to fruition.

CHALLENGES WITH SIMULATION

So far, this paper has argued *for* simulation in training. What must be appreciated however is that it does not come without its share of challenges. There are several factors that may prove very difficult to overcome in order to allow a better integration of simulation into the NTS, such as:

a. Costs;

b. Complexity of environmental conditions;

c. Cultural shift;

d. Standards; and,

e. Lack of supporting data.

What makes certain simulation models successful is the degree of fidelity built into the actual model. Fidelity indicates the "degree of similarity between the training system and the operational situation being simulated."[33] It is very challenging for designers and end-users to even articulate the fidelity requirement much less find the right balance between the

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[33] National Research Council, *Simulated Voyages: Using Simulation Technology to Train and License Mariners* (Washington: National Academy Press, 1996), 159.

mathematical accuracy of the model against the 'realism' of the visual effects. Moreover, the higher the fidelity of any model the more expensive it becomes to design. USS Trayer, for instance, cost $82.5 million (US).[34] Similarly the ORTT cost $65.8 million (Cdn), and it is only one small component of what could be a similar capability of the USS Trayer in Canada.[35]

Interconnectivity was briefly discussed earlier in the paper. There is an argument that states that while higher fidelity has been introduced in individual simulators, the ability of those simulators to interact in a realistic manner with other simulators in a distributed exercise has been significantly limited. [36] Varying standards and internet protocols have made interoperability between government and military organizations and defense contractors a very complicated, and often extraordinarily, expensive affair.

Related to the complexities regarding fidelity is the challenge in recreating the physical and environmental conditions experienced at sea.[37] Officers on a ship's bridge, for instance, deal with multiple visual cues to carry out their primary duties. These cues may include visually tracking the seemingly endless other shipping, differentiating amongst the deceiving back scatter lighting along the shoreline, reacting to the many meteorological variables and a deluge of similar stimuli. Additionally, boat operators must learn to launch and recover ships' sea boats while dealing with roll, heave and pitch. Similarly, weapons operators must equally understand the challenges of aiming an optically-guided gun system while positioned on a moving platform and confronting a moving target. Simulation designers are often put to the test to replicate the

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[34] Don Doherty, "Navy's New High-tech Trainer to Create Realistic Sea Battle Experience," http://www.readjobscope.com/archives/spring%202006/b020601.htm; Internet; accessed 16 February 2009.
[35] Department of National Defence News Release, "DND Announces New Naval Combat Training Simulator," http://www.forces.gc.ca/site/news-nouvelles/view-news-afficher-nouvelles-eng.asp?id=156; Internet; accessed 16 February 2009.
[36] Frank Hill, "Distributed Simulation in the 21st Century," IITSEC 2006 Paper 3035; http://www.simsysinc.com/IITSEC/ABS2006/SIM2006.htm#_Toc152918101; Internet; accessed 20 February 2009.
[37] National Research Council, *Simulated Voyages: Using Simulation Technology to Train and License Mariners* (Washington: National Academy Press, 1996), 9

sense of actually being onboard so that there is little to no training artificiality which could be considered as having a negative training impact.

There is also the human component to training that simply cannot be digitized. John Setear, while in this case discussing the lack of predictability of certain wargaming, stated, "[the operator] cannot…predict perfectly his opponent's decisions about where and with whom to attack."[38] This same argument can be made to demonstrate that even simulation cannot cover every conceivable reaction of an adversary or even every fault on equipment. There is also a belief that sea time allows better confidence building, command presence for line officer training, and interpersonal skills that simply cannot be accomplished through simulation. In fact, the Committee on Ship-Bridge Simulation Training concluded in its study of using simulation to license mariners that, in some cases, strictly conducting simulation training in lieu of sea time has the potential to "compromise mariner competency and safety and should therefore be approached cautiously."[39] This reality might provoke the sceptics to question whether or not the graduate of simulation training could actually exercise an analytical mind if he or she has only ever been confronted with the trainer scenarios and not forced to think outside the proverbial box.

