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PORT CITY CHALLENGES
E-NAV ("ELECTRONIC NAVIGATION")
THE FUTURE OF WATERBORNE SHIPPING

FINAL REPORT

by

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DISCLAIMER

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EXCUTIVE SUMMARY

This paper is about the importance of implementing the various technologies associated with electronic navigation strategies, or E-nav. Our objective was to find the main conceptual barriers within the maritime community to the fullest possible implementation of this technology. To this end, we conducted a self-administered email survey of the most knowledgeable individuals we could find regarding this topic. The survey questions were based on the most pressing issues related in the literature review. A content analysis of the survey responses was conducted to uncover the dominant themes in the thinking of these professionals concerning the benefits and challenges of global implementation of these navigational technologies, some of which are emerging and evolving during the course of this writing. Our findings indicate that for this study, the primary concerns about fully implementing E-nav technologies are: 1). the technology may be oversold to a younger generation of mariners, leading to the unintended consequence of an *increase* in maritime accidents related to the mariners' failure to sufficiently blend the technology with traditional seafaring– this is most often referred to in the literature and by our respondents as "looking out the window"; and, 2): that E-nav technologies are being cultivated with the purpose of implementing "drone" or pilotless shipping which mariners are resistant to because of safety and labor concerns. We relate the history of development of the E-nav concept as well as that of the more relevant technologies, such as satellite relaying, electronic buoys, web-based platforms for communications between vessels and communications between ship and shore. We discuss the history of some international maritime bodies' attempts to implement these strategies globally and the various roadblocks these attempts have encountered. In addition, we discuss how E-nav's impacts concern overall maritime cybersecurity, the advantages it has in terms of general shipping safety and the efficient global movement of goods, and its capacity to mitigate certain environmental impacts associated with shipping, such as oil spills. Finally, we relate the outcome of our efforts to identify relevant stakeholders in the implementation of the E-nav strategy, and identify their openness or resistance to opportunities for implementing these recommended navigational changes, for the purpose of cultivating a workable proposed implementation strategy for the full realization of the E-nav paradigm.

1.0 INTRODUCTION

1.1 E-NAV ("ELECTRONIC NAVIGATION") - THE FUTURE OF WATERBORNE SHIPPING

Currently the working definition of Electronic Navigation – also referred to as E-navigation, or E-nav – is "the collection, integration and display of maritime information aboard and ashore by electronic means to enhance berth-to-berth navigation and related services, safety and security at sea, and the protection of the marine environment" (Patraiko, 2007: 5). Water-borne freight shipping is rapidly increasing. In 2012, 975 million tons of American goods (imports and exports combined) moved by water, and this figure is projected to increase to 1,070 million tons by the year 2040 ("Weight of Shipments by Transportation Mode: 2007, 2011, and 2040 - Freight Facts and Figures 2013 - Federal Highway Administration Freight Management and Operations," n.d.). As this volume of freight increases, traditional methods of navigation – lacking the capacity for sufficient integration of vessel location and speed at both the ship-to-ship and ship-to-shore levels – need to be improved by modern Information Technologies that facilitate real-time awareness of vessel speed, direction, and location instantaneously to all relevant stakeholders (Baldauf et al., 2014). This improvement, in shipping lanes where it has been implemented (primarily in Southeast Asia and Europe), has proven to increase vessel traffic safety thereby ameliorating the occurrence of environmental disruptions such as oil spills. In addition, the increased efficiency with which vessels are able to move from berth to berth incorporating these augmented technologies lessens the travel time for waterborne freight, resulting in increased profit margins for shipping companies and commodities producers, as well as promoting greater economic productivity.

All of these benefits come with a significant concern regarding the integrity of cyber security in the global shipping industry. As the 21st century advances, cyber warfare and cyber terrorism are becoming increasingly relevant in the domains of national and international security. It is not a stretch of the imagination to see that once global waterborne shipping is integrated into a unified software platform, it would be possible for rogue states to hack that platform and bring the water components of global commerce to a halt, perhaps facilitating vessel collisions in the process. If such collisions were specifically targeted toward oil tankers navigating the fisheries of nations significantly dependent upon seafood commodities, severe economic disruptions could result (see Newberry, 2014). Nevertheless, international bodies such as the International Maritime Organization and the International Association of Lighthouse Authorities hold that the potential benefits of universal implementation of the E-nav paradigm outweigh the security risks. These significant anticipated benefits are the impetus for our qualitative research among the relevant stakeholders to discover the relevant perceptual and attitudinal facilitators of and obstacles to implementation of E-nav by the interested parties. We used an analysis of these cognitive factors to cultivate an implementation strategy for E-nav.

1.2 OBJECTIVE

An advanced navigation management system, E-navigation, is being implemented, on an uneven global scale, to both collect and organize maritime trip data in such a way that it can be used to inform commercial shipping efficiency, as well as overall maritime safety and security decisions. This system is composed of Commercial Remote Sensing & Spatial Information technology (such as cloud-based databases of changing depths and shoals); electronic Aids To Navigation; Geographic Information Systems; satellite tracking capacities; and all other relevant Information Technology-based enhancements of ship-to-ship, ship-to-shore, and shore-to-ship communications. The objective of this study is to propose an implementation strategy for more effectively moving E-navigation technology platforms forward. To achieve this, it is necessary to examine barriers to their widest possible implementation. Accordingly, we collected qualitative data in the form of structured, open-ended, self-administered email surveys from relevant stakeholders, in order to identify safety, security, and environmental concerns, which impede the full implementation of E-navigation. This report begins with a review of previous literature on E-navigation followed by a content analysis of the survey results, a discussion of the aforementioned implementation strategy, and finally a general discussion of the outlook for E-navigation in the short and long term.

2.0 LITERATURE REVIEW

The current working maritime industry definition of E-navigation, also known as E-nav is that it is "the collection, integration and display of maritime information aboard and ashore by electronic means to enhance berth-to-berth navigation and related services, safety and security at sea, and the protection of the marine environment" (Patraiko, 2007: 5). The use of AIS (Automatic Information Systems for collision avoidance and ship identification) was mandated by the IMO in 2002 (Chang, 2004). The concept which would come to be known as E-nav, however, originated in 2005, when "Japan, the Marshall Islands, Netherlands, Norway, Singapore, UK and USA" made a recommendation on development of the concept to the United Nations International Maritime Organization IMO (ibid.). Note that these seven nations are the top players in global maritime commerce. The United States, obviously, through the global projection of its sea power, has been the guarantor of the smooth flow of marine trade since the end of the Second World War. At the time, this was basically an umbrella concept oriented towards combining extant and nascent electronic navigation tools for the purpose of securing safer, more efficient, and secure maritime navigation (Patraiko, 2007: 9). The interface of real users with the evolving technology was considered a crucial component of its viable development (Patraiko, 2007).

A great deal of interest arose around the possibilities of using the developing E-nav technologies for mitigating incidences of collisions due to purposeful or unintended (i.e., fatigue related) negligence on the part of sailors on Watch (Gale and Patraiko, 2007: 4). The idea was not that the human element would be replaced by electronic monitoring systems, but rather that the application of these systems would augment and enhance quality adherence to standard maritime safety procedures (Gale and Patraiko, 2007: 8). This was to be accomplished in part by ergonomically sensitive changes in the design of ships' bridges and the placement of navigational equipment; electronically enhancing the signals and warnings which would reinforce the capabilities of the Watch; and facilitating the integration of navigational capabilities between sailors and the responsible shore personnel (Gale and Patraiko, 2007: 8).

