Proceedings of the 5th International Conference on Applied Human Factors and Ergonomics AHFE 2014, Kraków, Poland 19-23 July 2014
Edited by T. Ahram, W. Karwowski and T. Marek

Voice and Text Messaging in Ship Communication

Thomas Porathe, Peter Eklund, and Henrik Goransson

Department of Shipping and Marine Technology
Chalmers University of Technology
Gothenburg, Sweden

ABSTRACT

Misunderstandings in voice radio communication have been identified as a root cause of accidents at sea. One reason is language problems in a multi ethnic industry. Standard Marine Communication Phrases (SMCP) was developed by the IMO to mitigate this problem, but studies show it is not commonly used. Difficulties to pronounce and understand English spoken by different nationalities adds to the problem. Maybe text messaging could be useful in non-time critical marine communication? This paper presents a study where VHF voice versus text messages in a land-based deep sea pilotage scenario was compared. The finding was that text based messages worked well and that there was a lower risk of misinterpreting the information.

Keywords: misunderstanding communication, e-Navigation, MONALISA, VHF voice communication, text communication

INTRODUCTION

In 1912 after the Titanic accident the British postmaster general summarised: "Those who have been saved, have been saved through one man, Mr Marconi...and his marvellous invention“. Mr Marconi was of course the inventor that at the turn of the century 1900 was experimenting with wireless telegraph systems that also could be used on ships. In August 1912, as a result of the Titanic disaster, the Radio Act of 1912 was passed in the USA mandating that seagoing vessels continuously monitor distress frequencies. Ever since, radio telegraphy and later radio telephony, allowing messages to be exchanged by voice, has been a part of the marine safety environment. Today all bridge officers are accustomed to close range VHF radio communication. However, in the increasingly multi ethnic shipping domain the issue of language difficulties and misunderstandings has become a real problem. At the *Scandinavian Star* accident in 1990 the loss of lives was probably made worse by the language difficulties in the inter-ship communication (Diaz Pérez, 2003) and in 1996 the crude oil carrier *Sea Empress* spilled large amount of oil into the sea outside Milford Haven in the U.K.. This accident was made worse by the fact that a close by, large Chinese tug boat could not be used due to language difficulties (Diaz Pérez, 2003).

In meta-studies on accident root causes, misunderstanding in voice communication has been identified. Lee and Parker (2007) identified a number of factors leading to collisions at sea, among the more prominent factors we find

- Communication problems. The most frequently made mistakes were lack of communication and misinterpreting information.

In 2001 the International Maritime Organization (IMO) ratified a resolution adopting what was to be called Standard Marine Communication Phrases or SMCP in short. SMCP is a dictionary of standard phrases with the explicit aim of providing a communications toolbox that will minimize the risk of misunderstanding and ambiguity in voice communication (IMO, 2002).

In a study 2013 Nilsson recorded 168 hours of VHF communication between a Vessel Traffic Service (VTS) point and ships within that Ship Reporting Area and analysed the use of SMCP and misunderstandings. Although the narrow context of ship reporting, Nilsson found that SMCP was rarely used. However, he also found that misunderstandings seldom occurred. Nilsson concludes that “communication, even in this simple and narrow context, is too complex to be adequately pre-scripted” (p. 58). He argues that time on maritime colleges would be better spent teaching general English. The first author of this paper spent four month at a far east Asian maritime college in 2011 working with 4th year cadets, all of whom had passed the SMCP course stipulated by STCW, but none of whom could speak a word of English why all communication had to be done through interpreter.

The International Maritime Organization in 2006 started the work on a concept called “e-Navigation” (IMO, 2006). e-Navigation is defined as *the harmonized collection, integration, exchange, presentation and analysis of marine information onboard and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment* (IALA, 2014). The driving force behind this initiative was a concern among many stakeholders that lack of standards made development of new applications difficult and that the possible benefits of integration could not be reached. The important aspects were safety and efficiency and in the centre stood the human element that had to deal with a plethora of unintegrated systems. Much information necessary to solve real world problems was already out there, but needed to be made available in a human friendly way. Some of the misunderstandings leading to accidents could perhaps avoided by presenting the information in a more effective way.

