# 8 Sensemaking in Practical Design

## *A Navigation App for Fast Leisure Boats*

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## CONTENTS

## INTRODUCTION: THE CHALLENGES OF HIGH-SPEED NAVIGATION

### A Long Time Ago

When I was a boy, I used to spend my summers at my grandparents in a small coastal village in the west of Sweden. My grandfather was a fisherman and much of my time there was spent with him at sea. Just outside the harbour pier there was a reef, normally hidden by only a few inches of water. Some 20 m further out was the lateral buoy warning for the danger. However, all native fishermen took a shortcut inside the buoy, aware of the exact location of the shoal. Only strangers followed the rules of the road and took the buoy on the right side. One day, when my grandfather was in his 70s, he hit that reef. It was no big deal; the boat heaved over in the water and was then washed across the rock by the wake. But it was a big embarrassment. For 50 years he had gone in and out through the pierheads almost every day without problem, and then a few moments of inattentiveness in an area he knew so well. Does this tell us something about human behaviour?

### Three Years Ago

A warm summer night with heavy rain in the archipelago of southern Norway. After midnight, a water scooter at full speed is heading home after a late-night concert in a small coastal town. But the driver never returns home to the summer cabin where the family wait. The next morning the scooter is found crashed on a small island some distance from the home. The driver is dead, instantly killed on impact with the rocky island.

The police states that alcohol, darkness and bad visibility have played a role in the crash: “It is very hard to manoeuvre at sea in darkness. It can be different from time to time even if you go the same route”, said the search and rescue leader at the local police district (Verdens Gang, 2018). One of the challenges of high-speed navigation is short decision time. We will never know the full reason why this accident happened.

### Two Years Ago

Just before 2 o’clock in a dark and moonless night in August 2019, a fast leisure boat crashed into a small island in a fjord in middle Norway. The boat was homebound through a fjord and hit a small island just outside the fairway in high speed, 36 knots. Both the driver and the passenger were badly injured by the impact and later died. The driver was well known in the area and had done the trip many times.

**FIGURE 8.1** To the left, the crashed water scooter on the accident scene in 2018. To the right, the crashed open speed boat on the island where it ended up in 2019. (Images courtesy of VG, 2018 and NRK, 2020.)

The accident commission noted that there had been Snapchat activity on the driver's mobile phone in the seconds leading up to the crash (Statens Haverikommisjon for Transport, 2020). A few seconds of inattentiveness could very well be the crucial factor leading to the accident (Figure 8.1).

## BACKGROUND

### Finding Your Way at Sea

Navigation is a Greek word stemming from *navis* ( a ship) and *agere* (to drive). Navigation is about knowing where you are and knowing what way to take to reach your goal. In olden and even modern days, *pilots* are used to navigate the ship. Maritime pilots are people with local knowledge about underwater dangers and how to get from one place to another. Geographical data were collected and recorded first in itineraries and sailing directions and then as nautical charts, paper and nowadays electronic. Today also mariners unfamiliar with an area can find their way. Finding your own position by referencing landmarks on islands and coastlines has today been replaced by a position plotted by global navigation satellite systems. However, navigation in unfamiliar waters is difficult even with the help of nautical charts and automatic position fixing. Even if you know the way you need to go in the chart you still have to deduce steering marks in the terrain leading to your goal. To do that you need to pay attention to visual as well as other cues, focus on the task, use implicit, explicit and prospective memory resources. In short you need to pay attention and make sense of many cues in order to perform safe navigation. It costs cognitive resources. This is something humans can do very well – but also very badly as inattentiveness is part of the human condition.

### Human Factors

The ability to focus and sustain attention on a task is crucial for the achievement of one's goals. Although attention span is a complex concept and measures depend on a lot of different things, a common agreement among researchers is that the time span healthy teenagers and adults can concentrate to handle tasks without being distracted is limited to 10–20 minutes (Wilson & Korn 2017). Navigating in your own backyard is a piece of cake and very easy. This is what my grandfather felt in the story above. This might be what the driver of that water scooter and that fast leisure boat also felt navigating in well-known areas. Accident investigations often talk about complacency, a feeling of calm satisfaction with your own abilities or situation especially when accompanied by unawareness of actual dangers or deficiencies. Fifty years of successfully sailing in and out of the port had made my grandfather complacent to the danger posed by the shoal outside the pier.