The first substantive application of the E-nav concept was in 2007 in Southeast Asia, where it was designated "the Marine Electronic Highway project" (Pillich, 2007: 1). There was concern at the time in the broader maritime community that the potential benefits of E-nav were not being promoted aggressively enough to the domain of commercial shipping (Pillich, 2007: 1). Commercial shippers had high expectations of E-nav, and the initiative which resulted from this dynamic became known as "e-Maritime" (Pillich, 2007: 1)[1]. This laid the foundation for the potential of E-nav to become a truly global system of maritime navigational information.

Also in 2007, 23 different nations convened in London to discuss the ways in which E-nav would affect maritime law and the professional development of Mariners. For purposes of this research, the term "Mariner" refers to anyone involved in the navigation of a watercraft.

[1] This anticipated the potential many envisioned for the commercial applications of unmanned systems per se, such as the expectations many had for the full integration of Unmanned Aerial Systems (UAS) into their commercial air modes (see for example "Unmanned Aerial Systems," 2015). The construct of E-Nav as a replacement for, rather than an enhancement of, significant human components is quite controversial, as shall become clear below.

Although this is an exceedingly broad understanding of the term, its employment in this paper is meant to signify the enthusiasm with which recreational boaters (those whose use of watercraft – of any size – is restricted to personal/entertainment use) have recently greeted emerging E-nav technologies (see Smith, 2014 at the end of this review). In the more conventionally understood usage of the term, in which it refers more to the pilots of freight, military, and ferry vessels, the distinction is here noted between "brown water" and "blue water" vessels. Blue water ships are designed for exceedingly deep drafts, such as trans-ocean freight vessels. Brown water shipping, works primarily in the shallower waterways of ports, coastlines, and inland river systems. The importance of the distinction between these two types of vessels is in their size. The blue water vessels, of much larger size and deeper drafts, share space with brown water vessels in the crowded freight ways of the coastlines and inland river systems. In a setting like the Mississippi river, this crowding of large and small vessels into limited space is extremely dangerous.

The findings of the 2007 London meeting included the following: a global E-nav system is attainable and should be aggressively pursued; it should be user-driven; it should never be seen as a means of replacing Mariners or truncating their functions; functional extant methods of ensuring safe navigation should remain in place; mandatory training in E-nav is paramount; and both patent law concerning technological innovation as well as international maritime law should be respected (IALA E-navigation seminar, 2007: 1). Additionally, ergonomics – the physical interface between Mariners and the various components of the E-nav system – should always take priority; the shore-based component of E-nav should be kept up to speed with the development of its nautical components; and simulations adequate to the tasks of testing and training in E-nav should be developed (IALA E-navigation seminar, 2007: 1).

It was at this time that the International Association of Lighthouse Authorities (IALA) made a global solicitation on behalf of the IMO of all maritime stakeholders to convey their particular needs concerning E-nav. IALA distinguished between three broad groups of stakeholders. These consisted of the maritime personnel engaged in ship-to-shore and shore-to-ship communication, such as "Merchant vessels (including all types of cargo and passenger vessels)…Pilot vessels…Law Enforcement vessels" (The Nautical Institute, 2007: 1); the shore-based personnel directly engaged in navigational applications- "VTM [Vessel Traffic Management] organizations (competent authorities within the concept)" (The Nautical Institute, 2007: 1); and the shore-based personnel engaged in commercial logistics- "Shipowners and operators, logistic stakeholders…Insurance and financial institutions…Port authorities (strategic)" (The Nautical Institute, 2007: 1). The primary goal of this request from the relevant stakeholders was stated as follows: "E-navigation should support mariners in the maintenance of safe passing and clearing distances and collision avoidance"- this was the fundamental distilled understanding of the purpose of E-nav at this time (The Nautical Institute, 2007: 1)

Polish stakeholders began to apprehend the development of E-nav as fundamentally linked to the incorporation of emergent technology. Specifically, they advocated for the aggressive incorporation of "automation, electronics, telecommunications, informatics, telematics, geomatics and global position fixing techniques, achievement in data storing, processing, analyzing, transferring and visualization" (Weintrit, 2007: 261). Note, however, that they sought to preserve the ultimate responsibility for safe navigation in the hands of ships' captains (Weintrit, 2007: 261). They saw the responsibility of the IMO as being the cultivation of a global, technologically-driven E-nav network. The role of this network would be to facilitate improvements in marine safety and efficiency. It would incorporate current technology, like the Marine Electronic Highway Project as well as a handful of others in use at the time, "such as the World Bank-funded Marine Electronic Highway project in the Malacca Straits and the European Union's projects ATOMOS IV (Advanced Technology to Optimize Maritime Operational Safety - Intelligent Vessel) and MarNIS (Maritime Navigation and Information Services)" (Weintrit, 2007: 269). Note the evolving dichotomy between a felt need to aggressively incorporate emerging technology and a sense of obligation to the traditional roles of maritime personnel.

Norwegian researchers continued to navigate this tension with a focus on the requirements of Mariners as real humans and a simultaneous exploration of the incumbent bandwidth requirements for satellite components of the E-nav framework. This was known as "the MarCom project ('Maritime Communications - broadband at sea')" (Fjortoft et al., 2009: 87). This perspective included concerns about the cost-effectiveness of implementing the E-nav concept on a global scale. This was primarily due to the fact that commercial Mariners, at the time of Fjortoft et al., 2009, by and large still did not see themselves as relevant E-nav stakeholders (see p.92, "Challenges And Possible Solutions"). "Commercial mariners" is understood here to mean those whose livelihood depends upon the maritime transportation of freight and goods for profit. At the time of this article, Fjortoft et al. were addressing the issue of a generational divide in the maritime community, with a newer generation of Internet-savvy mariners being more interested in the emerging navigational technologies. Additionally, a serious concern was noted regarding the differing communications broadcasting regulations internationally and how this would slow global implementation of the concept (Fjortoft et al., 2009).

By 2010, a re-emergent focus was expressed with putting the emphasis on E-nav as a technological paradigm driven by the needs of Mariners, rather than vice versa. Patraiko et al. 2010 thoroughly revisited the 2007 survey work of the IALA mentioned above. They examined a multitude of surveys in an effort to tease out Mariners' expressed needs regarding new technology from their praise of extant systems. The more important expressed needs which they examined included "Common…Data Structure"; "Automated and Standardized Reporting Functions"; "Effective and Robust Communications…between vessels"; "Human Centered Presentation Needs to optimize support for decision-making"; "Human Machine Interface"; "Data and System Integrity"; "Analysis [to] support good decision-making…"; and "Implementation Issues [i.e.]…training and familiarization" (Patraiko et al., 2010: 12-13). The authors envisioned E-nav as a paradigm that would evolve and morph over time as data, technology, and stakeholder objectives changed (Patraiko et al., 2010: 15). The literature shows that this has been the case. For example, advances in Internet software platforms facilitated the development of the Common Maritime Data Structure, a navigational and hydrographic data synthesis, which has brought the global potential of E-nav closer to reality (Bergmann, 2013). In addition, the increase in private-industry satellite launches for commercial navigation based on the use of Geodetic Reference Systems, or GRS – "…systems of parameters, describing the Earth as a complex geometric and physical figure" (Bannister and Neyland, 2015) – have brought the stake of the shore side (shipping companies) more to the foreground. This has even led to concern on the part of pilots that commercial forces are driving push for the progression of unmanned shipping technologies (see Pelletier, 2014). In 2011, Bergmann wrote on the broadening of the Electronic Chart Display & Information System (ECDIS) by the incorporation of new information, such as AIS (Automatic Identification System) and "real-time tide information" (Bergmann, 2011: 25). His concern was that proper attention be paid to the E-nav potential of the Electronic Nautical Chart (ENC). He brought to the forefront the objectives of hydrographers as stakeholders, and the need to address their concerns with the evolving technologies of the ENC. Specifically, he advocated for the incorporation of the official goals of the International Hydrographic Office (IHO) into the technological evolution of the ENC. These goals are as follows: "The object of the Organization is to bring about: The coordination of the activities of national hydrographic offices; The greatest possible uniformity in nautical charts and documents; The adoption of reliable and efficient methods of carrying out and exploiting hydrographic surveys; The development of the sciences in the field of Hydrography and the techniques employed in descriptive oceanography (www.iho-ohi.net)" (Bergmann, 2011: 25). He described how rapidly advancing Geographic Information Systems (GIS) technology would be able to bring the cartographic component of the ENC into a more user-friendly, real-time platform, as opposed to the simple electronic sharing of "Raster Charts" composed along an analog paradigm which originated in the early 17th century (Bergmann, 2011: 27). This article is a strong push for the specific hydrographic capabilities of this technology to be made available via the ENC, and for pressure to be put on hydrographers to deliver, as vessel sizes increased along with shipping densities in dangerous channels. His primary capacity focus is for hydrographers to take advantage of the fact that with GIS technology, "The hydrographic data [can be managed] as a complete set, rather than individual puzzle pieces, which are stitched together like a patchwork quilt to create an individual coverage. This underlying data layer will be rendered based on situational needs, i.e. zooming level as desired by the mariner, and as such will result in a situational centric display" (Bergmann, 2011: 28).

