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Dangers of overreliance on ECDIS and paper chart navigation

Differences, advantages and disadvantages of navigating by ECDIS and paper charts

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Abstract

In this thesis I explore the possible dangers of overreliance on ECDIS and paper charts, focusing on the advantages and disadvantages of using one or the other form of navigating. While the introduction of ECDIS has revolutionized navigation by enhancing the accuracy, efficiency and convenience. Although overreliance on systems like ECDIS poses risk, as evidenced by several maritime accidents. On the other hand, paper charts, less prone to technical failures in comparison to their digital counterparts, are susceptible to errors due to outdated information or human error in manual plotting. Through a combination of literary reviews and interviews, this study examines the impact of digital navigational equipment on navigational practices and its potential dangers. Findings highlight a divide amongst the officers: while younger officers tend to rely on digital systems and tend to not outright question the information given to them by these systems, the older officers emphasize the importance of scepticism and importance of cross checking the information.

Language: English

Key Words: ECDIS, Paper charts, Navigation, Overreliance

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1 Introduction

The Electronic Chart Display and Information System (ECDIS) has revolutionized maritime navigation, by offering precision, efficiency and convenience. On modern ships, it integrates real-time positioning with digital charts, in turn reducing the workload for navigational officers. However, such incredible advantages can not come without their disadvantages. That is what is explored in this thesis, what dangers over-relying on ECDIS entails, comparing ECDIS to traditional paper charts and whether the issue of over-reliance can be combatted.

1.1 Background

The thing that initially inspired me to write this work was a combination of different factors all adding up to each other at perfect times. Having been on many different types of cargo vessels I have noticed that some do not carry the paper chart necessary for their voyages. On top of this, some of the younger officers when asked if they knew how to use a paper chart they answered with a simple “No”. Afterwards I realized that, with the introduction of such tools as ECDIS many new officers don’t see need in paper charts anymore, since anything a paper chart can do ECDIS can as well, with more on top of it. But this is not something that happens once in an industry, it will keep happening going forward as technologies get better.

Now the talk in the digital world is AI, and it is understandable, since it is an amazing tool that borders on science-fiction. Still, AI technologies are nowhere close to being complete, or at a level where their operation can be considered sufficient, and yet there are already people talking about incorporating this bleeding edge tech into the maritime industry. If we look back in history, a similar situation has already happened. A new more advanced technology compared to its predecessor. Although it should be said that back then it wasn’t as big a jump as with AI, yet still it was a big enough shift for some people to be sceptical about its introduction. The process was the introduction of ECDIS on board vessels.

A little bit over 13 years ago an amendment was passed to regulation v/19, which made it mandatory for all new ships built to have ECDIS already installed and currently active ships to install ECDIS onboard. When you look at it one-way ECDIS is a tool which makes the everyday of navigation easier to a degree. That is all ECDIS is – a tool, although time and

time again, accident after accident it was shown that through inexperience, ignorance the people responsible for the navigation do not know how to properly use the digitalized equipment on-board to help them with their given task. Of course, with the amendment came the requirement for those responsible for navigation to take course and have a certificate that indicates the completion of training on ECDIS. This is good practice all around, but different versions of ECDIS exist, making it difficult for technologically inept people it harder to use it to its full potential. Whereas paper charts are universal, if you have the knowledge of how to read a paper chart you do not need to waste time with settings, the user interface and everything else present in ECDIS. The tools to make a route plan with the help of a paper chart are also the same every single time you make a route.

In this thesis I will explore the implications of digitalization of navigational equipment, compare the advantages and disadvantages of paper charts and ECDIS, and probe the depth of challenges and opportunities laying ahead of the industry and how the human factor plays into all of it. By looking back at the past of maritime industry and its relationship with the digital world we can make assumptions about the possible future, yet we can only guess the impact it will have on the industry and how the process of navigating will be conducted.

1.2 Aims and objectives

With this thesis I intend to explore what effect the digitalization has on the current and future work force, mainly bridge crew responsible for the navigation of vessels. As well briefly touch on whether overreliance on one way of navigating could impact the operation of a vessel. With all this stated I aim to tackle these following questions.

1.3 Research questions

I. How does over-reliance on digital means of navigation affect vessel navigation?

II. What can be done to minimize the reliance on digital equipment?

1.4 Research Methods

For this thesis I mainly utilized a literary review of existing written material, with interviews to compare. Several articles and existing papers written on the topic or in similar nature, sourced from Novia using Alma-Novia. As for the interview, I chose to interview the bridge crew members (navigational officers, chief officers and officers of watch), since they are the ones utilizing the equipment and interacting with it the most. The interview focused on getting to know the experiences the officer had with the digitalization on-board vessels and to get an understanding of the officer's stance on the rapid introduction of newer technologies as well as how it has affected the workforce in the past and how it can affect it in the future. I will go more in-depth on the nature of the interview in the "interview analysis" section of this paper.

2 Literature review

This section will provide definitions and explanations of what and how ECDIS operates, what paper charts are. As well as explore a handful of accidents caused by over-reliance on either ECDIS or paper charts.

2.1 ECDIS and paper charts

ECDIS – Electronic Chart Display and Information System, is a navigational information system that incorporates and displays information from various other navigational equipment. While it is hard to pinpoint who invented the modern ECDIS and who produced the first modern ECDIS, the first mention of something like ECDIS goes back to 1952, when a theoretical concept combining radar imagery and digitized chart data. By 1985 US Navy started using electronic chart data on board military vessels. Only at the end of the century the standards for ECDIS were introduced and the trend of moving away from paper charts started (Ian Grainger, 2023) (International, 2010). To comply with IMO standards, ECDIS must receive information about the exact position, heading and speed of the vessel. These sensors are required for ECDIS to fully function: GNSS receiver, gyro compass and a speed and distance measuring device. Additional sensors can be connected to compile even more information, such as: echosounder, radar, AIS, autopilot, NAVTEX and many other. With all this information available in one place it makes the job of the Officer of Watch (OOW)

easier to some degree. Using all the information gathered the OOW must make decisions to navigate efficiently through waters. Information provided by the ECDIS is obtained by sensor, sensor that have their limitations and setbacks. On top of this, ECDIS being a digital medium is open to cyberattacks and malfunctions. While ECDIS has its advantages it has its disadvantages as well, the officer should always keep this in mind and cross check the information with visual conformation.