The accidents described in the beginning of this paper could be examples of “human error”. According to Donald Norman (2013), one category of such errors is *slips*. Slips occur when a user is on mental “autopilot” and takes wrong actions pursuing a goal, typically when the user does not fully devote his or her attention to the task at hand. The question a designer asks himself here is if there is any simple help that can be provided to avoid these kinds of accidents in the future? The necessary data are already available: the position of the boat and future position within a reasonable time frame and chart data showing water with enough depth to sail in. This information could be available on a chart application ready to be used by a user. And there is in fact an abundance of such apps. Figure 8.2, left, shows a typical chart plotter used by leisure mariners (the same was used in the accident boat in the last story above). The problem is only that you still need to pay attention to the information shown on them, and in a context as shown in Figure 8.2, right, that attention needs to be spent on driving. A typical chart plotter is simply not useful in many small and fast leisure boats.

## SENSEMAKING

“Sensemaking can be seen as the process to establish situational awareness based on cues” (Kilskar et al., 2020). This is your conscious and focused navigator comparing the planed route on the map with landmarks in the archipelago around us. But when you are sitting on a water scooter in 40+ knots with both hands clung to the

**FIGURE 8.2** To the left, a chart plotter used in many leisure crafts including the one in the last accident narrated above. To the right a water scooter. Typically, with speeds between 40 and 60 knots. (Images courtesy Garmin and Sea-Doo.)

handles not to fall off, or in moments of inattention in a fast-moving leisure craft it is a different thing. In this situated context, sensemaking is “the process of searching for a representation and encoding data in that representation to answer task-specific questions” (Russel et al., 1993). Russel et al. continues “Different operations during sensemaking require different cognitive and external resources. Representations are chosen and changed to reduce the cost of operations in an information processing task”. So, while drivers in slow weather-sheltered cabin cruisers might benefit from the protection and time to study information on a chart machine, the speed, vibrations and time constraints of very fast boats and water scooters necessitates other solutions. This was the one of the motivators of the *Sikker kurs* project. The other was the problem of inattentiveness.

### SIKKER KURS

In 2016, the Sikker kurs project started, financed by the Norwegian Coastal Administration and Geomatics Norway AS. The purpose was to develop an application for ordinary smartphones to increase safety and possibly decrease the number of groundings by leisure boats in Norwegian waters. The project was a proof-of-concept demonstrator, coordinated by Geomatics Norway. The design was made by the author, working at the Norwegian University of Science and Technology (NTNU) in Trondheim, and technical implementation was conducted by Combitech AB in Linkoping, Sweden. Other partners in the project were the Norwegian Hydrographic Office (Kartverket) and the Norwegian Maritime Authority (Sjofartsdirektoratet). It was decided that the project would use the human-centred design process (HCD) in ISO 9241-210 (ISO, 2015) and International Maritime Organization’s (IMO) guideline on HCD (IMO, 2015).

### CONCEPT

Our goal was to make a navigation aid that would support sensemaking during sea trips and reduce the risk of groundings (increase safety) in small boats. We would do this by designing a smartphone app that would warn the driver of an imminent grounding danger 30 seconds before impact. Because of the challenging environment on many fast leisure boats (e.g. a water scooter), the warning should be aural (and could potentially trigger an automatic engine cut). After stopping the craft, the driver should have an opportunity to see and understand why the warning had been given and also find a way out of the situation (Porathe & Ekskog, 2018). In order to test this concept, we started to develop a proof-of-concept.

## METHOD

### HUMAN-CENTRED DESIGN (HCD)

The point of HCD is to ensure user-driven development and good usability by including the end users early in the process and keep them involved during the whole design. This is done in an iterative process with four steps according to ISO 9241-210:

1. Understand the context of use by field studies and interviews with the users.
2. Specify the user and organisational requirements.
3. Produce a design solution, this will be the prototype.
4. Evaluate the design against requirements. Here, the prototype is tested on the end users.

The findings are then brought into a new iteration of the design process resulting in a new, improved prototype. The process is then iterated until the application meets the requirements.

## TEST AREA AND USER GROUP

Before a user group could be recruited, a location had to be decided. One way would be to look for an area with a large amount of leisure boat traffic. However, the availability of very detailed bathymetry was necessary and a difficult problem. The Norwegian Hydrographic Office offered an area in Søre Sunnmøre, a district south of Ålesund on the Norwegian west coast which had been declassified and could be used. A central municipality in this area was Ulsteinvik, which was to become the centre of the project. We needed to find local leisure boat mariners. A letter was sent out to 30 pleasure craft clubs in the district informing about the project and asking about participation in development and testing of the application. Unfortunately, only six leisure boaters responded, all male, all relatively experienced and in the age group of 60+. But luckily for us, these end users have helped us a lot with testing during the years.