Online accessibility of information regarding these densities is the focus of Stupak and Zurkiewicz (2011). They presented the Internet as a key component of the E-nav concept. The challenges of establishing a uniform, global system of technically advanced, human-integrated navigation protocol are brought up here again. The two fundamental difficulties faced by the theoreticians and technologists of the E-nav paradigm which seem to be recurrent themes in the literature are: 1). Problems posed by differentials in nautical regulations among various national coastal zones and inland waterways; and 2). Necessity of ensuring that the technology is driven by the needs of Mariners rather than the other way round. The technology Stupak & Zurkiewicz discussed at this point was automated messaging to Mariners giving them time to avoid the dangers inherent in very high density sea lanes and coastal areas (Stupak and Zurkiewicz, 2011: 290). Today, the rapidly-shrinking navigable space for mariners, particularly along coastlines due to wind farming, environmentally protected areas, and endangered species habitats, is complicating the situation wrought by increasing ship size and volume of maritime traffic (Bergmann, 2015). The recent notable increase in the pace of technological innovation manifested in the phenomenon of computer "apps"[2] has led to a sort of leapfrogging, whereby the navigational needs of the mariners in an ever-decreasing space drive the software innovation- but the advances in these innovations wind up driving the shore-side expectations of the mariners as well; this dynamic is already well-known in the air and rail modes of navigation. Indeed, "While navigation of a ship is very much different than driving a car or a train or flying an aircraft, the task is not necessarily easier. As such the lessons learned in other industries have already inspired the maritime manufacturers to develop situational centric tools." (Bergmann, 2015: 440).

[2] In 2014, the United States Navy began developing an "app" known as Mission Planning Application technology, for its surface fleet. This app is adapted from technology already in use by the submarine fleet; see Szondy (2014).

Another emergent technology of interest at the time was the use of electronic radar oriented positioning systems (Amato et al., 2011: 11). The authors summarized these new developments and discussed their future implications for global implementation of the E-nav paradigm. Their most important finding was the possibility of integrating new solid-state radar technology with the existing system of buoys and beacons (Amato et al., 2011: 14). Their primary conclusions were that use of this technology in this context was increasing rapidly among recreational and trade-oriented Mariners (those whose use of watercraft is primarily involved with the transportation of freight for the facilitation of international commerce), and that this variety of radar positioning should continue to be incorporated into the existing system of AToN (Aids to Navigation; ibid.). The primary focus of this article is technological rather than ergonomic.

In March 2012, the Nautical Institute published an issue of its journal Seaways, with a heavy focus on the potentials of emerging E-nav technology to truly globalize the uniform coordination of navigational information (Budd, 2012: 1). The issue also emphasizes the challenges of shepherding the now rapidly emerging different E-nav technologies through the maze of differential international regulations. They addressed concerns as to whether or not "there is a sufficient link between technology, procedures, people and training" (Hagen, 2012: 14, in Budd, 2012). Hagen echoes familiar themes of anticipating technological innovation, particularly those innovations with digital platforms; coordination of usage protocols among all stakeholders; sufficient training; concerns with ergonomic viability; and the continued leadership of the IMO (Hagen, 2012 in Budd, 2012: 14-18). Note how this signals a shift in focus away from simply integrating all of the technologies available at the time, to a philosophy of a uniform navigation system accessible equally by all mariners. The emphasis is on developing a tool to augment and update traditional navigational practice, as proposed in Patraiko (2007). The accent in this document is a sense of readiness for a continuously evolving Internet/software/satellite-based platform for the global synthesis of all relevant maritime navigational data.

In 2013, at the direction of the Department Of Homeland Security, the United States Coast Guard outlined the current state of how the nation is addressing concerns related to the interface between navigation and cyber-security. E-nav was discussed as one of the many examples of how traditional Marine AToN's have become more comprehensively digitized, and therefore susceptible to natural, accidental or intentional disruption (Wilson, 2013). The primary means by which the USCG is addressing the concerns is the work of the Coast Guard Cyber Command (CGCYBERCOM). CGCYBERCOM addresses cyber-threats by "'[working] as subject-matter experts for the deputy commandant for operations to support our partners on how cyber-attacks might impact our ports and waterways. A big part of that is working with the Defense Department [DoD] and the intelligence community to gather indications and warnings of threats,' according to Cmdr. Cliff Neve, CGCYBERCOM's chief of strategic planning" (Wilson, 2013: 2). A second strategy is the thorough dissemination amongst shore-based navigation stakeholders, as well as seamen, of pertinent information related to navigational cyber security. Thirdly, cyber-strategies are utilized by the USCG in the prosecution of its missions. GPS is seen as a particular concern, because it is so easily hacked/disrupted. To combat this, the USCG pays particular attention to the promulgation of protocols related to "computer hygiene" (2013: 2).

In August 2015 the U.S. Army Corps of Engineers (USACE) released Engineering and Construction Bulletin 2015-14, (ECB, 2015-14), "Integrating Cybersecurity Requirements", in order to give "…direction and guidance to support the implementation of cybersecurity requirements into all applicable projects executed by the U.S. Army Corps of Engineers…" (USACE 2015). The key issue addressed in this document is that what are known as "Platform Information Technology (PIT) systems" – typical electronic security and facility monitoring systems such as security cameras, environmental controls, and basically all USACE electronic systems related to remote functioning (for example, the electronic components of the inland waterway system of locks) – were not composed with modern cybersecurity requirements in mind (USACE 2015: 1). They were built upon what is known in the computer and information-technology (IT) industries as "open architectures [which are] legacy in nature…" (USACE 2015: 2). Briefly, this means that they are what is commonly known as easily "hackable", constructed without an eye towards the necessity for basic precautions such as firewalls and other software safeguards, as they were not meant to be upgraded with the rapidity of current IT-based software systems. As such, each of these open architecture electronic security control systems is in need of individualized retrofitting for purposes of cybersecurity. These tasks are to be coordinated through the USACE ICS Cybersecurity Technical Center of Expertise (TCX), which is scheduled to release a Unified Facilities Criteria (UFC) for these systems in 2016 (USACE 2015: 2).