In the ongoing e-Navigation project ACCSEAS (2014) a focus group interview with pilots, port authorities and VTS operators in a European harbour area was conducted by the first author of this paper. The aim was to investigate efficiency problems and possible e-Navigation solutions with ships transiting in and out of the port area. One finding was that misunderstanding VTS instructions was a quite frequent problem. For example, to bring out the very deep draught ships the northern part of the inbound (west – east going) channel had to be used (see Figure 1). During the time an outbound vessel had to contravene the inbound channel, inbound ships were instructed by the VTS to use “the southern part of the inbound lane.” Instead vessels frequently misunderstood this instruction and used the outbound channel which was located just south of the inbound channel.

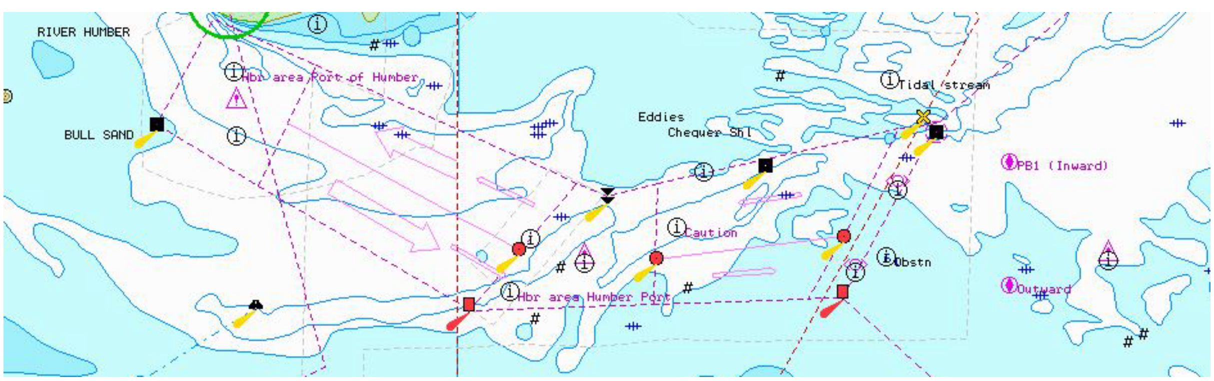

Figure 1. The TTS outside the river Humber in the U.K. Very deep draught ships has to transit the northern part of the inbound lane going both in and out due to limited under keel clearance. In such cases where an outbound ship uses the inbound lane, inbound ships are instructed to use “the southern part of the inbound lane”. This instruction is often misinterpreted to “use the southern (outbound) lane”

One may wonder why the instruction in is not understood? Whether it has to do with language problems or other difficulties to understand the content of the instruction? The proposition was that written instructions that could be easier to understand.

Another example, in this case regarding forgetting instructions, was given by a Rotterdam pilot (personal communication, 2013). Voice VHF instructions are given to vessels inbound to the port of Rotterdam as to in which turn they should arrive at the pilot pick-up station to receive pilot. (The area around Maas centre buoy in the red circle in Figure 2.)