## UNDERSTAND THE CONTEXT OF USE AND USER REQUIREMENTS

A first focus group meeting was held in Ulsteinvik in January 2017. The users were interviewed about their experience with leisure craft navigation and the proposed concept of using a smartphone as a means of preventing groundings was discussed. The group concluded that the idea was interesting and that there was a need for a safety device alarming if the boat was approaching unsafe depths. The group agreed on a prioritised list with different possible features (Porathe & Ekskog, 2018).

### Alarm

The phone should sound an alarm a configurable time before the boat went aground. The application should be automatically started in the background when a boater steps onto his boat, so that he or she does not forget to start the application. The time should be short so that the number of false alarms in narrow archipelagos would not be annoying and thus making boaters turn off the alarm (which is often the case with the look-ahead-sector in professional shipping). The default setting was agreed as 30 seconds, and the procedure of the boater should be to immediately stop the boat on alarm. The alarm should be silenced by picking up the phone and clicking on the warning icon shown. The alarm should also be silenced by slowing down to a configurable maximum speed (default three knots) to allow boats to make landfalls or approach a jetty without getting an alarm.

### NoGo Areas

When the phone is picked up and the alarm silenced, the screen should show “NoGo Areas” in red overlayered on the camera image (so called augmented reality, AR). These NoGo areas are the polygon inside a configurable depth contour. The default was the 3-m contour, but ideally, any depth should be able to be picked based on the current draft of the boat, plus a safety margin. Ideally, the depth alarm should also compensate for the current tidal situation based on tide tables or real-time tide gauges. The user should be able to see these NoGo areas all around by pointing the smartphone camera.

### Landmark Names

Conspicuous landmarks around the boat should be named by overlaying text on the camera image. Examples of such conspicuous landmarks could be names of islands, shoals, buoys, beacons and mountaintops (the area is very mountainous). Much time on board a small craft is spent trying to find buoys and beacons. An overlaid pointer should show their position to aid visual search. To avoid cluttering, the names and pointers could be toggled on and off by tilting the camera (slightly up turns text on and vice versa).

### Air Draught

An alarm similar to the grounding alarm could be configured for sailing boats with a mast height that is higher than the span of oncoming bridges and power lines.

### Fairways and Planned Routes

Official fairways should be shown as an AR “carpet” rolled out on the water in the camera image. Also, individual routes planned in a chart program and imported into the phone could be shown in the same manner. This feature must be able to be turned on and off to avoid cluttering. This requirement was later dropped for the tested prototype due to time constraints.

## TECHNICAL PROTOTYPE DEVELOPMENT

After the meeting with the user group, discussions started about the technical implementation and what could be achievable within the time and budget available. Of the five prioritised solutions suggested by the user group, the first four were selected for development.

### The Android Platform

We decided to make the test implementation on the Android platform because Combitech had earlier experience in this platform, had available equipment and the relative ease with which test implementations could be distributed without being passed by the AppStore (for Apple’s iOS), thus giving us a quicker development cycle. Recently, the app has also been developed for iOS.

### NoGo Areas and Alarm Execution

Part of an Electronic Navigational Chart (ENC) was imported into a database in the phone's memory. From the ENC, only the polygons making up the area with a water depth of less than 3 m at chart datum were kept. These polygons made up the "NoGo Area" that was used to alarm the navigator for grounding. Ideally, we would have NoGo polygons for every decimetre, which would be turned on and off depending on the set draught of the boat and the tidal situation. However, this would require large memory storage or a constant online connection, so we decided to have just one NoGo depth of 3 m for the test. The Norwegian Hydrographic Office delivered the necessary depth contour with a high-resolution horizontal grid of 1 m. The internal map would consist of polygons marking water depths between 3 m and 0 (the beach line).

The timed alarm function was implemented using a vector extending from the present position in the direction of the current course. The length of the vector was dependent on the speed and the alarm time set. In the default setting, the alarm was set to be triggered 30 seconds before the boat "grounded" (passed into the 3 m NoGo area polygon). At 10 knots, the length of the vector would be (10 knots * (1,852 m/3,600 seconds) * 30 seconds) =154 m. The length and direction of the course-speed vector was calculated from recent satellite positions. The precision was dependent on the position rate the phone could muster, which in general was one position per second (1 Hz). The alarm would be triggered when a course-speed vector intersected with a NoGo area polygon.