2013 is when the E-nav concept began to gain significant organizational momentum. The IALA and in the IHO (International Hydrographers Organization) developed the "IHO GI Register (often known as S-100 Register) as the conceptual basis for the Common Maritime Data Structure (CMDS)" (Bergmann 2013: 371). The key difference between the S-100 and its various preceding versions, different editions of S-57, is that S-100 incorporates third-party data that go beyond those of S-57. S-57 primarily functioned as the basis of an Electronic Navigational Chart (ENC), mainly focused on the IMO requirements for an Electronic Chart Display and Information System (ECDIS; see Ward and Greenslade 2011). S-100, by contrast, "…includes new spatial models to support imagery and gridded data, 3-D and time-varying data (x, y, z, and time), and new applications that go beyond the scope of traditional hydrography (for example, high-density bathymetry, seafloor classification, marine GIS, etc.)" (Ward and Greenslade 2011: 3).

The CMDS was designed to synthesize extant and emerging digital navigational data – such as that related to digital AToN's, tidal information, and data derived from cutting-edge navigational software via the vehicle traffic service (VTS; the land-based marine vessel coordination system) – into a single user-friendly computer-based platform (ibid). The globalization and all-vessel-encompassing implementation of the E-nav paradigm via full integration of the ENC and CMDS by the IMO now comes directly to the foreground. A model was proposed that outlined "a universal 'Marine Information Registry' to host data modeling of all aspects of shipping and the maritime domain, including the modeling of non-spatial information" (Mathias and Oltman, 2013: 45). The focus on real-life human interaction with emerging digital ships' bridges technologies in terms of training and ergonomics continued. "The Human Element Analyzing Process (HEAP) - was applied" (Mathias and Oltman, 2013: 45) to identify areas where an authentic interface between mariner and technology was weak or missing. The authors anticipated standardized vessel-to-vessel and vessel-to-shore digital E-nav communications of uniform, fully functional bandwidth (Mathias and Oltman, 2013: 49). In addition, they advocated a media driven strategy to facilitate support for the paradigm from all stakeholders, who would be bound together via "the CMDS" (Mathias and Oltman, 2013: 49).

In 2014, the IMO formally repeated its original definition of E-nav, summarized the technological developments which have taken place since the concept first came to the table in 2005, and identified the areas of greatest concern regarding the global maritime implementation of the paradigm. These centered around issues of differing international regulations, language barriers – especially as these related to issues of training and procedural normalization on the part of all stakeholders – and the cultivation of reliance on E-nav by Captains and other Mariners who were still more inclined to rely on traditional methods of steerage. Most notably perhaps, the IMO focused on recurrent concerns regarding what was variously referred to as "the human element…ergonomics…[or] the human-machine interface" (Norwegian Coastal Administration 2014: 2).

The increased safety potential for smaller vessels gained by the use of technological improvements in (Automatic Information Systems) AIS on the part of larger ones began to come to the fore in 2014 as well. Specifically, the implications for facilitation of what is known as Sea Transport Management (STM), a term referencing a greater reliance on emerging AIS technologies rather than ships' traditional on-board radar systems, was discussed (Stupak: 2014). The STM aspect of E-nav is fluid and constantly evolving due to the increasing rapidity of technological innovations. Current trends include increased utilization of satellite-based navigation systems, utilizing "…geodetic reference systems (GRS). GRS are systems of parameters, describing the Earth as a complex geometric and physical figure" first established in the early 80s through a then-limited system of international cooperation (Dachev, 2015: 23); and the contemporary rapidly-expanding utilization of this aspect of the paradigm, largely due to the boom in private-industry launched navigational satellite systems (Bannister, N.P., Neyland, D.L.: 2015). A specific contemporary example of the ever-advancing technological capabilities of the E-nav paradigm is the European Union's MONALISA 2.0 navigational system, which is scheduled to be fully implemented by end of year as of this writing- 2015. Due to the number of collaborations between various navigational technology innovators involved in the development of MONALISA 2.0, the promoters of this particular version of the E-nav paradigm promote it as having the potential "…to shake up and sharpen the whole transport chain by making real-time information available to all interested and authorised parties… it will change the maritime world. It is like introducing the Smartphone, at first no one really knows what they need it for, and then they cannot live without it" (http://monalisaproject.eu/).

However, some governments have expressed concern about the proprietary nature of such rapidly advancing navigation technology. The potential monopolization which could result from this kind of arrangement is seen as a threat to safety, in which maritime actors without financial access to these proprietary databases will not have the latest data. Conversely, the potential for unregulated commercial dissemination of bad data exists as well (see Committee on the Marine Transportation System [CMTS], n.d.:1).

The integration of E-nav components into simulator-based training for deep sea mariners, such as the Safety and Security Trainer (SST) were discussed in Benedict et. al., 2011. These included technologies such as a software platform known as MADRAS, which, along with the Ship Handling Simulator (SSH) was combined with the SST and the entire training system in order to facilitate the anticipation of on-water incidents and real-time effective decision making and actions to handle the same (Benedict et. al., 2011). STM-generating developments in the total integration of all existing earth-based (ship & shore) E-nav components were anticipated in

Watson, 2015. Perhaps most important in this piece is Watson's discussion of how the functions and roles of actively evolving E-nav technologies are conflicting with the IMO's vision and agenda for the E-nav paradigm. For example, on page 19, he states that

The concept of a standardized mode for a navigation display was initially presented to IMO in 2008. Under this original version, S-mode would require navigation displays to have the ability to revert, by a single operator action, to a standardized navigation display… S-mode supporters see it as a component of E-navigation and have succeeded in having it, along with the pilots' concept of default settings and save/recall function, included in the SIP as part of the larger E-navigation program. Manufacturers, however, are already independently developing the pilots' concept. Pilots are concerned that linking their concept with S-mode under the strategy implementation plan could interfere with, or at least delay, the full roll-out of their concept.

Simulation-based training using E-nav technologies is also used to reflect the distinction in levels of navigational difficulty during inland as opposed to open-sea shipping. "…DCPA (distance to closest point of approach), TCPA (time to closest point of approach) and other key parameters…" reflecting the greater maritime densities of inland shipping were the subject of recent simulated modeling exercises in one of the denser ports of Shanghai, YangShan (Yu et al., 2015: 2799). In the European Union, VHF-based radio technologies are the primary means of facilitating safe inland travel integrated into the River Information Services (RIS), with an eye towards the "…possibility of implementation and use of the Global Maritime Distress and Safety System (GMDSS) in inland navigation" (Lisaj, 2015: 287).

The initial promise of E-nav based technologies such as the Vessel Traffic Management and Information System (VTMIS), which initially appeared as simulators for the navigational training of mariners (Gucma et. al., 2011) was great. However, concerns have repeatedly been raised in the maritime community about how dangerous it can be for bridge personnel to lean too heavily on current and emerging E-nav technologies to the exclusion of traditional methods of navigation. Examples of specific incidents which were ultimately traced to such an overreliance on emerging technology are a staple of the literature (see Yousefi and Seyedjavadin, 2012). The traditional methods are colloquially referred to in the maritime community as "looking out the window", and are a recurring theme in the content analysis of our survey results. They have also been referred to in a concern to properly address ergonomics, the human-centered science which "…increases the efficiency of people and device interaction" (Vidan et al., 2012: 17).