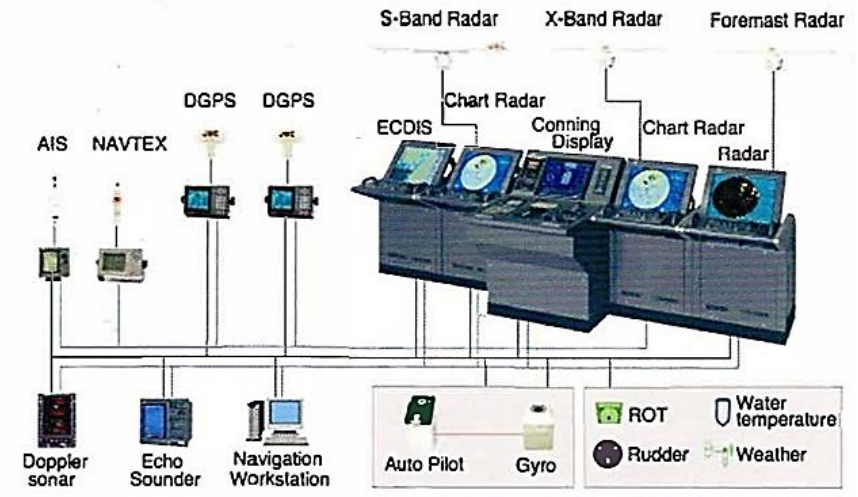

Figure 1 ECDIS and other station and how they exchange information (Communication and radionavigation, 2021)

Paper charts or nautical charts - a graphic representation of sea routes, coastlines and islands. Paper charts have been used extensively through out history as the main method of navigation through water. A paper chart, compared to ECDIS, does not offer as much information to the officer. Typically, a nautical chart will show depth of waters, features of the seabed, detailed coastlines, navigational hazards, natural and man-made navigational aids, tide and current information. Navigating by paper charts is harder, since the officer will do most of the heavy lifting. Checking for underwater hazards on the route plotted, correctly calculating the distance and heading required, to name a few. This forces the officer, to a certain degree, to stay vigilant and keep his mind on the navigation. Although it is harder to do and more reliable, since the paper chart cannot give out incorrect data, it is not without flaws. Paper chart relies on surveys to get the correct depths and any underwater hazards and as will mentioned later, it is not always possible to map out the seabed with a hundred percent of accuracy.

2.2 Causes and effects of over-reliance on ECDIS

Relying heavily on a single piece of equipment is something that is rather common, and understandably so. It is easier to look at one screen with all the necessary data piled up than to cross check each piece of that data with secondary sources. This is something that everyone at some point has been guilty of, but being sceptical of the equipment used will go a long way in ensuring that good seamanship is maintained. Over-reliance on digital navigational equipment is not a new phenomenon, it has been happening for quite some time.

In an article (Wingrove, 2014) published by Martyn Wingrove in August of 2014, Tony Brown, MAIB principal inspector mentions an incident where a tanker hit a sandbank in the Dover Strait while navigating by paperless navigation. In the article Tony suspects that the incident occurred because of young, inexperienced officers; incorrect configuration of ECDIS and no positional awareness. In the mentioned article, very little is described about the incident, since at the time Tony was not able to give out more information, because the investigation was still ongoing. An accident report sounding very similar to what was described can be found on the MAIB website (MAIB, GOV.UK, 2015), and the dates line up well with the time of this article being published. On September 18, 2013, a Malta registered tanker, Ovit, ran aground in the Dover Strait. Ovit's primary navigation was ECDIS, and the officers followed the route as the grounding occurred. UK MAIB Accident report 24/2014 (MAIB, GOV.UK, 2015) states that: the passage was planned by an inexperienced officer and the plan was not checked by the master, the ships position was monitored only by ECDIS, the scale was not configured correctly and did not show the correct depths. Through this we can conclude that over-reliance on a specific piece of digital equipment and incorrect use of said equipment caused the accident. Whether or not this incident could have been avoided if the bridge crew checked the route plan with a secondary source, such as a paper chart or even just cross checked the position with navigational markers can not be said with hundred percent certainty. But with more sources of information, the chance of successful, incident-free voyage adds more room for error for to be noticed and fixed. Scouring through the MAIB Accident reports lot of similar sounding cases can be found from all of them the same lessons can be learned: 1. If ECIDS is the main navigational equipment onboard double checking the route plan should be done always, cross checking with secondary sources is also a viable option. 2. Avoid relying

solely on ECDIS for route monitoring. Radar, echo sounder and good old visual conformation are good ways to keep on the correct route. 3. Set up the crucial system used for navigation up correctly. Alarms should be set to the appropriate values for the route.

Potential causes of putting so much trust into digital equipment could be from the false notion that these systems are “near perfect”. Dana Goward of the Resilient PNT Foundation has said in an article (Cameron, 2017) by Alan Cameron, “Because it could exacerbate the public’s growing over-reliance on, and often blind faith in, GPS.” This could be one of the causes of why so many people put their trust in digital navigation. Using a device that does most the heavy lifting for you is convenient, but, as all things, it does not work perfect all the time. A GPS signal can get spoofed rather easily by either personal devices, solar activity or even the local geography.

2.3 Over-reliance on other digital equipment

While nowadays we have many different pieces of technology to help us navigate safely through waters back in 50s-60s this was not the case. Radar is a sensor used for detecting objects at distance. It operates by sending out an electromagnetic wave out with the target then reflecting the wave and observing the echo returned (Skolnik, 2024). In 1956, during which time radar was started to be used heavily for maritime navigation, the collision of two passenger ships made waves through the industry in how the technology should be used. Stockholm and Andrea Doria (Bec, 2024) collided with each other because both misread each other’s course on radar resulting in a staggering loss of life. After the incident mandatory courses and training programs were made mandatory to avoid similar situations happening. This just goes to show that not all the equipment is always correct, if the officer on watch is unsure of something regarding the passage the officer must look to other means to confirm the information given. Nowadays the radar image can be overlayed on-top of the ECDIS screen. This helps with confirming own position in regards not only to other vessels but also navigation buoys and other notable landmasses as an example.