The air draught alarm was treated the same way using the same course-speed vector intersecting a safety rectangle extending 15 m on both sides of bridges and power lines. The set mast height would then be compared against the maximum air draught allowed as stated as an attribute to the safety rectangle. In the test area, there was only one power line and no bridges.

### The Augmented Reality (AR) Layer

The NoGo area polygon map was to be shown on top of camera image at the correct position. The polygons should apparently be "floating" on the surface of the water. In order to do this, the map had to be georeferenced and projected using a virtual camera positioned in virtual space as the real camera was in the real space. This projection is a standard virtual reality (VR) operation conducted in real time taking the virtual camera's height over the water (preset to 2 m), direction (from the phone's compass) and field of view (preset to match the device's camera) as in-parameters.

The course-speed vector was also made visible and projected into the camera view: white when not in alarm mode but changing colour to red when an intersection had taken place and the alarm was triggered. It was then red as long as it was intersecting with the NoGo polygons, thus visualising the alarm state, also when the aural alarm was silenced. The initial intersection point was shown by an arrow.

The stability and precision of the satellite positions and the compass heading from the internal phone sensors was an area of concern. The course-speed vector triggering the alarm was created by extrapolating present course and speed into the future. Low-pass filters were applied to these values to avoid large jumps due to unstable satellite fixes. This was done to reduce the risk of false collision alarms. The point of view in the polygon map was also dependent on the satellite-based present position, but the direction of the camera (which was independent from the course-speed vector of the boat) was relying on a compass direction from the phone's internal magnetic compass. We had little experience of the precision of these two sensors, which might also be dependent on local conditions in the area for the test. However, to anticipate possible problems with the compass, we made it possible to shut down this sensor and use the course-speed vector as direction for the virtual camera in the augmented reality layer, then assuming that the camera was fixed in a forward-looking manner (for example, on the windscreen).

The only text-based information we considered we had time and resources to implement was the pointer for navigational marks. The position of all buoys and marks in the test area was collected in a list. We did not succeed in populating the list with all the marker names in time, so the markers in the tests prototype mostly showed "POI" for point of interest.

## RESULTS

The first iteration of the prototype was tested during a technical test in Ulsteinvik with two people from the user group on 8 May 2017. The full user test was conducted a month later with the six people from the user group (Porathe & Ekskog, 2018).

### TECHNICAL TEST

For the technical test in May, a relatively complex 5.8 nautical miles long track was drawn in an ENC (see Figure 8.3). This track could be negotiated in a little more than an hour at a moderate speed of 5 knots (not to take any risks should the prototype prove unreliable).

For the test, we used a 7-m leisure boat owned by a member of the user group. He also had very good local knowledge, which would be a safety barrier against

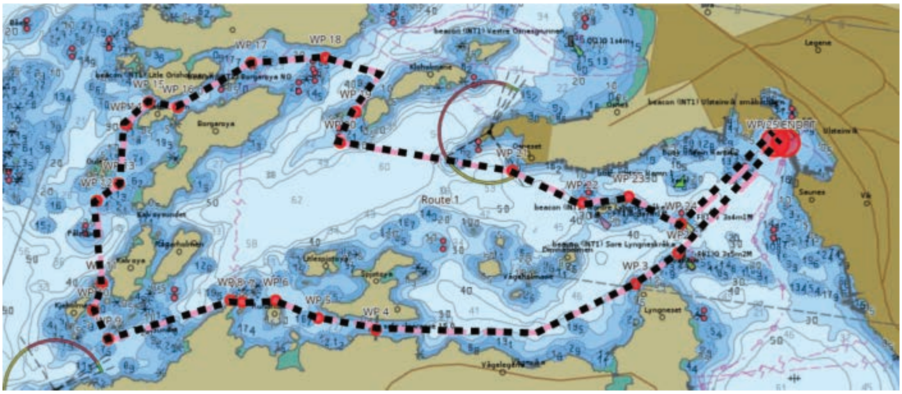

**FIGURE 8.3** The test track outside Ulsteinvik in western Norway. (Map courtesy Kartverket.)

**FIGURE 8.4** The test application on the smartphone (Lenovo Phab 2 Pro) during the pilot test. To the right, the boat's reference stationary chart plotter. (Photo courtesy of the author.)

unintentional grounding should the prototype fail. The boat was also equipped with a stationary chart plotter which was used as a reference system (see Figure 8.4).