In the United States, surveys of different classifications of mariners by the USCG, The National Oceanographic and Atmospheric Administration (NOAA), and the U. S. Army Corps Of Engineers (USACE) about the diffusion of the E-nav concept and its lived practice within the maritime community seemed to reveal that professional mariners were less concerned with the paradigm than were amateurs. Of all those surveyed, the responses were broken down as follows "2/3 of the results were from Recreational boaters and 1/3 of the results were from Professional mariners" (Smith, 2014). Specifically, 67.18% of the respondents were recreational boaters; 2.29% were pilots; 0.25% commercial fishermen; and 15.52% were licensed mariners (Smith, 2014.). For purposes of Smith 2014, the USCG definitions of these categories are as follows:

Recreational boaters: those engaged in piloting Recreational vessels, that is, “Watercraft manufactured for operation, or operated, primarily for pleasure. This term includes any watercraft leased, rented, or chartered to another for the latter's pleasure” (see 50 CFR 85.11);

Pilots: “…a pilot, so far as respects the navigation of the vessel in that part of the voyage which is his pilotage ground, is the temporary master charged with the safety of the vessel and cargo, and of the lives of those on board, and entrusted with the command of the crew” (Quick n.d., note 13.1: 13);

Commercial fishermen: Mariners who pilot “…vessels engaged in activities which are pursuant to the harvesting or processing of fish for commercial purposes. This includes tender vessels that transport, store, refrigerate or provide supplies to the commercial fishing industry” (USCG 2013: 2);

Licensed mariners: All persons involved in the operation of a marine vessel who fit the categories defined in 46 CFR 10.107.

Reasons for the dearth of responses on the part of maritime professionals could be broadly dichotomized. On the one hand, it may be that American maritime professionals are more resistant to acceptance of the E-nav concept, and more reliant on traditional methods – the dynamic alluded to in Norwegian Coastal Administration, 2014 above. Or, it could be that these professionals are already well-versed in the theory and practice of E-nav. However, the assessment of other maritime professionals seems to indicate that the former of the two is operative: “I would consider the greatest impediments to developing and deploying new technology in the marine industry to be resistance to change, unwillingness to invest, and the time lag from innovation to deployment. The typical mariner has relied on traditional means of navigating for many years, and they're unwilling to accept new technology as a replacement for the traditional means. Many will accept new technology as an augmentation, but they won't let go of the past” (Sollosi 2013 in Singh 2013, Appendix).

3.0 METHODOLOGY

In-person semi-structured interviews – or even open-ended ones – in which the respondents have more latitude to go in topical directions unanticipated by the researcher (Hesse-Biber, 2011) would have been ideal for the study of such a fluid and rapidly-evolving topic as E-nav. However, due to constraints of time, distance, and funding, this strategy was not feasible. Instead, we boiled down an original 14 question survey instrument to a five question self-administered open-ended email survey (see appendix B) which addressed what we understood to be the most pressing domains addressed in the literature review.

There are advantages to online/email surveys. Most notable are that the speed of delivery, and potential turnaround, are vastly superior to those of conventional postal mail surveys at a fraction of the cost (Babbie, 2013). However, other research has shown that email surveys tend to have lower response rates (Jin, 2011; Jacob, 2011). This was certainly a problem we encountered. It has been suggested in the literature that mixed modalities, such as combining email with postal mail or telephone calls, can improve the response rate (Saunders, 2012). One of the usual pressing concerns about the usefulness of email surveys – that by default they cherry-pick those members of the population with access to the Internet (Babbie, 2013) – was a non-issue for us, because academic, government, military, industry, and corporate personnel in the maritime world can safely be assumed to have such access.

Our approach to understanding how the most pertinent issues of E-nav are understood by knowledgeable persons in this field was qualitative. We used a nonprobability stratified single-stage purposive sampling method. Our strata consisted of the following operationally-defined categories: Government (officials employed by national governments to facilitate their country's shipping industry); Military (persons who work primarily in maintaining their country's coastal safety, as well as its anti-piracy initiatives), Academia (those whose primary occupation is the education and training of future maritime professionals), Corporate (persons representative of corporate entities whose revenue stream is heavily dependent upon the maritime component), and Industry (those persons involved with international organizations who function in advisory, oversight, and regulatory capacities for the facilitation of all aspects of shipping).

3.1 PURPOSIVE SAMPLING

In purposive sampling, "…the units to be observed are selected on the basis of the researcher's judgement about which ones will be the most useful or representative" (Babbie, 2013: 190). Although constraints of time and funding certainly factored into this choice of sampling strategy, a purposive sample is ideal for gaining an understanding of rapidly emerging E-nav technology, because the knowledge base and skill sets associated with its use are currently in a state of flux. Representatives of the population of E-nav experts from the last five years therefore represent the best sampling frame for facilitating insight into the implications of its development and applications.

The primary weakness which is raised in objection to all qualitative research is a concern with validity (Hesse-Biber, 2011). Traditionally, researchers from the disciplines associated with the development of E-nav – computer science, mechanical and software engineering, physics, ergonomics, oceanography, etc. – would have good reason to be skeptical of a research paradigm based upon an understanding of subjective impressions. The whole point of implementing E-nav technology is to standardize the objectivity associated with the exigencies of navigation in its extremities. However, as this research was focused on the most effective ways to promote full utilization of the best aspects of E-nav technology, the matter of subjective impression became quite relevant.

A primary obstacle to this goal, as suggested by the literature review and emphasized in the responses we received, is the subjective impression on the part of some mariners that the purpose of this technology is to eventually replace them with automated ships that require little or no human participation apart from remote shore-side monitoring (Pelletier, 2014). Recall as well that stories of maritime accidents due to overreliance on E-nav technology to the exclusion of traditional methods are standard fare for a certain generation of pilots and crews (see Yousefi and Seyedjavadin, 2012). The validity of our sampling strategy therefore ultimately stems from two facts. First, we derived the research questions which composed our survey from the literature review. Second, the coding we used to bundle the "word groups" (Colby, 1966: 375) into the themes used to analyze the responses to these questions, was derived from the same literature – a significant cultural product (Tylor, 1871) – produced by the maritime community itself.

3.2 CONTENT ANALYSIS

The modern form of content analysis is ultimately a mixed-methods research paradigm which began to take root in the science of anthropology in the mid-1960s (see Colby, 1966). Then-current advances in computer technology allowed for the collection of word-groups from source documents. Computers were used to generate statistical analyses of the relative frequencies of word-groups to gauge their significance to the peoples who composed the narratives under analysis (recall that the relatively small sample size and response rate of our survey did not necessitate the use of statistical analysis software). For Colby (1966), these narratives were myths and folk-tales. For purposes of this study, the narratives are the interviews we collected with interested parties in the maritime community concerning E-nav. The following discussion of the details of our content analysis approach is based upon the outline of this research methodology, contained in Babbie (2013: 332-339).

The methodology of content analysis raises a host of issues which can rapidly descend into a conceptual thicket. The most pertinent ones for understanding the process of this component of our methodology are questions surrounding the unit of analysis; the process of defining code categories; coding; and the distinction between manifest and latent content. In an attempt to simplify this discussion, we chose here to relate this methodology through the composite lens of "Who said What the Most for What Reason". The "Who" in this construct consists of the survey respondents, comprising what Babbie (2013) refers to as "…the units of *observation*…" (Babbbie2013: 332; italics mine). He takes great pains to distinguish these from the "…unit of analysis…" (Babbbie2013: 332). The unit of analysis is the "What". It is the word groups – the

E-nav-expertise-holder-derived responses – in the interview results. These responses were bundled – coded – into themes which were derived from issues repeatedly raised in the E-nav literature which we reviewed. The “Most” refers to the frequency counts for each theme within each stratum of the respondents (these are summarized in Table I). It is these frequency counts which led us to infer which themes held the greatest importance for each stratum of the E-nav experts who participated in our survey- the manifest (self-evident or obvious) content under analysis. The “What Reason” component of our composite lens refers to the subjective impression of latent content- what it *means* for each stratum that x or y or z theme manifested the relative degree of importance which it did.