Another piece of digital navigational equipment that is widely used is the AIS or Automatic identification system. The system provides vital information between ships, yet the information can be out of date and some smaller ships are not at all equipped with the system. Now a worrying growing trend has started to emerge where the AIS signal is

spoofed deliberately. Transmitting incorrect data has grown in the recent times and presents a growing risk in the industry. Several incidents have already occurred due to incorrect AIS data and over-reliance on said data, one such case in the collision of cargo ship Rickmers Dubai and crane barge Walcon Wizard (MAIB, GOV.UK, 2015). While the AIS is a very good system it is not without its flaws and, as with everything, should be solely relied on for navigational duty.

Chart data is something that is very hard to always keep fully accurate, especially in areas not so heavily trafficked (Amos, 2020). Chart data could be out-date and should always be checked before making any crucial decisions. ENC data relies on the quality of chart survey data, which is, in many cases, out of data by many years. Large areas of the worldwide oceans are still poorly surveyed, and this should play a huge part in the decision making of navigational officers.

Other incidents occurred because of relying too heavily on a specific piece of technology. Such as the grounding of Royal Majesty in 1995, where the GPS showed an incorrect position. Instead of GPS position the display showed Dead Reckoning position. It is stated in the report that all the OOW relied too much on the GPS and did not cross check their position with what was displayed. Because of this the actual position of the ship was 17 NM away from what they believed. This is an enormous error which could have been avoided and saved many lives.

2.4 Accidents related to digital systems

Accident reports related to digital systems, especially ECDIS, are rather common to find. Since systems like ECDIS are, in comparison to paper charts, newer this is a given. Understanding these accidents is crucial for improving the resilience of navigational officers and ensuring safer operations going forward.

2.4.1 **Cruise vessel Radiance of the Seas, May 9th, 2022, collision with pier.**

On May 9th, 2022, the cruise ship Radiance of the Seas, a cruise vessel owned by Royal Caribbean, collided with the Sitka Cruise Terminal pier in Alaska causing millions in damages to the pier and vessel itself. In April 2021, the Sitka Cruise Terminal was expanded by roughly 120 meters. The Terminal had not informed the agency in charge of updating the

US coastline charts, the National Ocean and Atmospheric Administration (NOAA), of the extension. As a cause of this, the extension was not present on the electronic navigational chart used to execute the mooring operation. The master and the bridge crew, which at the time included four pilots, relied heavily on ECDIS to conduct the mooring, despite other navigational aids being present and available to use. On May 9th in the early morning hours, the Radiance of the Seas, approaching the port, the bridge team discussed the planned actions to dock. It was agreed that the vessel would rotate 180 degrees before going astern into berth and mooring portside with the stern facing the terminal. When the vessel was 0.37 miles from the pier, which the master saw as the vessel was coming in, the master began the 180-degree rotation to dock.

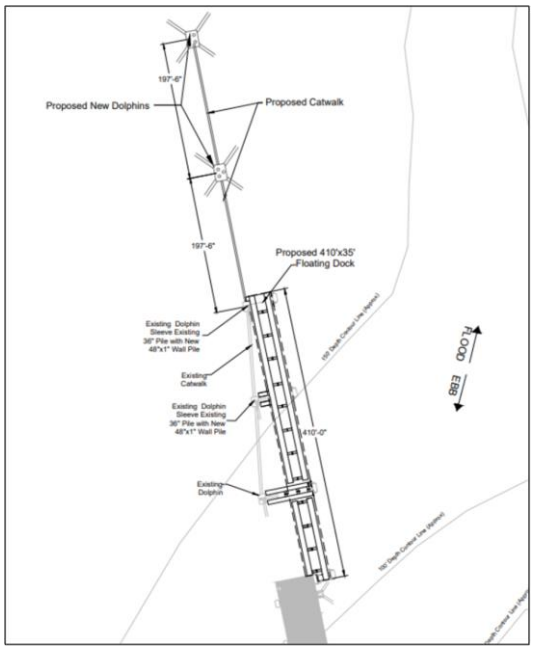

Figure 2 The proposed extension to the terminal pier

Up until this point the first officer, who was stationed at the ECDIS, called out the distance to the pier to the master, when the rotation started the first officer stopped giving the distance reading as the master started to rely more on the callouts of the bosun and the ECDIS present on the port side bridgewing. The bosun, stationed at the aft mooring station, called out the correct distance to the present extension. The master assumed that bosun was reporting the swinging clearance of the pier. Shortly thereafter the ships starboard quarter struck the mooring dolphin the end of the extended pier. After the collision the master moved forward, cleared the dolphin, and backed in properly to moor.

The investigation concluded that the bridge team relied too much on the information given by ECDIS and that the Terminal should have reported the completion of the extension to the NOAA, which they did only after the incident. (NTSB, 2023)

From this short description of the incident, it can be concluded that the overreliance on ECDIS and not cross checking to confirm the data with visual aids led to the collision.

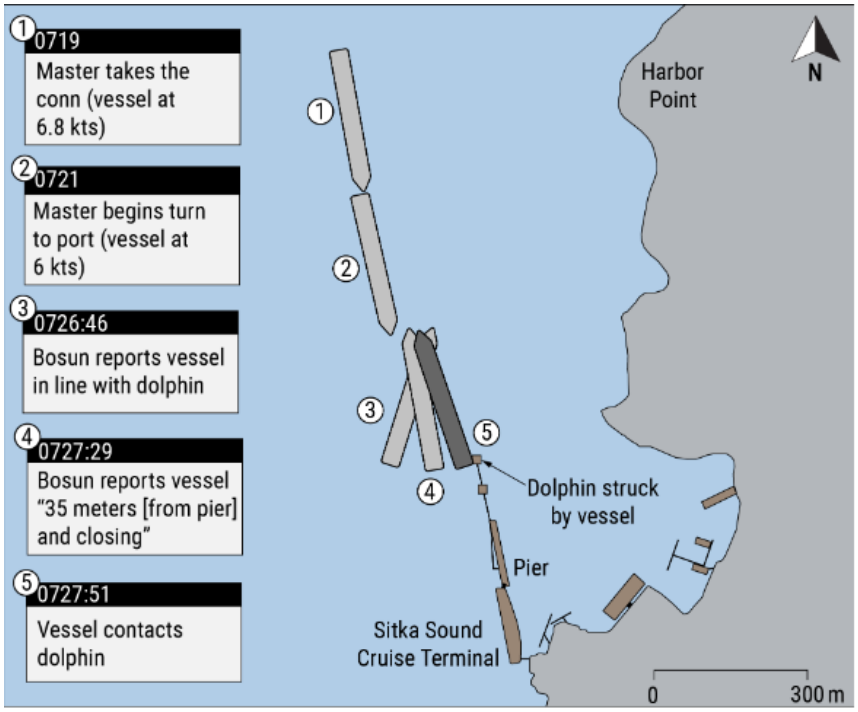

Figure 3 The approach of Radiance of the Sea (NTSB, 2023)