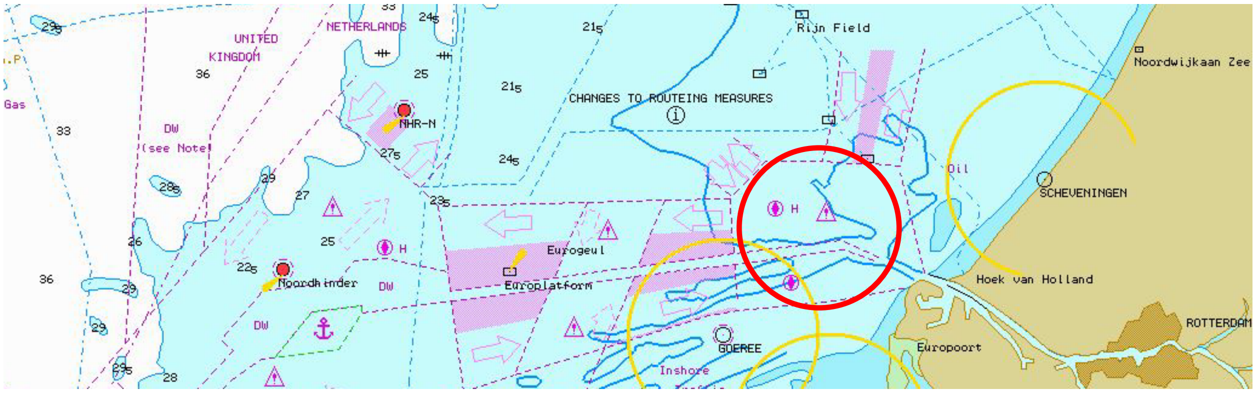

Figure 2. The pilot pick-up area outside Rotterdam in The Netherlands. Three TTS come together in this area creating an often complex traffic situation around the Maas Centre Buoy (in the middle of the red circle. Pilot instructions radioed to incoming ships about in which order to arrive is often misunderstood.

The instructions were given in the format "M/V Alpha, you are number one, M/V Beta, you are number two, M/V Gamma, you are number three, etc." Due to the traffic intensity into the port of Rotterdam this list can at times be quite long and it is important that the ships keep this order when arriving at the pick-up area because of the logistics of the pilot boat that delivers the pilots on-board the different ships, and also of the following transit logistics in the port area.

However the information was often misunderstood or forgotten and the pilots have to repeat this information.

The question arises if providing a text based messaging system to complement voice VHF communication in some cases could bring safety and efficiency benefits? In the ongoing MONALISA 2.0 project (2014) a small text messaging system, maybe included in a future electronic chart system, has been proposed for investigation (see Figure 3).

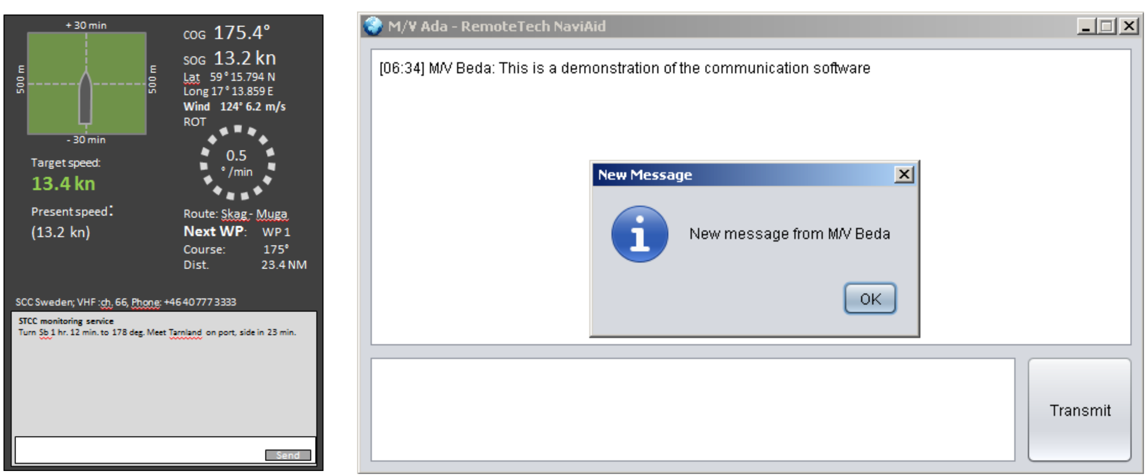

Figure 3. To the left one proposed floating window in a prototype MONALISA nautical chart interface. To the right the simplified text messaging interface used in the study described below.

A small pre-study comparing acceptance and efficiency of voice versus text based navigational advice in a land based deep sea pilotage scenario, is now presented.

METHOD

This study was conducted for a diploma thesis at the master mariner program at Chalmers University of Technology. The two 4th year cadets, Peter Eklund and Henrik Goransson (2013), compared VHF voice call versus text messages as means to send navigational advice from shore to vessels in a deep sea piloting scenario.

Participants

The study was conducted in the simulator centre at the Department of Shipping and Marine Technology using 9 Swedish participants. Four was experienced watch officers and five were 4th year cadets at the master mariner program, all with watch keeping experience. Their ages spanned from early-twenties to mid-forties with the average age of 26.