We reiterate here that in this instance, content analysis is essentially a qualitative study, and that therefore the meanings for each stratum’s thematic frequency count are “…only rough (though hopefully objective and reproducible)” representations of the real meanings for “…the people [mariners] being discussed…[s]hared by a group [sample stratum] within a speech community [E-nav specialists]” (Colby 1966: 377, 378).

We reduced the number of questions in our survey significantly, in an effort to facilitate the response time (see appendix B for the text of our survey). In our returns, we found six repetitive themes, for which we composed the following operational definitions, based on elements of the literature review. These were as follows:

Education & Training- A focus on hands-on learning in the use of current and emerging E-nav technologies

Generational Factors In Acceptance Of E-nav- An awareness that mariners born in a world where digital technology in general, and the Internet in particular, are ubiquitous, will adapt more easily to the concept – if not actual pilothouse best practices – of E-nav technologies;

E-nav Facilitating - Not Replacing - Traditional Maritime Roles- The understanding on the part of the maritime community that current and emerging E-nav technologies are meant to serve as enhancements, rather than replacements of, traditionally derived maritime skill sets;

Software Integration of International Maritime Regulations- The understanding that the details of nation-state navigational procedures, particularly as these impact coastal, channel, and inland navigation, are encoded within current and emerging E-nav software;

Government-Industry Committee Collaboration To Promote E-nav- The traditionally understood “top down” methodology of inculcating E-nav technologies into a nation’s maritime culture;

Cybersecurity- The awareness of, concerns over, and plans to address the porous nature of various current and emerging E-nav technologies, such as VIS (Virtual Information Systems), to hacking for purposes of criminal and / or terroristic threat.

We sent surveys to the following strata of involved maritime personnel:

Government (officials employed by national governments to facilitate their country's shipping industry);

Military (persons who work primarily in maintaining their country's coastal safety, as well as its anti-piracy initiatives);

Academia (those whose primary occupation is the education and training of future maritime professionals);

Corporate (persons representative of corporate entities whose revenue stream is heavily dependent upon the maritime component);

Industry (those persons involved with international organizations who function in advisory, oversight, and regulatory capacities for the facilitation of all aspects of shipping).

The population – leading E-nav experts in the world – from which to choose our sample is small and very narrowly defined to begin with. Our chosen strategy was purposive sampling; recall that in this technique, choices about which members of the population compose the sample are determined by judgements about "…which ones will be the most useful or representative" (Babbie, 2013: 190). While we are not drawing on a large pool of respondents per se, the knowledge base related to the topic under study which our sample members represent is quite large.

We sent out a total of 31 surveys. The number of surveys we sent to each stratum is listed below. We had a five week response window for the survey, with a total of three reminders.

Academia- four (13% of total);
Corporate- six (19% of total);
Government- seven (23% of total);
Industry- five (16% of total);
Military- six (19% of total).

Note: Percentages not equal to 100% due to rounding

4.0 FINDINGS

We received replies from a total of nine respondents for a 31% response rate (RR). While this is a low number, preliminary research shows that it may in fact approach acceptable lower boundaries for RR's from persons "…at the executive level" of organizational capacity, particularly as RRs have been declining since the mid-70s (Baruch & Holtom, 2008: 1144; Baruch, 1999). For purposes of this report, if we understand Industry professionals in particular as former CEOs of organizations – former captains of ships – the response rate is within keeping for this classification, which would also apply to persons within the Government designation, who are often former or current senior members of their nations' coast guards.

These are the thematic concentrations broken down by the strata from which we received surveys:

Table 1: E-nav survey thematic response concentrations.

			Strata			
Themes	**Govt**	**Military**	**Academia**	**Corporate**	**Industry**	
Education & Training	*	*	1	*	4	
Generational Factors	1	*	1	*	6	
E-nav as Facilitation	3	*	1	1	8	
International Regulations	1	*	1	1	5	
Government-Industry Collaboration	1	*	*	*	*	
Cybersecurity	3	*	*	2	7	
TOTALS	9	0	4	4	31	48
	19%	0%	8%	8%	65%	

4.1 ACADEMIA

Under the theme of Education and Training, the one representative of academia who responded stated that these are “essential". Regarding generational Issues affecting use of these technologies, he opined that younger generations of mariners would be much more likely to accept the use of E-nav technologies than current one, which is heading to retirement. In terms of E-nav facilitating rather than replacing current navigational techniques, our academic gave the quintessential across-the-board summary of the sea-side mariners’ feelings on the subject: “It should be designed to increase the time the mariner spends looking out the window, not lessen it.”[3] When discussing the issue of how E-nav technologies could effectively account for differing international regional maritime regulations, especially as these applied to coastal zones, ports, and inland river systems, this respondent offered up an ideal which other experts confirmed was in fact already in place. Specifically, he advocated a system which would be able to use GIS technology to pinpoint the vessel’s location and communicate the regionally applicable maritime regulations to the ship’s software operating platform. The unanimity with which the other respondents spoke of the current use of such a system was somewhat surprising in the context of how great a cause for concern this was in the literature until relatively recently. The representative of Academia was very forthcoming about his lack of expertise in the field of Cybersecurity.

4.2 CORPORATE

In terms of E-nav replacing as opposed to facilitating traditional navigation, the corporate respondent expressed the industry viewpoint in terms of “push” and “pull”, that technological developments should be pulled out of software and hardware potential by the desires and needs of the mariners, rather than pushed upon them by them by the fact that the technology exists simply for its own sake. As has been repeatedly stated in this report, this is the standard and deeply-felt position of the ship side of the maritime community. However, as was revealed in the most recent components of the literature, it appears as of this writing that in fact this is not how the process is playing out. The facilitation of cybersecurity upon the part of this respondent was represented by his advocacy of the concept of “redundancy”. The best way to guard against either terroristic hacking or simple malfunction of navigational software databases and information streams is to not be entirely reliant upon any one system in the first place.

4.3 GOVERNMENT

Regarding generational differentiations in openness to E-nav, one of our Government respondents raised the potential for tensions between the expanded “voluntary” use of these

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[3] This phrase “looking out the window” occurs so frequently within the literature concerning mariners’ feelings about the implementation of E-Nav that from an anthropological point of view it is difficult NOT to give it the status of a major, discursive element within the entire mythology of life at sea. We will return to the implications of the ubiquity of this term when we examine the implications of our research findings for the cultivation of an effective means of transmission of the acceptance of E-Nav technology in our discussion section.

technologies and the just-to-get-by implementation of imposed regulatory minimums.[4] In terms of E-nav facilitating, not replacing the capabilities of the mariners, he advocated their involvement in the development of the technology. Regarding cybersecurity, one Governmental representative simply stated, in response to the inquiry "Which E-nav technologies are the most vulnerable for cybersecurity", "This sort of information cannot be shared". Another was more forthcoming, however, stating "Anything connected to the internet".

4.4 INDUSTRY

It is clear from Table 1 that the Industry professionals, according to our survey sample, perceive themselves as by far having the greatest stake in the outcome of the E-nav process. Regarding education and training, a representative quote from the Industry side was "Implementation of E-nav both from the vessel side and the shore side should be done slowly with Measures of Success built into the program. On the vessel side; types, quality of equipment, certified data bases and proper training is most important." In terms of generational differentiation, one industry professional interestingly made a comparison to the implementation of radar for navigational purposes: "Introduced in the 1940's radar was a less than effective tool for collision avoidance for something over 30 years". As to concerns over facilitation versus replacement of traditional skill sets, this same professional stated that "The trend afloat is to reduce manning by the substitution of technology, but done without recognition that at times the resulting requirement for "multi-tasking" degrades performance of the human component below a safe level."[5] Where cybersecurity is concerned, one industry professional remarked, "This will be a major issue. The Coast Guard has a special group of Tech experts working on Navigational cyber-security for the US. I understand the international community through IMO (International Maritime Organization) has not been as forceful with proposed regulations on cyber-security. At this point they are defaulting to the member country's to develop their own procedures."