2.4.2 **Cargo ship Edmy, October 4th, 2022, collision with fishing vessel Tornado.**

Early morning on 4th October 2022 cargo ship Edmy left Larvik, Norway bound for Copenhagen, Denmark. Vessel was under pilotage until it reached Langesundbukta bay, after which the OOW was left alone on the bridge. The officer sat a southernly course, looked through the bridge windows for potential windows, the visibility was good, and the sea was calm. Officer knew that they were present in a fishing area and checked for fishing vessels that would conflict with the course. After checking for potential dangers visually, the officer observed AIS signals on ECDIS and radar and concluded that no dangers were present. The officer then turned his attention to the computer for administrative work. After 30 minutes, the OOW felt something hit the bow of the ship and observed a fishing vessel listing in front. The fishing vessel that was struck, Tornado, was trawling for prawns in the area prior to collision. The AIS of the fishing vessel was set to passive as to conceal

the location of the vessel, as the exact location was considered a trade secret. AIS information was only turned on 5 minutes before collision, probably to avoid collision with Edmy. The skipper of Tornado briefly considered calling the cargo ship on VHF but decided against it since the visibility was good and believed that the vessel observed them. Onboard Edmy, the officer did not observe the AIS of Tornado, although the vessel did show up on radar, but only as a faint echo, which the officer did not identify as a danger to navigation. Tornado started trawling for prawns with the engine sat in forward gear, although, because of the currents in the area the vessel was moving astern at around one knot. When the skipper realised that collision was imminent, he set the engine full astern but was unable to avoid contact. The Norwegian Safety Investigation Authority (NSIA) concluded that the incident occurred due to overreliance of the OOW on the AIS data provided on the ECDIS display and the vishing vessel turning of their AIS data. (NSIA, 2022)

From this incident it can be deduced that, even during good visibility and with confirmed visuals, dangers might still be present and the OOW should stay vigilant and observe the situation closely, as somethings may not be noticed at first glance.

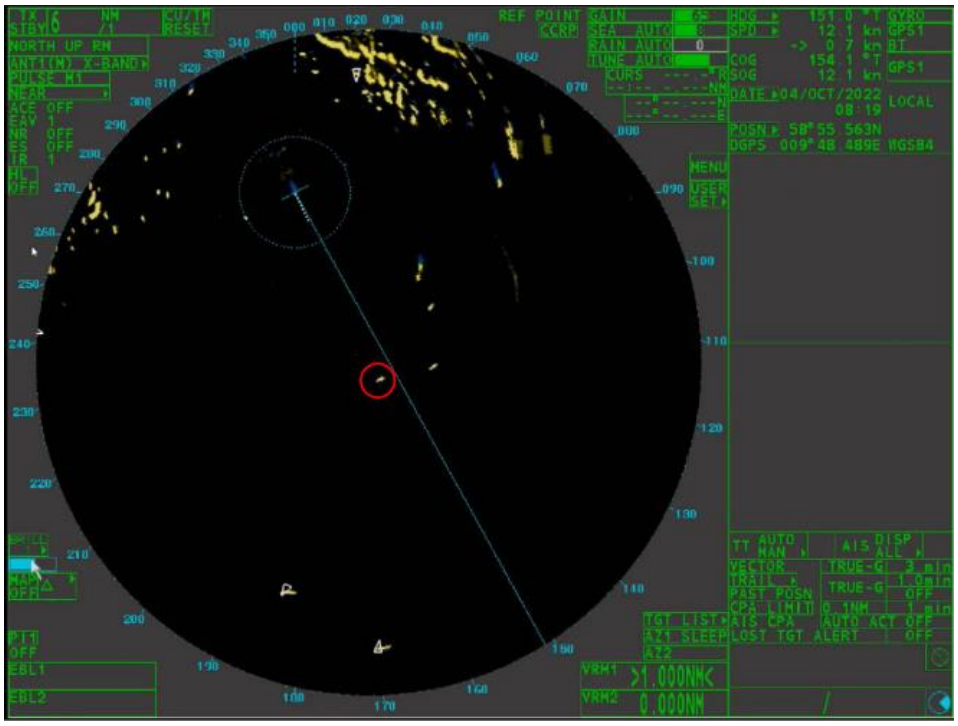

Figure 4 Radar picture after the pilot left the ship, Tornado is marked with a red circle

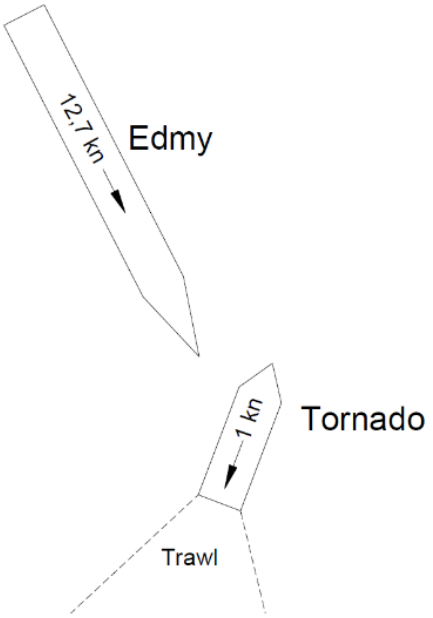

Figure 5 Both vessels and their speed moments before collision

2.5 Accidents related to paper charts

Accidents related in some way to navigation by charts are rather hard to find. Those that can be found offer limited information concerning what happened. A vast majority of these date back to previous centuries, yet there are some that happened recently.