In order to avoid learning effects each participant only participated in one trial, either getting navigational advice by voice or by text. The participants were randomly drawn to each condition so that 3 cadets and 2 officers became allocated to the text condition and 1 cadet and 3 officers became allocated to the voice condition.

The study

Two Kongsberg bridge simulators of the standard type used by the master mariner program to train navigation (see Figure 4) were used for the study.

Figure 4. One of Chalmers bridge simulators of Kongsberg's make. The cadet to the right is using the VHF radio telephone hand-piece to communicate.

The simulator bridge was equipped with radar and an electronic chart system (ECDIS). The surrounding environment was visualised on screens in the bridge windows.

For the simulation the passage through the Great Belt strait in Denmark using the Route-T was chosen. This is the way out of the Baltic Sea to the North Sea for deep draught vessels (max draught 16.4 meters). In this area it is recommended, but not mandatory, for all ships with a draught of 11 meters or more to take on-board a deep sea pilot (Danish Maritime Authority, 2013).

The participants were conning a 294 metres long container vessel with a breath of 32 meters and a draught of 11 meters. For the simulation was chosen an early morning (8.00 A.M.) with moderate traffic density in the straight. The weather situation was chosen to be clear skies, and moderate wind and current. A normal day.

Each test lasted about 30 minutes, and three navigational messages were sent with appropreate time for the participants to react and manoeuvre. The messages were sent at the same time in each test using either VHF voice call or as a text message to the prototype text application shown in Figure 3, right.

Scenarios

Message 1 (sent as the ship approximately passed position A in Figure 5):

> *"An uncharted obstruction has been reported in position 55° 17,5' N 011° 04,0' E. All ships are advised to keep a distance of at least 2 cables from this position."*

This instruction was designed to be a clear and concise instruction of the type usually transmitted as navigational warnings through NAVTEX or other similar communication channels, and containing a position spelled out in the form of latitude and longitude.

Message 2 (sent as the ship approximately passed position B in Figure 5):

> *"Due to migrating sandbanks the charted depth in the eastern lane of the TSS may be incorrect. To avoid unexpected squat or banking effects it is recommended that you keep in the westernmost half of your traffic lane during the transit through the TSS under the Great Belt Bridge."*

This instruction was designed to be less strict and concise and more "chatty" with superfluous information about the background and the consequences in a manner more akin to how a navigational instruction might sound if given by a pilot located aboard the vessel.

Message 3 (sent as the ship approximately passed position C in Figure 5):

> *"Due to a strong anomalous easterly current in the area north of the Great Belt Bridge it is recommended that you keep tight on the fairway buoy no 26 as you turn around it to course 327º, but do not cross over into the oncoming lane."*

This instruction was intentionally malformed. The fairway buoy no 26 is the second to last fairway buoy and as such it is impossible to turn around it to course 327º without crossing over into the oncoming lane, the instruction as such is logically inconsistent. This instruction was design to determine whether the participants would ask for clarification, or just go ahead with their assumption of what was intended.

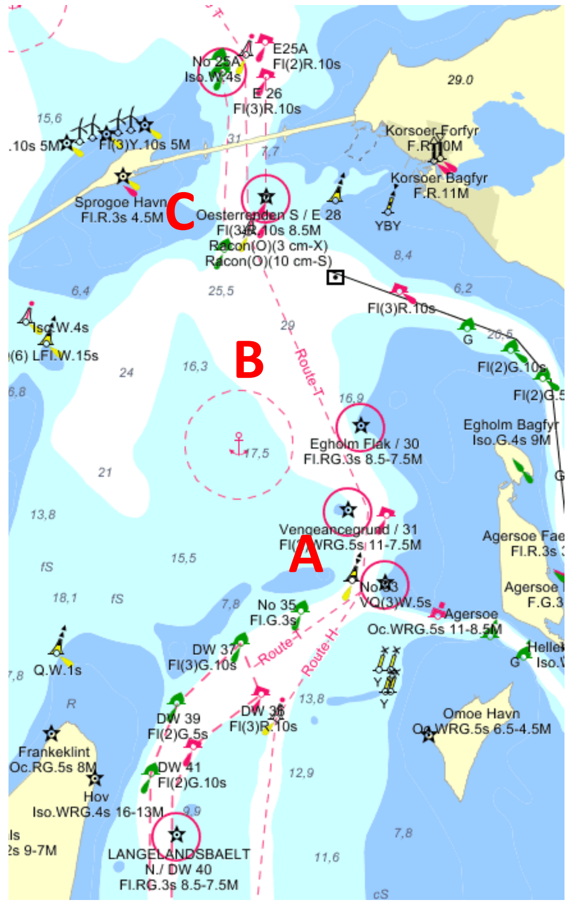

Figure 5. The test area south of the Great Belt bridge in Denmark. The three messages sent by either VHF voice call or text message were transmitted at about the three points marked A, B and C.