The prototype software was tested on two phones: a Samsung Galaxy S7 and a Lenovo Phab 2 Pro. We found no differences in behaviour between the two phones. Some problems with the fluctuating AR layer are described below.

## USER TEST

The final user test was held in Ulsteinvik on 14 June 2017. The same test track as in May was used and all six of the original users were present on the 15 m M/S Legona used during these tests. The boat made the passage at about 5 knots speed in just over an hour and the prototype was tested on the two phone types mentioned above. Below are the results of this user test (Porathe & Ekskog, 2018).

### Alarm Execution

The function to automatically turn on the application when leaving port was not developed for this first prototype. The application was manually turned on when the test run commenced. When the course-speed vector intersected the NoGo area, the alarm was triggered, both while the phone was "sleeping" in the pocket or (as in Figures 8.5–8.7) when the phone was used to actively monitor the water ahead of the boat. By touching the stop sign, the alarm is acknowledged and silenced, and the stop sign disappeared. However, the vector remained red as long as it was intersecting a NoGo area. This feature worked perfectly as designed and the comments from all the users were very positive.

### NoGo Areas

The AR layer was projected over the camera image based on a virtual camera positioned by latitude and longitude from the phone's GNSS sensor, and the virtual camera's direction was based on input from the phone's internal magnetic compass. Both these sensors had fluctuations as opposed to the camera image, which of course moved only when the phone moved. This resulted in smaller or larger fluctuations of the AR layer over the camera image. The AR layer with the NoGo areas, course-speed vector

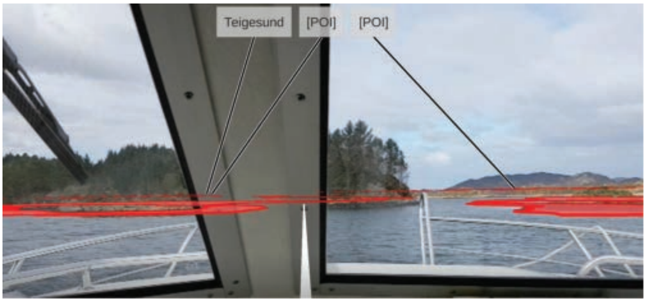

**FIGURE 8.5** Screen dump from the Galaxy test phone. The projected NoGo areas in red. The 30 second course-speed vector in white just before the alarm is triggered. The pointers showing three points of interest (two of which is hidden behind the island). (Photo courtesy of the author.)

**FIGURE 8.6** Screen dump from the Galaxy test phone. The grounding alarm has been triggered with both an aural and a visible alarm. (Photo courtesy of the author.)

**FIGURE 8.7** A very narrow passage on the test track. The distance between the 1-m shoal and the small skerry is 33 m (in the chart, left). Right, the app view entering the narrows (northbound). (Photo courtesy of the author.)

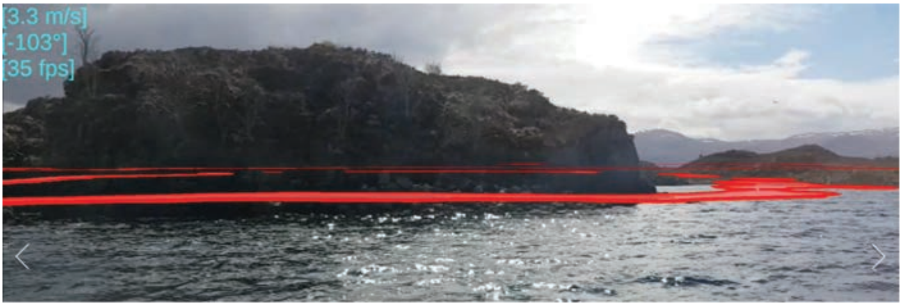

**FIGURE 8.8** The picture shows the offset of the augmented reality (AR) layer with the red NoGo areas. There is a vertical offset and a horizontal and fluctuating offset due to noise in the phone's internal compass. However, users judged it acceptable during the tests. (Photo courtesy of the author.)

and POI pointers would float or jump in the image, mostly in the horizontal plane. These fluctuations would be more or less prominent depending on factors such as if the camera was being panned and/or magnetic disturbances in the boat or in the area. The sensitivity to magnetic disturbances is illustrated by this example: one phone tested had a leather cover that could be closed over the screen with a magnetic lock. This lock jammed the compass causing the AR layer to become unreliable.