2.5.1 **Muirfield, 1973, Muirfield seamount**

MV Muirfield was underway in the Indian ocean through waters that were supposedly charted to 5000 m, when suddenly she struck an unknown object. This resulted in a damaged keel but no loss of life. Ten years after, a survey was carried out and it was discovered that the Muirfield had struck a submarine mountain. Subsequently, the submarine mountain was named Muirfield Seamount after the vessel that had struck it. (O'Hara, ei pvm)

2.5.2 **World Discoverer, 2000, Struck and grounded**

World Discoverer was a cruise ship operating in the Antarctic polar regions. During one of its voyages, the ship struck an uncharted object in the Sandfly Passage off the coast of Solomon Islands. A distress signal was sent out and the vessel later beached resulting in no lives lost. Afterwards the ship was beached at Roderick Bay close by where it remains to

this day. The uncharted object which was struck was later identified as a rock formation.(Channon, 2024)

2.5.3 **USS San Francisco, 2005, undersea mountain**

USS San Francisco, a US Navy submarine, struck an underwater seamount on January 8th, 2005, at a depth of 160 meters. The collision resulted in ninety-eight crewmen injured and one loss of life. USS San Francisco's forward ballast tanks and sonar dome were severely damaged, so much so that the submarine struggled to surface afterwards because the vessel had problems achieving positive buoyancy. San Francisco arrived in her home port on January 10th, shortly after which an investigation into the accident began. It was made clear that the charts used onboard for navigation either did not show the seamount or indicated that there could be a seamount in the area. The Navy determined that the seamount should have been present on the charts used onboard, subsequently, a study concluded that the Navy's charts did not contain the necessary information because the area was deemed not a priority for the Defence Mapping Agency. (Mizokami, 2021)

These few accidents reveal that even navigating using paper charts cannot be without its flaws. It appears that most commonly the issue is that most of the seabed is not surveyed or not properly surveyed. It can be argued that because of these short comings of paper charts the accident tend to be more severe, to the vessels involved and the crew and people onboard. Yet the frequency of these accident is far lower than those of ECDIS related ones.

3 Interview

For this paper I chose to conduct interviews with navigational officers from Finnish-flagged vessels. I believe that this can give a deeper insight into how officers conduct themselves with the different means of navigation. An interview provides a more person to person way of communicating and provides ground for further investigation. In contrast to a questionnaire, which I believe, will only give a surface level understanding of the raised questions, as many people will answer in short phrases to get through the questionnaire more quickly.

3.1 Aims of interview

To confirm what has previously in this paper has been stated I have decided to carry out interview with several navigational officers and other members of bridge crews to determine whether over-reliance on ECDIS is prevalent across vessels. The newer generation of officers are, in theory, more trained in using the ECDIS and similar systems, so they should be more sceptical of the information being given to them. In addition, I believe, there is a generational divide, where the newer officers are putting too much trust in the digital parts of navigational duties, and the older officers, who have many more years of experience, tend to be more sceptical of the digital systems and do not rely on them too heavily. With the interview I aim to confirm whether this is true and validate if over-reliance is a growing trend. I will be interviewing bridge crews from different companies, different vessels and varying in age groups. So-to-say casting a wider net will help gather more data, that can show results which were not expected.

3.2 Interview questions

I have compiled various questions regarding the topic which I will list in this section. These questions are to get the conversation started, depending on the answers I get I can dig in further. I am looking to understand what each individual officers believes, I am not looking for “yes”, “no” or “I am not sure” answers, as that would not help with getting to understand the issue at hand.

1. Have you ever experienced ECDIS malfunctions during your time working? What kind of malfunction was it? How did it affect your ability to carry out your duties? How did you resolve the error?

This is the first question is aiming to establish if the officer has had any issues with ECDIS. Since this exact problem is what is most concerning, figuring out whether it is a common occurrence and if the issues noticeable is key.

2. Why, in your opinion, do officers tend to rely so much on digital equipment?

The second question is vaguely connected to the first one. Because if the officer encounters an error with ECDIS and does not notice it or starts to behave irrationally because of it, then it can be assumed with a high degree of probability that the officer

relies too much on the digital means of navigation. The question is more so about finding out the officer being interviewed can see his own shortcomings, not just others.

3. Do you cross check your vessels position with other sources of positional information? How do you do it? Has it ever happened that by cross checking you have noticed an error in one of the systems?

As has been said in some of the accident cases above, sometimes finding the error is the hard part. If the officer can notice something is wrong with the equipment without an alarm telling it to him, then the officer knows what went wrong in the long chain of information exchange how and why it is giving with the wrong information he is receiving. Cross-checking the information is a good way to reassure oneself that everything is working as it should, and if something is not working then it will stick out and be noticeable enough to raise concerns.

4. Do you have experience in navigating by not digital means of navigation? What kind? Do you think that it should be mandatory for everyone in the bridge crew to know how to?

If you have had experience in paper chart navigation, then you know what the digital equipment is doing. ECDIS, Radar and everything else on the bridge are just tools to make the job of the officer easier and free up his time for other tasks. Yet still, knowing what those systems are doing when they make their calculations to show the information you need is just as important as is what to do with that information. I plan to understand if the officer knows the so-called building blocks. This is the question I believe where most of the contrast will come from. The officers who have had many years of sea going service will most likely have had to use paper charts at some point, whereas the younger generation would not have had the opportunity and probably even forgotten how it is done.

5. Do you trust what the digital systems tell you in terms of navigational data? Why do you trust it? Why do you not trust it?

Rather straight forward question. Trust, whether it be with a machine or a person, must be built up on something solid. With this question I aim to understand each officers' reasons for their respective reasons of trusting and not trusting their equipment.

6. What, in your opinion, can be done to prevent overreliance on digital equipment?

This question is meant to spark the conversation about the future generations of officers and if overreliance is a serious enough problem in the opinion of the currently working officers that something must be done at the early stages of training.

As stated beforehand, this interview and these questions in turn are both aimed at starting a conversation about the given topics. Digging in deep and hearing what each officer has experience to make them think and act in their own ways when it comes to navigating.