It is these very sceptics that are the next barrier to simulation training, and arguably one of the most difficult to overcome; the significant cultural shift required of the senior leadership.[40] Most admirals today were trained in what was the training squadron; a fleet of steam-driven destroyer escorts whose sole purpose was to develop the necessary skills of sailors and junior officers. This squadron of ships was gradually faded out of the Canadian fleet inventory but

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[38] John K. Setear, *Simulating the Fog of War* (Santa Monica: RAND, 1989), 5.
[39] National Research Council, *Simulated Voyages: Using Simulation Technology to Train and License Mariners* (Washington: National Academy Press, 1996), 6, 148.
[40] R.J. Yardley, *et al*, *Use of Simulation for Training in the U.S. Navy Surface Force* (Santa Monica: RAND, 2003), 38.

never replaced given the ever-increasing operational tempo of the Navy during the past two decades. To that end though, we have a cadre of seniors that have not had the advantage of capitalizing on training via simulation and therefore find it difficult to rationalize the expense, or have the willingness toward simply mitigating the risks involved. The notion of replacing sea time with simulation is explicably very foreign to many seniors, who remain sceptical and ambivalent about policies which judge how many days of simulator based training would equal OJT onboard ship. Until at least a generation or two of sailors and officers have completed a training cycle using simulation, there will remain a cultural bias toward completing training at sea. It will be these future leaders that will be able to apply personal experience and appreciation towards the benefits of simulation and better understand the impact of comprehensive and explicit policies.

Yet another disadvantage of simulation training is the lack of any measures of effectiveness or empirical data to quantitatively validate the benefits of simulation over training at sea.[41] Many advocates of simulation based their opinion on conjecture and anecdotal evidence. There have been few, if any, real studies conducted to determine whether there is an equivalency between simulation training in selected skills and the skills learned onboard. Until such studies are conducted, policies and curricula will continue to rely on presumptions and subjective perceptions.

LACK OF OVERARCHING SIMULATION STRATEGY

[41] National Research Council, *Simulated Voyages: Using Simulation Technology to Train and License Mariners* (Washington: National Academy Press, 1996), 146.

As was illustrated in an earlier section, Canada does in fact have several policies on simulation. Broadly speaking, most of them carry a similar theme. However, what is lacking is a strategic vision of where the CF, and in this particular case the Navy, ought to advance in modelling and simulation training. In order for the Canadian Navy to move forward and keep pace with the complex capabilities and interconnectivities with modeling and simulation, a comprehensive plan is required, to be executed in conjunction with the Navy's various recapitalization initiatives.

Over the next two decades, HALIFAX class frigates will undergo a major modernization, IROQUOIS class destroyers will be replaced as will the PROTECTEUR class replenishment ships. Recapitalization of this magnitude will, in itself, take decades to bring to fruition. In order to ensure the training solution for these new capabilities is the right one, the necessary forethought needs to occur now. A naval simulation and training strategy, like the proposed strategy for the USN[42], would need to clearly delegate the responsibility and authority to address the use of simulation in training. Equally important is an investment strategy that is sufficiently robust to meet the needs of the Navy's recapitalization.

CONCLUSION AND RECOMMENDATIONS

Military organizations world-wide have reaped benefits from incorporating simulation into their respective training regimens. Cost savings have been realized by not having to deploy ships to sea, tanks to the field or fly aircraft. Simulation has also proven that skills sets can be

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[42] R.J. Yardley, *et al*, *Use of Simulation for Training in the U.S. Navy Surface Force* (Santa Monica: RAND, 2003), 63

both garnered and maintained if delivered with the appropriate degree of fidelity. Yet, the evidence also indicates that weak policies, disparate organizations responsible for simulation training and the enduring culture of cynicism towards computer-based training remain challenges to be overcome. Acceptance of simulation as a method of preventing skill fade must occur amongst the senior leadership so that a strategy may be developed and resources can be adequately committed and allocated. What is required is a top-down vision of the future of simulation in the navy.

What is needed to at least start such a paradigm shift would be for CMS to direct a study to fully analyze all the Navy’s training requirements and verify what can be reasonably accomplished ashore through simulation instead of sending one or more ships to sea. Certain measures of effectiveness must be put in place for any such study to be successful: the simulation standards must not degrade the proficiency of any skill sets that would have otherwise been achieved at sea; the cost of simulation must not overly outweigh the time that would have been spent on a ship, and; the fidelity in the simulation must be sufficiently comprehensive to best replicate the physical and technological complexities of what would be experienced at sea.

This essay has only briefly touched on the remarkable technological advances in modelling and simulation, training over a distributed environment and the ability to achieve skill proficiency without exploiting valuable sea time. It has also shown that these benefits do not come without a cost. Technology acquisitions most often equal tremendous expenses. A thorough cost benefits analysis must be done every time new systems procurement is made. But what is needed first and foremost are more explicit strategic guidance and sufficient resources to fully realize the potential simulation has to offer. Further study is needed to validate that simulation can indeed reduce training at sea as well as reduce operations and maintenance costs while maintaining proficiency and readiness of its sailors and the fleet. Such a study may prove that it is not the panacea for future force generation but simulation, I would submit, certainly affords the flexibility to achieve *excellence through habit*.

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