The horizontally fluctuating AR layer was the one disappointment in an otherwise successful test. Ideally, the layer with its added information should be steady and "glued" to the camera image, in the test prototype it jumped or sailed some 5°–10° to either side of its intended position. However, the user group judged it to be within reasonable limits. This was because the inside of the NoGo areas was visually easy to pair together with the island's beach line, making the fluctuations "some kind of visual expression of uncertainty" (user comment). In Figure 8.8, an offset to the right and slightly up can be seen. The beach line of the island and the front beach line in the inner hole of the red NoGo areas match. Note also that the NoGo areas behind the island are visible which they should not be. Theoretically, they could be clipped using an invisible 3D terrain model in some future version of the app. This 3D terrain model could then be shown during darkness and fog when the camera showed nothing. However, the most important thing was that the triggering of the grounding alarm function was not affected by the fluctuations due to the magnetic compass. The alarm computation was done entirely in the map layer using the relatively more stable GNSS position.

## Points of Interest

The pointers to named points of interests (for example, lighthouses, buoys and other marks) are potentially beneficial as a second source of information to cross check the visual integrity of the system. However, this feature was not tested as we did not get access to names of the markers in the area (which were not present on the chart). In the prototype, most marks only carried an anonymous "POI" label. This feature will be investigated further.

### Survey

After the test voyage and a short debriefing, the six users answered some questions in a small survey. The first question was whether they thought that the tested prototype could have any favourable effect on boat navigation. On a scale from 0 to 100, where 0 was “no favourable effect” and 100 “large favourable effect”, they were asked to indicate their answer with a cross. The mean result of all six users was 83, close to “large favourable effect”.

The second question dealt with the usability of the prototype application. On the same type of scale from 0 to 100, where 0 was “simple to use” and 100 was “difficult to use”, they were asked to mark their answer with a cross. The mean result from the six users was 13, clearly on the “simple to use side”.

They were also asked to comment on the prototype and asked if they missed any functions. Three answered “no”, one gave no answer and the remaining two made these comments: “The matching between the AR layer and the camera image could be better”, “Automatic Identification System (AIS) data could be added”, “Some adjustments and it will be fine”, “Get it out as soon as you can, new versions can come later”.

During a concurrent television interview (NRK, 2017), one of the users commented on the alarm function: “I am often out sailing in my boat and when tacking we often want to use the water between the islands as much as possible, and then often go close to land. If we could get an alarm by a buzzer in the pocket instead of having to constantly look on our navigator screen, that would be great”.

## ONGOING AND FUTURE DEVELOPMENT

The proof-of-concept was successful, but after 2017 the development stopped lacking funding. However, the user group in Ulsteinvik continued testing the app, now named *GrunnVarsel*. The area was very limited to the archipelago west of Ulsteinvik but the user group managed to uncover some important problems not found during the initial user test. Figure 8.9 shows a screen from the test videos made by the user group. One such important problem was that when the side of an island fell steeply into the sea, there was no NoGo area polygon generated and thus no warning. In

**FIGURE 8.9** Tests in October 2019. To the left two tested smart phones where the grounding alarm has just been triggered. To the right the chart plotter shows speed position, heading and distance to the triggering depth curve. (Photo courtesy of Harald Notøy and Leidulf Garshol.)

these cases, there needed to be a safety margin manually added to the beach line (and also around buoys and markers moored on water deeper than 3 m).

The app has now also been ported to the iOS (Apple) platform. In 2020, the decision was taken to start a second phase of the development with the same actors and financed by the Norwegian Coastal Administration. This time, the test area will be outside Tønsberg on the Norwegian south coast and the test will focus on technical benchmarking and reliability of the app.

## DISCUSSION

The intention of this project has not been to develop an application to replace traditional navigation methods but to create a "last line of defence" against accidents. However, it will be difficult to prevent a few boaters from using it as a sole means of navigation. The question is: If we develop a "simple, stupid" application, which facilitates boating for leisure mariners without navigational training, – do we then lure new "unfit" groups of people out on the sea, which in the end might lead to more accidents? And, do we contribute to the de-skilling of leisure mariners?