3.3 Expected results

I expect to see a clear divide between the more experienced older generation of officers and the newer generation, with the newer generation being more reliable on the digital systems for their main tools of navigation. With some of the questions being open-ended, the results may vary by a lot, but the general point of the answers will most likely fall somewhere close to each other. I do not expect for one of the officers to completely not trust digital equipment and refuse to use it, but instead I believe that quite a lot of officers will be sceptical and think twice about what information is being given to them.

3.4 Results of interviews

A total of five interviews were conducted, all of them currently working on-board Finnish flag vessels. Coincidentally, three of the five officers have either finished their studies at Aboa Mare or are currently studying there, the other two are studying and finished studying at Kotka. The officers wanted to stay anonymous, so to differentiate between them each has chosen another name. They are as follows:

“Mikael” – 25 years old, has recently finished studies at Aboa Mare, is currently working on-board a general cargo vessel and has had experience working on many other types of vessels. Rough estimate of seagoing experience is 4 years total.

“Vietti” – 43 years old, studied at Aboa Mare, mainly worked on-board Ro-Ro vessels for around 10 years total.

“Vaino” – 27 years old, currently studies at Kotka, mainly worked on Ro-Ro vessels, total seagoing experience is a little over 5 years.

“Rauli” – 25 years old, student at Aboa Mare, has worked on a variety of different vessels, 4 years of seagoing experience.

“Simon” – 26 years old, recently finished studies at Kotka, currently working on-board a bulk cargo vessel, has around 3 years of seagoing experience.

Before diving deep and looking into the overall results, some standout answers should be pointed out and compared to the other participants answers. Let us start with the first question, “Rauli” and “Mikael” are the most outstanding answers I have gotten. The interview with I had with “Rauli” took the longest at around an hour and a half. Over that time “Rauli” shared many anecdotes and stories from his time working at sea, one of which being incorporated into his answer on the first question: “Have you ever experienced ECDIS malfunctions during your time working? What kind of malfunction was it? How did it affect your ability to carry out your duties? How did you resolve the error?”

“Yes, I have had experience with many different versions of ECDIS. Some of the older versions are very prone to crashing when the route plan contains too much stuff, like contours, notes, text, all that stuff that you usually put on a route plan. But I think that it was mainly because of a lack of memory in the computer. On one of the vessels I was on a very common error was that the ECDIS image would start shifting a little to the south-west or sometimes just not update at all. I called the previous officer who was onboard, and he told me to unplug the ECDIS from the power source, unplug the GPS and then reconnect everything. That fixed it, but only for some time, after a couple of days the issue still arose. So, I tried calling the customer support, the US number and the UK number but there no-one picked up. I had even sent out emails to them also no answers, so I had to periodically unplug the ECDIS to keep it functional.”

I will be juxtaposing this answer with the answer I got from “Mikael”:

“Well, no, I have mainly been on ships where the OS was Furuno, and it, in my experience, rarely gives out errors. The only thing coming to mind is that sometimes there is a slight desynchronisation with the GPS, but it was rather insignificant, and you could still use the radar image if you felt that it was a big enough issue to stop using ECDIS.

Situations where it was completely screwed up never happened. Most of the vessels I have been, the equipment was new or just installed in the previous years, so very few kinks were present. And they were all Furuno so that helped with it."

These two answers are the opposite of each other. With one officer not only struggling to keep the equipment handed over to him operational, but also not getting any help from the manufacturer of said equipment, and the other officers getting used to one form of ECDIS and it proving to him to be reliable. Based on what was described, assumptions can be made on who of these two officers is most likely to rely on ECDIS and that is where the other two questions and answers come to mind. Questions number 5 and 6 have been answered by all the respondents with the same ideas in mind:

"Vietti" - Do you trust what the digital systems tell you in terms of navigational data? Why do you trust it? Why do you not trust it?

"I generally trust the digital systems for most navigational data, but I do so with a healthy level of caution and always cross-check when necessary. The trust I place in these systems comes from their precision, efficiency, and ability to handle vast amounts of data quickly. However, there are also reasons why I don't fully rely on them without verification, as even the most advanced systems can have limitations or errors that can affect safety if overlooked. Modern GPS systems are highly accurate, often providing positions with an error margin of just a few meters. Digital systems like ECDIS combine multiple data inputs, such as depth, weather conditions, radar, AIS, and GPS, into one cohesive display. This makes it easier to get a comprehensive picture of the general situation. Route planning on ECDIS is automated and can be done in a fraction of the time it would take manually. Digital systems rely on complex hardware, such as computers, GPS receivers, and radar sensors. Any malfunction in these components can lead to incorrect or missing data. Like any software-based system, ECDIS or other digital tools can experience bugs or glitches. This can lead to incorrect data being displayed, such as faulty position updates, chart rendering errors, or system crashes. While I trust digital systems for most aspects of navigation due to their accuracy, efficiency, and ability to integrate real-time data, I don't blindly rely on them. Digital systems can and do fail."

What, in your opinion, can be done to prevent overreliance on digital equipment?

“In my opinion, preventing overreliance on digital equipment requires a balanced approach that emphasizes both education and training in traditional navigation skills as well as a conscious, proactive mindset towards using digital systems as tools rather than as the sole means of navigation.

Mandatory Refresher Courses

Encourage the Use of Digital Systems as a Support Tool, Not the Sole Tool

Foster a Culture of Vigilance and Critical Thinking

Maintain Awareness of Environmental and Technical Limitations”

“Mikael” - Do you trust what the digital systems tell you in terms of navigational data? Why do you trust it? Why do you not trust it?

“I trust the equipment because it has not given me a reason to not trust it yet. I have sailed for a couple of years and in those years, I have not gotten a serious error from ECDIS, so for me, there’s no reason not to trust it.”

What, in your opinion, can be done to prevent overreliance on digital equipment?

“Teaching the officers the basics so that they know how to do it without the equipment is a good starting point. They should know what happens inside the machine, why it is giving out the information that it is.”

“Vaino” - Do you trust what the digital systems tell you in terms of navigational data? Why do you trust it? Why do you not trust it?