RESULTS

"Closed loop communication," as mentioned below, is a communication technique whereby the receiver repeats the information given, and the sender finally closes the loop by acknowledges that the information was transferred correctly.

The findings below are quoted from Eklund, and Goransson (2013).

Instruction 1

Out of the four participants who were communicating over VHF radio, all four responded in some way to the given instruction. Two participants responded with proper closed loop communication. One of the participants misunderstood the given position, but this was discovered and corrected in time due to the use of closed loop communication. None of the participants who were communicating over VHF radio asked any additional questions.

Out of the five participants who were communicating over the text based chat, two responded in some way to the given instruction. None of the participants responded with closed loop communication. None of the participants misunderstood the position. One of the participants who were communicating over the text based chat asked follow up questions pertaining to the safe speed at passing the obstruction as well as directions to whether going east or west of the obstruction was recommended.

The time it took from the point at which the transmission of the instruction begun until the point at which the turn brought into action as a result of the instruction was completed and the ship's heading line was pointing outside of the area that was to be avoided, was on average the same for the participants from the group consisting of last year students and the participants from the group consisting of nautical officers. The participants who were communicating over the text based chat took, on an average, two minutes and fifteen seconds less than the participants who were communicating over VHF radio to complete the same turn,

Instruction 2

Out of the four participants who were communicating over VHF radio, all four responded in some way to the given instruction. One participant responded with proper closed loop communication. Two of the participants responded with a rudimentary type of closed loop communication, but left out the repetition of some of the vital parts of the instruction. One of the participants did not use closed loop communication at all when responding to the instruction. One of the participants asked for the question to be repeated and then asked if it was correct that they were to travel in the western – that is the south going – traffic lane. After receiving the reiteration that they were to go in the “westernmost half of the eastern lane”, the participant in question then responded with “OK”.

Out of the five participants who were communicating over the text based chat, two responded in some way to the given instruction. None of the participants responded with closed loop communication. None of the participants who were communicating over the text based chat asked any additional questions.

Two of the four participants who had been communicating over VHF radio stated that they (wrongly) interpreted the instruction only to concern the area south of the Great Belt Bridge. The other two participants stated that they interpreted the instruction to concern the entire length of the TSS, both north and south of the bridge.

All of the five participants who had been communicating over the text based chat stated that they interpreted that the instruction to concern the entire length of the TSS, both north and south of the bridge.

Instruction 3

Out of the four participants who were communicating over VHF radio, all four responded in some way to the given instruction. One participant responded with proper closed loop communication. Three of the participants did not use closed loop communication. Two of the participants asked for the question to be repeated. One of the two participants that asked for the instruction to be repeated then immediately moved over to the chart table and studied the nautical chart while the message was repeated.

Out of the five participants who were communicating over the text based chat, two responded in some way to the given instruction. One responded right away after reading the message with the message “well received”, and the other one responded with the message “ok” approximately four minutes after reading the message. None of the participants responded with closed loop communication.

None of the participants who were communicating over VHF radio asked for a clarification of the malformed message. When probed by the master of the vessel, all four participants stated that there were no uncertainties about the upcoming situation. Two of the participants mentioned that the pilot had given a somewhat confusing instruction, but that they assumed that it obviously was the fairway buoy no 25A that they were supposed to turn around. One of the participants, however, explained that the pilot had instructed him to keep tight on the lateral buoy no 26E as he turned to course 327°, which the participant in question also later did.