The above summary makes clear that at least these maritime industry professionals, who are drawn from the ranks of real-world experienced mariners, seem to perceive their greatest stake in promoting the understanding that E-nav technologies are augmentations to traditional methods of navigation, rather than their replacement. This thematic concentration was followed by either concerns with, or information on how to address, issues related to cybersecurity. The issue of software integration of international maritime regulations was not discussed by these industry representatives as a concern. Rather, their answers to the question were uniformly discussions of the actions taken by the IMO to address this issue. This is notable considering the degree of prominence concern over this issue played in the literature derived from relatively recently in the 21st century.

In addition, the Corporate and Government representatives paralleled each other when speaking of technology-specific responses to potential problems involving cybersecurity. Because of the

[4] This is in fact an issue, as commercial navigation satellites create more flexible navigation capabilities unregulated by the IMO, complicating issues of liability in case of accident from mariners' disregarding "unofficial" data.
[5] The reasons for this conflict of gathering intensity between the ship side, which desires augmentation of the mariner skill set, and the shore side, which is in a full press for the drone paradigm, come down to a tension, possibly unforeseen, between concerns over maritime safety per se and the commercially efficient movement of vessels.

current state of penetrability of the Internet-based components of the E-nav paradigm, the main strategy for addressing security issues involved the use of multiple information-technology / digitally-driven systems of navigation, combined with traditional ones. In short, by all means mariners were urged to utilize a robust strategy of “Redundancy, do not depend on single point solutions.”

The Industry professionals were also realistic about the potential magnitude of the problem, but in addition were willing to speak to how to most effectively address the issue in the context of international maritime policy in statements such as “This will be a major issue. The Coast Guard has a special group of Tech experts working on Navigational cyber-security for the US. I understand the international community through IMO (International Maritime Organization) has not been as forceful with proposed regulations on cyber-security. At this point they are defaulting to the member country’s to develop their own procedures.”

Perhaps the most interesting thematic concentration among the Industry professionals focused on E-nav Facilitating, Not Replacing Traditional Maritime Roles. This narrative was summed up in pithy phrases such as “E-nav is a harmonization process and should not be confused with the generic term and use of ‘electronic navigation’”; “On the shore side quality control (aids to navigation) and proper training would also be important”; and, most notably, “Any system being developed should have local input. It benefits all”.

5.0 DISCUSSION

Recall from the literature the findings of the 2007 IALA E-navigation seminar: "…a global E-nav system is attainable and should be aggressively pursued; it should be user-driven; it should never be seen as a means of replacing Mariners or truncating their functions; functional extant methods of ensuring safe navigation should remain in place; mandatory training in E-nav is paramount; and both patent law concerning technological innovation as well as international maritime law should be respected (IALA E-navigation seminar, 2007: 1)". However, even before the writing of this paper, in 2014, the shipping industry was insistently promoting the paradigm of "unmanned" or "Remote Controlled Ships" (Levander, 2014; see also Burmeister, 2012).

This is an extremely revealing document. It shows how diametrically opposed the understanding of the essential purpose behind the conceptualization and development of E-nav is on the part of mariners when compared to the shipping industry. In fact, Levander (2014) specifically addresses many of the themes which we explored in our survey, from this alternate point of view. For example, generational factors are specifically mentioned in the presentation topic headings for this slide: "Attract young people to shipping" (Levander, 2014; see also Burmeister, 2012: 14). This could be an expression of a desire on the part of the shipping industry to vocationally market to a "screen generation" which would feel a greater affiliation to a navigation paradigm which bears more resemblance to a videogame or some aspects of the internet rather than the traditional "life at sea" narrative which motivated previous generations of mariners. In fact, the promise advanced by Levander (2014) that remote shipping would provide this new generation of mariners with a life that is "Safe…Comfortable…Close to family and friends" seems entirely opposed to the long-standing narrative construct of life at sea in Western culture. This interpretation is summed up in phrases akin to Zorba's bitter descriptive epithet[6] about the sea itself to the naïve "Boss" (Kazantzakis, 1953). Zorba is expressly referring to the frequency with which mariners traditionally lost their friends at sea, and left their families as widows and orphans.

In regards to the overwhelming thematic concern revealed in our survey - E-nav as facilitation rather than replacement of the traditional skills of mariners – Levander (2014) is explicit: "The trend is towards more intelligent and automated systems and the role of crew is becoming more supervision of the operation" (Levander, 2014: 8). Further on, perhaps in acknowledgement of the provocative nature of this kind of statement to the sea side of the maritime community, he adds "Unmanned operation is not suited for all types of ships- we will still have seafarers at sea in the future" (Levander, 2014: 8, 15). Recall that one of the primary reasons mariners expressed concern about the remote shipping paradigm involved safety. According to the mariners, over-reliance on E-nav by younger pilots and crew less experienced in traditional navigation methods was directly linked to accidents at sea (see Yousefi and Seyedjavadin, 2012). Levander's (2014) presentation of safety concerns on the part of the shipping industry centers on the promise of remote, pilotless shipping to reduce "human error" (Levander 2014: 15). Notice the opposed emphases between the narrative construction of the mariners and that of the shore side. Both attribute the occurrence of marine accidents to the action of people, not technology. However, for the mariners it is human overreliance on technology which generates these events, whereas

[6] "Listen to that Bitch- The sea…maker of widows" (Kazantzakis, 1953)

for the shore side, technology is presented as a means to remove most of the error-prone humans from the water, thereby ensuring the safety of the humans still in the process – shore-based remote controllers of ships – and increasing the guarantee of safe cargo delivery (Levander 2014: 17).

6.0 CONCLUSION

The E-nav paradigm originated as the creation of the IMO in 2007 designed primarily for the safety of mariners. The IMO has steadfastly held to its original position of E-nav technologies being used to support, rather than supplant, the traditional navigational tasks of mariners in life at sea. However, the rapidity of recent E-nav technological developments – particularly satellite-based global positioning and shore-based technologies – has created the capacity for remote-controlled shipping. In sum, regardless of the fact that mariners are opposed to E-nav tech supplanting traditional navigation rather than augmenting it, the shipping industry component of the shore side is determinedly pushing ahead with what we have referred to in this paper as the drone shipping paradigm. The needs of the shipping industry rather than the needs of the mariners themselves are what is driving the evolution of E-nav technology. In other words, to summarize the current state of E-navigation, the technology is driving the direction of mariners' navigation practice, rather than facilitating the cultural transmission of these practices to the next maritime generation. When E-nav originated with the IMO, the narrative – increased safety at sea – drove the technology. Now that the technology has advanced to a tipping point, the narrative of the shipping industry – remote shipping is safer – is driving further technological developments.

Because E-nav technology is being aggressively promoted via corporate (shipping industry) rather than maritime channels (IMO, IALA), questions of how to respond to / regulate these private products have arisen. This brings up issues regarding the relationship between E-nav and the law. Trust in the rapidly advancing technologies on the part of an older generation of mariners is an intensifying issue. For example, it is now technically possible to navigate a vessel with an "app" on a smartphone (Bergmann 2015), but a person who has spent their life at sea could be justified in wondering if this is a good thing. Liability issues come into play with technologies developed apart from the input of the international regulatory agencies. In an accident derived from overreliance a navigational app, or misadventure involving a shore-controlled ship, who is at fault? The developer of the technology, the mariner, and the shipping company all play a role in this scenario. If a mariner doesn't use the newest technology and an accident could have been avoided had they done so, are they at fault for ignoring data?