“I trust digital systems like GPS and ECDIS because they’re accurate, fast, and integrate lots of data in real-time. However, I don’t trust them blindly because they can malfunction, lose signals, or have glitches. That’s why I always cross-check with radar or visual observations.”

What, in your opinion, can be done to prevent overreliance on digital equipment?

“In addition to training, I think creating a culture of awareness where everyone remembers that digital systems are just tools is key. Encouraging regular manual checks, practicing without systems, and emphasizing redundancy can help avoid overreliance. We need more training on traditional methods like dead reckoning and celestial navigation. Regular drills

simulating system failures, and always cross-checking digital data with radar or visual fixes can help keep us from relying too much on tech."

"Rauli" - Do you trust what the digital systems tell you in terms of navigational data? Why do you trust it? Why do you not trust it?

"Both yes and no, skeptically trust it you could say. You should trust it and check the information you get from it."

What, in your opinion, can be done to prevent overreliance on digital equipment?

"It cannot really be prevented. People will still choose what is the easiest to do in any situation. What we can do is teach the fundamentals and prevent errors happening in ECDIS. One more thing that can be done – standardize the ECDIS user interface. It is like with computers, there is DELL, Asus, HP and more, but they all have the same Windows on them, there is no Dell Windows or Asus Windows. Why is not like that with ECDIS? It would make everything even easier, then you don't have to re-learn ECDIS and its functions when you're on a new ship, because the version is different from the one you're used to."

"Simon" - Do you trust what the digital systems tell you in terms of navigational data? Why do you trust it? Why do you not trust it?

"I trust digital systems most of the time because they aggregate multiple streams of accurate data. However, trust is conditional. I'm aware of potential errors from GPS interference, sensor faults, or software bugs. The trust mainly stems from their proven reliability, ease of use, and redundancy in design. That said, I always keep a mental "what if this fails" scenario in mind. Blind trust is risky, so I prefer to use them as a primary tool but stay ready to switch to manual methods."

What, in your opinion, can be done to prevent overreliance on digital equipment?

"Overreliance can't be eliminated completely, but fostering balanced habits will ensure officers are ready for contingencies. More emphasis on traditional navigation during officer training and frequent drills to refresh these skills. Regularly simulate ECDIS or GPS failures during bridge resource management training. Encourage officers to routinely cross-check digital systems with independent sources. Cultivate a culture of scepticism—treat digital tools as aids, not infallible solutions. Require manual fixes to be plotted at least once per watch, regardless of ECDIS."

These are just some of the answers and excerpts from the interviews I have had with the participants. You can see that there is a general consensus on what should be done with the issue of over-reliance, even though some of the participants have not experienced it themselves firsthand.

When looking at background that each of them shared it is noticeable that most of them are rather young, around 26 years old. Vietti being the only one who is considerably older than the rest and has more experience as well. Three of the participants have either recently finished their studies or used to study at either Kotka or Aboa Mare. Let us start looking at and comparing the results with the first question that was raised.

When asked whether the participants have experienced any malfunctions with ECDIS and how they dealt with it four out of five answered that they have encountered various errors and dealt with them in their own ways. The issue most common between all four is ECDIS losing GPS signal and displaying incorrect data. This severely hinders the ability of an officer to monitor the vessels position and route. Especially if such a malfunction were to happen in a heavily trafficked area and go unnoticed, the consequences could be tremendous. The second most common malfunction is ECDIS freezing up and not responding to any input from the officers. This can be caused by a variety of factors: a corrupted chart, overfilled computer memory, old hardware or a software glitch. These malfunctions the officers cannot predict, but they should always be anticipated. The participants who have had this happen to either switched to secondary ECDIS or, because of the situation, started using paper charts. The malfunctions would later be fixed by rebooting the systems that caused the malfunctions, as well as ECDIS itself. This would resolve the issue in most cases. The only one who seemingly has not had any malfunctions with ECDIS was Mikael. He said that on most of the vessels he has worked on the operating system of ECDIS was Furuno. He praised Furuno for rarely crashing or giving out errors that would result in the ECDIS becoming unusable.

To sum up, most of the officers have had some form of malfunctions with ECDIS during their time and malfunction was noticed and resolved. The officers knew what to do when a malfunction occurred.

The second question, why officers tend to rely on digital equipment so heavily, was answered shortly by all the participants. They all agreed that digital equipment is easier to

used and saves time. Rauli gave an interesting example of human error playing a part in chart correction: “Just when you compare those two tasks to a paper chart - you save a lot of time, and the human factor is not at play as much as it is when you use paper charts. When doing chart corrections with the notices to mariners, you can misplace a, let’s say, cable that is being laid down on the seabed. You made a mistake and now the cable on your chart is more south than it should be. Whereas with ECDIS, you just plug in the USB with the downloaded charts and just leave it for a couple of hours. Much more convenient and easier to use”. Elimination of human error was also something that most of the participants cited as a reason for reliance on ECDIS, but when asked further, no one could give a clear example like Rauli.

An important part of using digital equipment is making sure that it gives you the correct information. With ECDIS, this can be done by cross checking the position on screen with your actual position using landmarks as reference points. That is where the third question comes in, do any of the officers use cross-check regularly and has it happened that by doing so they noticed an error. The answer varied from person to person, Mikael does it, but only rarely, as he has said that he has not experienced any errors or malfunctions. Vietti went on to explain in depth how he cross checks with every available means of doing so. First comparing data that GPS is giving him with the data shown on ECDIS, since ECDIS gets its data from the GPS no error should be present. The second method is by taking bearing to a landmark on radar and comparing them to the same landmark bearing on ECDIS, if any discrepancies are found – it warrants for further actions.

When it comes to traditional methods of navigating it doesn’t surprise that only a few officers have had experience working with paper charts during their time at sea. One of these was Rauli, who for his very first contract worked on-board a vessel with no ECDIS, only a radar and paper charts. Rauli shared that at first, he felt nervous since he was not as trained with paper chart navigation as ECDIS and was not certain that he could do the job to the same degree of efficiency. With time, however, Rauli said that he found paper chart navigating easy and even grew to like as much as digital means of navigating. Other respondents shared that they used dead reckoning and celestial navigation, but when it comes to using primarily paper charts only Rauli has had experience with this method. Even though not all have had to use traditional methods during their work, there is a unanimous agreement that everyone on the bridge crew should be at least familiar with how to carry

out paper chart navigation. Mikael noted that paper chart navigation can be considered as a foundation on which all subsequent knowledge of navigating is built on, without the foundation, eventually, it would all fall over and tumble.