Three of the five participants who were communicating over the text based chat wrote back to the pilot, asking if he perhaps was referring to the fairway buoy no 25A. Two of the participants did not ask any such questions. When probed by the master of the vessel, all five participants stated that there were no uncertainties about the upcoming situation. Two of the three participants that had asked about which buoy to turn around mentioned that the pilot initially had sent an incorrect instruction but that it later, upon questioning, had been corrected.

Notes from the debriefing

One of the participants, who had been communicating over VHF radio, stated that he felt it was easy to miss vital parts of the message, for example to only hear the word “buoy” when the message was referring to a “fairway buoy”.

Another participant, who had been communicating over the text based chat, mentioned that, due to the fact that the text messages would remain in the message log, the next officer taking over the watch would not have to rely on second hand information from the previous officer but could instead read the original messages himself.

Three of the participants expressed the feeling of comfort in being able to go back and read the instructions several times to make sure no part of the message was overlooked or misinterpreted.

Three of the participants reflected on the necessity of writing down the message when receiving it over VHF radio in order to remember it. One of the participants commented that even though the participants in the simulation had pen and paper readily available, this is not always the case in real life situations and that writing down the message is not necessary when using the text based chat.

One of the participants, who had been communicating over VHF radio, reflected on the perceived expectation of the receiver to drop the task at hand and immediately respond to radio communication. Another participant, who had been communicating over the text based chat, expressed the feeling that it was easier to choose when to read the message and for instance finish the task at hand before tending to the communication.

DISCUSSION

One of the most striking differences between the two modalities of communication was the difference in tendency for the receiver to respond to the messages. All the participants who had been communicating over VHF radio responded in some way, be it only a short “OK” or by using proper closed loop communication. The participants who had been communicating over text based chat did not always respond. Some participants chose to respond to every text message with a short acknowledgement, whereas others only responded when they needed a clarification of the message. This might be due to the fact that there at the present time is no formal education in the use of real time text communication during the training to become nautical officers, as there is for radio communication (STCW, 2011).

None of the participants who had been communicating over the text based chat used closed loop communication.

One factor leading to the lack of closed loop communication by the participants using the text based chat might be the fact that all sent and received messages are readily available in the message log to both parties of the communication. As Grech et al. (2008) states, one of the primary reasons for using closed loop communication is reducing the risk of the message received not being identical to the message sent. When both parties in the communication have all the sent and received messages readily available and they have no apparent reason to mistrust the system's technical integrity, the perceived need to use closed loop communication seems to be reduced. However, another point raised by Grech et al. (2008) is that it is easier to recognise that a mistake has been made if the message is spoken out loud. This positive aspect of closed loop communication is lost when using text based communication in the way it was used in the simulation study of this thesis.

There was also a difference in the type of questions asked by participants using the two different modalities of communication. The participants who had been communicating over VHF radio had a strong tendency to only ask for general repetition of information already given, whereas the participants who had been communicating over the text based chat tended to ask for additional information or for specific clarification of already given information.

It will be of great importance, if text based communication is to become reality, that some way of acknowledgement of information designated to an individual vessel is reported back to a sender. Transmission equipment might very well report that a message was delivered to a text application, but there should also be an acknowledgement that the message has at least been read.

Another difference between the two modalities of communication was the difference in tendency to make assumptions. The participants who were communicating over the text based chat were less prone to make unfounded assumptions regarding the instructions and were more prone to ask follow up questions when needed because of contradictions in the instructions.

The average time from the beginning of the transmission of the instruction, to the point at which the corresponding action had been completed, was shorter for the participants who had been communicating over the text based chat. This can be attributed to the time it took to transmit, and in some cases repeat, the instructions. When the instruction is sent as a text message the recipient can read it at normal reading speed, whereas if the instruction is sent over VHF radio, it has to be read out aloud at a speed slow enough for the recipient to correctly receive it and also be able to write it down. It might also be necessary to repeat important parts of the instruction or in some cases the entire instruction. This naturally leads to a longer period of time before action in accordance with the instruction can be taken.