What else is happening in the world ("holism" in anthropology) which might be driving the push for drone shipping on the part of the shore side? We suggest a perfect confluence of trade-liberalization policies, technological attainments, demographic changes, and unpredicted shifts in certain elements of international relations. Specifically, the intersection of NAFTA legislation in the United States, along with the Panama Canal expansion, were in the process of ramping up anticipated global shipping traffic on their own. This increased maritime traffic pressure fueled rapid developments in E-nav technology, which led this entire navigational paradigm to be taken from the supervision of the IMO and IALA and made into the brainchild of the shipping industry. The wild card of normalization of diplomatic relations between the United States and Cuba, with its potential to shift freight from American roadways to the maritime mode via the process of Short Sea Shipping will only intensify this pressure. Finally, due to demographic changes, the European shipping industry is keenly feeling the pressure to recruit a new generation of mariners in the face of this lifeway being thoroughly unpopular with an up and coming generation; it is this labor market burden, and not concerns over labor costs, which is driving them towards the autonomous shipping paradigm, in their narrative (Burmeister, 2012).

In this context then, UNOTI's charge to cultivate a method by which to facilitate the promotion of E-nav to American mariners becomes quite challenging. The current narrative this population is faced with is that new technology is taking away not only their jobs, but their very existence. The aggressive promotion of a safety-centered narrative on the part of organized American mariners, focusing on the lived experiences which they are able to bring to the discourse, illustrating their point of view regarding the dangers of unmanned shipping – no one "looking out the window" – can form the basis of a mariner-centered pushback against the automated shipping paradigm. Ironically, by picking and choosing those aspects of the evolving technology which actually do have the potential to augment the safety of traditional methods, may result in an adoption of the very technology which they are resisting. The key is to filter or "spin" this adoption through a strong, competing narrative.

7.0 SUGGESTIONS FOR FURTHER RESEARCH

Further research directions on E-nav in the context of American mariners could have an applied focus. The goal would be the facilitation of self-advocacy on part of Mariners. Methodologically, this could be accomplished through the practice of what is referred to as a "quick ethnography" (Handwerker 2001) of American mariners, in order to capture their lived experiences as opposed to sending out a mass of standardized survey instruments. This involves the use of teams of ethnographers collecting data on a large population for purposes of time compression, and inclines heavily towards statistical thematic analysis. The mass of data analysis from a quick ethnography could be punctuated for emphasis with life histories of those mariners whose lived experiences are especially representative of the life at sea which is interpreted by some as an anachronism. The goal of this process would be the solicitation of a counter-narrative to the touted safety and demographic benefits of automated shipping.

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APPENDIX A

ANTHROPOLOGY 0.01

THIS IS A BRIEF EXPLANATION OF SOME BASIC ANTHROPOLOGICAL CONCEPTS USED BY WEBB WHICH ARE KEY TO UNDERSTANDING OUR METHODOLOGY, CONCLUSIONS, AND RECOMMENDATIONS.[7]

Culture Concept- By this time in the development of anthropology there are literally hundreds of definitions of culture. Webb has found the most utility in his research in general, and in this investigation into E-Nav in particular, in the first one recorded: "Culture or civilization, taken in its wide ethnographic sense, is that complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by [people] as [members] of society" (Tylor, 1871, p.1). Mariners are a "subculture"; Webb prefers the phrase "particular style of expressing Culture (see Hebdige, 1979). The preceding study then, involves a confrontation between the "…knowledge, belief…law, custom, and any other capabilities and habits acquired by [Mariners] as a member of [a ship's crew]" and the narrative implications opened up by rapid changes in technology.

Materialism ←→ Idealism- At one time in the social sciences, there was a gaping divide between those who saw human behavior as a response to material conditions and those who saw ideology as the driver of human action (see Harris, 2001). This conflict is generally seen as being resolved (see the introduction to Wacquant 2009[8] for an excellent summation of this resolution). The double-headed arrow indicates that these two directions work together in a feedback loop. The E-Nav example is that material conditions (increasing global vessel traffic due to trade liberalization) generated a narrative about the safety-driven need to technologically augment maritime skills. The technology then progressed to the point where it opened a window for the narrative to shift towards the desirability of remote shipping. The task for mariners now is to reclaim the narrative.

Ethnography- The written document of a witnessed population's stylistic expression of Culture. In the last forty years or so, needed emphasis has arisen for the anthropologist to detail how the life experiences which they bring to the table influence the content of this document. This principle is known as **reflexivity.**

Participant-Observation- A technique to make the witnessing process more authentic, in which the anthropologist walks the cognitive line of being "in the shoes" of the people observed, while simultaneously maintaining the detachment to accurately describe what behaviors are actually occurring.[9] This is such a feat of mental gymnastics that some modern anthropologists doubt its feasibility. The original anthropological style is referred to as "Observer as participant- role of researcher is known" (Creswell, 2014: 191).

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[7] Webb has an extremely conservative theoretical orientation, and some of his discussions – such as that concerning the Culture Concept – will elicit a great deal of protest from the wider anthropological community as being "outdated".

[8] The politics of this volume are irrelevant to the topic of E-Nav. It is referenced for the quality of its summation of the resolution between materialist and idealist approaches to social science research.

[9] For the record, it must be said that the average anthropologist would probably not make it through the day of a typical Mariner.

Life History Analysis- The collection of spoken autobiographical narratives from participants for the purpose of obtaining a transcript, which can be analyzed in a variety of ways (Cole, 2001). Webb's preferred analytical mode is content analysis to gain a statistically valid sense of what themes are of the greatest significance to the members of the population.

Etics/Emics- These terms are derived from linguistics, referring to the inner units which compose a single word – phon*emes* – and the function of the whole word as a unit of the larger meaning of the sentence, known as phon*ics* (Pike, 1967). The idea is that different styles of Culture are composed of inner meanings significant to the participants. The external meanings, which are documented by the anthropologist, are often quite different. The distinction between etics and emics in anthropology for this study concerns the effective development and implementation of E-Nav in relation to the emphasis on "…local input". Etics is not only "the outsider's view", but also the outsider's understanding, their frame of analysis, of the true meaning of the phenomenon. Emics is "the insider's" frame of reference. The emic concept has to do not only with the idea that, for example, If You Want to Learn How to Bake Bread, Ask A Baker, but also with the different meanings of "bread" to the baker and the eater. This is critical to understanding where E-Nav has been and is potentially going. The etic/emic piece is at the heart of the whole E-Nav discussion, because it goes to the issue that how you understand E-Nav depends upon who you are and what your stake in the technology is.

Contrast between the Ideal and the Real- Understanding the difference between the ideals promoted by a given stylistic expression of Culture and what actually takes place in the population under examination is one of the fundamental goals of anthropology (Scupin, 2012). The tie-in with the concept of etics/emics is apparent.

APPENDIX B

SURVEY INSTRUMENT

2015 UNOTI E-Nav Survey

1. **What are the best ways to incorporate E-Nav with the traditional role of Mariners?**

   Click here to enter text.

2. **Are the different rules of navigation along the world's coastlines and rivers a problem for E-Nav? Please explain.**

   Click here to enter text.

3. **Problems involving software / hardware failure and / or hacking of E-Nav technologies –"cyber-security" – are inevitable. What are the best ways to cope with these problems when they arise?**

   Click here to enter text.

4. **Which E-Nav technologies are the most vulnerable for cyber-security?**

   Click here to enter text.

5. **Is there anything else about E-Nav which you would like us to be aware of?**

   Click here to enter text.

On behalf of UNOTI, thank you very much for participating in this survey!