Blind trust in equipment is something that is bound to happen at some point, that is why for the fifth question I discussed with the participants whether they trust their equipment fully or look at it with a skeptical view. All the respondents agreed that trusting digital navigational equipment blindly is highly unprofessional. The equipment used is used as a tool to help the officers with navigating, it should be used with a healthy dose of skepticism, as anything electronic is prone to give out false information. Noticing this false information is what some of the respondents said, one of the crucial tasks of the officers. ECDIS has proven, however, that it is a reliable and accurate system. None of the participants trust it blindly and take information from various sources at their disposal to get the full, clear picture of what is happening.

For the last question, I asked the participants if they feel like the issue of overreliance is a growing danger to the maritime industry as a whole and if there is anything that should be done to combat it. The officers did not agree that overreliance is a growing trend, most of the officers trained in the two schools are tough to always see ECDIS, GPS and radar as merely tools. Although they did all agree that periodic training in using traditional methods would ensure proficiency. Incorporating more digital system failures into bridge simulator trainings was suggested as a possible way to prepare and engrain that these systems are merely tools that can fail, this could prepare the future generations of officers to for any type of situation. One respondent, Rauli, suggested that a standardized ECDIS operating system and user interface could help with preventing confusion when switching vessels. Fostering a culture of awareness was suggested by all the respondents, encouraging the officers to always be skeptical and never taking the information given with hundred percent of certainty, practicing manual fixes as well as taking bearing on a regular basis during watches could ensure that the officers would be more trusting in their own abilities, rather than the digital systems.

There are some broader observations and recommendations that should be noted, but did not fall into any of the previous answers to questions. Theres is a noticeable gap in the level of preparedness of officers.

4 Conclusion

The findings of this research highlight the balance the maritime industry must maintain between utilizing advanced digital navigation systems, such as ECDIS, and maintaining competence in traditional navigation methods like paper charts. While ECDIS and related technologies provide exceptional convenience, precision, and efficiency, they are not without their respective faults. The analysed incidents demonstrate that excessive dependence on digital systems, especially without critical evaluation, can result in significant navigational errors which in turn can possibly lead to accidents. Similarly, paper charts, despite being less vulnerable to technical failures, are still susceptible to inaccuracies caused by outdated information or human error in manual plotting. This, however, is not revealed in the interview part of the paper. It suggests quite the opposite, that while officers do rely on the digital equipment onboard, those with more experience look at it as a tool which can be wrong and right. In the end, it is up to the officers to make the final decisions based on the information either provided to them by systems such as ECDIS or simply by visually observing the surrounding situation. Admittedly, most of the participants have had enough experience working as officers, in this regard in it very difficult to get a clear picture of difference between less and more experienced officers. This shows me that there is still more to be discovered within this topic. Looking back on it, a bigger pool of participants with varying levels of experience would have given interesting results regarding how exactly they conduct themselves while on watch and faced with an error in the digital navigation systems.

Looking back at the research conducted, it should be noted that more participants could have given a bigger scope of the problem, with five people you only get a small look at problem and in some cases, you may get “lucky” and get to interview people who had not experienced anything like the problem the described. It would have been interesting to get to hear people who have been in accident described in the literature review.

Based on the before mentioned above, it could be said that reliance on digital navigation means should not be without reasons and the systems themselves should always be used as a mere tool in helping the officer.

5 References

Amos, J. (2020, June 21). *BBC.* Retrieved from https://www.bbc.com/news/science-environment-53119686

Bec, T. F. (2024, August 28). *Institute of Marine*. Retrieved from https://www.imarest.org/resource/mp-ss-andrea-doria-a-tragic-success-story.html

Cameron, A. (2017, June 28). *GPS World*. Retrieved from https://www.gov.uk/maib-reports/grounding-of-oil-chemical-tanker-ovit-on-the-varne-bank-in-the-dover-strait-off-the-south-east-coast-of-england

Channon, M. (2024, August 19). *Express*. Retrieved from https://www.express.co.uk/news/world/1937865/cruise-ship-MS-World-Discoverer-Nggela-Islands

Communication and radionavigation. (2021, December 24). Retrieved from https://cirspb.ru/en/blog/ustroystvo-sudov/soenky-na-bortu/

Ian Grainger, F. D.-H. (2023, August 17). *Ship Owners Club*. Retrieved from https://www.shipownersclub.com/latest-updates/news/ecdis-and-modern-navigator/

International, H. (2010, Febuary 15). *Hydro International.* Retrieved from https://www.hydro-international.com/content/article/the-iho-s-role-in-the-development-of-ecdis

MAIB. (2015, January 23). *GOV.UK*. Retrieved from https://assets.publishing.service.gov.uk/media/547c6f2640f0b60244000007/OvitReport.pdf

MAIB. (2015, January 23). *GOV.UK.* Retrieved from https://assets.publishing.service.gov.uk/media/547c6f1640f0b6024100000b/RickmersDubai.pdf

Mizokami, K. (2021, November 25). *National Interest*. Retrieved from https://nationalinterest.org/blog/reboot/story-uss-san-franciscos-underwater-collision-2005-196931

NSIA. (2022, December 13). Retrieved from https://safety4sea.com/wp-content/uploads/2022/12/NSIA-Collision-between-Edmy-and-Tornado-2022_12.pdf

NTSB. (2023, May 26). Retrieved from https://www.ntsb.gov/investigations/AccidentReports/Reports/MIR2310.pdf

O'Hara, T. (n.d.). *Museums Victoria*. Retrieved from https://museumsvictoria.com.au/article/the-mighty-muirfield-seamount/

Skolnik, M. (2024, September 18). *Britannica.* Retrieved from https://www.britannica.com/technology/radar

Wingrove, M. (2014, August 26). *Riviera*. Retrieved from https://www.rivieramm.com/news-content-hub/news-content-hub/over-reliance-on-ecdis-can-cause-accidents-and-oil-spills-38103