Some of the participants reflected on the perceived expectation to immediately tend to VHF radio communication, whereas some of the participants who had been communicating over the text based chat stated that they felt that they could choose, to a larger extent, when to tend to the communication. While the increase in freedom of choice of when to tend to the communication can lead to a decrease in the level of stress perceived by the navigational officers, this can lead to an increased risk of not tending to time-critical communication in time. However, this increased risk can be mitigated by dividing information into two different categories; information that is time-critical and information that is not time-critical. The information that is time-critical is probably best sent over VHF radio, whereas the information that is not time-critical can be sent over the text based chat. In fact, by transmitting all information that is not time-critical over a text based medium, instead of over VHF radio, the risk of non-time-critical communication tying up the VHF channel when time-critical information needs to be transmitted is reduced.

Should a text based communication system, additional to the existing voice based, be one application in the e-Navigation concept? Some initial examples of problems which might be mitigated with text based communications were given in the introduction of this paper. The study presented above indicates that a potential to avoid some types of misunderstandings.

For future research, an area of computer aided SMCP editors could be investigated; maybe even comprising automated translators so that messages can be constructed in one language and received in another. Safety issues will of course be crucial to ensure that the message sent is actually what was intended.

CONCLUSIONS

Text based messaging systems to exchange information was found to be a possible compliment to the traditional voice based VHF radio communication. Professional bridge officers and 4th year cadets found receiving text based navigational instructions in a land based deep sea pilotage scenario less stressful that receiving voice calls which they felt was necessary to attend to immediately. However, for time critical responses VHF was prefered.

The study found that when using a text based mode of communication for transmitting navigational instructions there was

- a lower risk of the receiver misinterpreting the instructions,
- a lower risk of the receiver making his or her own unwarranted assumptions regarding the meaning of the instruction,
- less need to spend time on repeating the instructions,
- a decreased tendency for the receiver to respond to the instructions, and
- an increased tendency for the receiver to ask relevant follow up questions in order to clarify a confusing instruction.

ACKNOWLEGMENTS

The major part of this paper consists of quotes or summaries taken from the diploma thesis of Peter Eklund and Henrik Goransson at the master mariner program at Chalmers University of Technology 2013. The diploma thesis will in due time be available at http://publications.lib.chalmers.se/

This work has been a part of the project MONALISA 2.0, which is funded by the European Union's Seventh Framework Programme for infrastructure TEN-T, and also from the Region Vastra Gotaland.

REFERENCES

ACCSEAS, (2014), http://www.accseas.eu/ [acc. 2014-03-15]

Danish Maritime Authority. (2013) "*Navigation through Danish Waters*". Website: http://www.soefartsstyrelsen.dk/SiteCollectionDocuments/Publikationer/Navigation/NtDW.pdf [Acc. 2013-12-29].

Diaz Pérez, J.M. (2003), "*IMO Standard Marine Communication Phrases and teaching their use in VTS-context*". Bulletin de l'AISM, 20-33.

Eklund, P. Goransson H. (2013), "*Texting while piloting: A simulation study comparing verbal and written navigational instructions in shore-based deep sea pilotage*", Diploma Thesis for the Master Mariner Program, Gothenburg, Sweden: Chalmers University of Technology.

Grech, M.R., Horberry, T.J., Koester, T. (2008), "*Human Factors in the Maritime Domain*". Boca Raton: CRC Press.

IALA, (2014), "e-Navigation". Website: http://www.iala-aism.org/committees/enav.html [acc. 2014-03-15]

IMO, (2006). "*Aids to navigation in a digital world*". Keynote address by Efthimios E. Mitropoulos, Secretary-General of the International Maritime Organization, Shanghai, 22 May 2006. Website: http://www5.imo.org/SharePoint/mainframe.asp?topic_id=1322&doc_id=6334 [acc. 2014-03-15

Lee, G. W. U., Parker, J. (2007), "*Managing Collision Avoidance at Sea: A Practical Guide*". London: The Nautical Institute.

MONALISA, (2014). Website: http://monalisaproject.eu/ [acc. 2014-03-15]

Nilsson, A.N.R. (2013), "*Ship-to-Shore radio calls within a SRS: The use of SMCP as pre-script and framework in complex communication*". Master's Thesis, Gothenburg, Sweden: Chalmers University of Technology.

SMCP. (2002), "*IMO Standard Marine Communication Phrases*." London: International Maritime Organization.

STCW, (2011), "*International convention on standards of training, certification and watchkeeping for seafarers*". London: International Maritime Organization