Let us make a parallel with professional navigation. Traditionally, ship's positions were acquired by measuring the angles to the sun or terrestrial landmarks. After some calculations, you obtained a "historical" position, where the ship recently was. This position was then manually plotted onto the paper chart. There were abundant opportunities of making errors during the measurement, the calculations or during the plotting, let alone that overcast days or bad visibility sometimes made measuring the sun height impossible.

When the radio-based Decca and Loran systems and later the global positioning system came, the measuring process was automated and only the manual plotting into the chart remained until Electronic Chart Display and Information System (ECDIS) allowed the officer to have the ship's position automatically plotted on the chart in real time. In 1989, the IMO issued the first provisional performance standards for ECDIS (IMO, 1989) and in 1995 the US Coast Guard presented an early human factors study (Smith et al., 1995). It concluded that "ECDIS had the potential to improve upon the safety of navigation, compared to conventional procedures", and that "there was strong evidence that the use of ECDIS increased the accuracy of navigation, […], and reduced the proportion of time spent on navigation, with a corresponding increase in the proportion of time spent on the higher risk collision avoidance task. In addition, ECDlS was shown to improve geographic 'situational awareness' and to reduce navigation 'errors' " (Smith et al., 1995, P.VIII). Spontaneous comments such as "Navigation goes away as a task" were made by the participants.

However, this was achieved at the cost of what we call de-skilling. No longer did the mariners need to train their skills in taking sun heights with the sextant or bearings with a pelorus. They became more dependent on the automatic systems. In an article in the *Journal of Navigation*, Edmund Hadnett (2008) from the Port of London Authority reacted to the de-skilling of navigators in dependence on modern bridge technology leading to "over-confidence in situation awareness, encouraging individuals to take far greater risks than was previously the case where a good look-out and a safe speed were intrinsic parts of watch-keeping". Hadnett (2008) concluded that "The drive to improve safety at sea by the introduction of electronic navigational equipment to enhance situation awareness and assist the watchkeeper has unwittingly compromised safety standards by reducing the core competences that were demanded of previous generations and engendering the undesirable human trait to select the easiest option".

Furthermore, de-skilling continues, now the ECDIS itself has become too complicated. In the foreword of the UK Maritime Accident Investigation Board's (MAIB) report after the Ovit grounding in the English Channel 2013, the UK Chief Inspector of Marine Accidents wrote "This is the third grounding investigated by the MAIB where watchkeepers' failure to use an Electronic Chart Display and Information System (ECDIS) properly has been identified as one of the causal factors." (MAIB, 2014. P.1)

However, although the observations that the de-skilling amongst professional navigators are undoubtedly true, the safety and reliability of modern shipping keep improving from year to year. To provide a perspective, it is interesting to note that in the 3 years 1833–1835, on average 563 ships per year were reported wrecked or lost in the United Kingdom alone (Crosbie, 2006). The world fleet of tankers, bulk carriers, containerships and multipurpose ships, which have risen from about 83,000 ships in 2011 to more than 98,000 in 2020 (UNCTAD, 2020). The global number of reported total shipping losses of over 100GT declined during 2019 to 41 – the lowest total this century and a close to 70% fall over 10 years (Allianz, 2020). So, although automation has led to de-skilling, it has also led to safer shipping. The question now is, can the same argument be made for technology in leisure navigation? I would say yes and argue that a simple, automated tool, warning leisure mariners against grounding, will potentially result in fewer accidents if properly developed in the process of going from prototype to product.

## CONCLUSION

Sensemaking in small and fast leisure crafts works differently than in the protected environment of slower and lager boats. In this study, a simple, smartphone-based safety application was developed and tested. Leisure boaters often have a limited knowledge of navigation according to accident statistics, and the application was designed to be easy to use and understand without prior knowledge. It worked in two ways: (1) In a "turned off" mode in the pocket, the phone would give an alarm 30 seconds before the boat entered into "dangerous waters" (depth less than 3 m). The boat owner was then expected to immediately stop the boat. (2) Picking up the phone, the owner could look through the application's camera view and see red "NoGo Area" polygons overlaid on the camera image. By looking around, he or she could then detect navigable water and continue the voyage.

The application contained a high-resolution map of the 3-m depth contour extracted from a nautical chart. This map was then projected on the camera image's "egocentric view" of the surroundings, thus bypassing the potentially cumbersome mental rotations a human navigator has to do when comparing a traditional exocentric map with the world around. This would facilitate use by inexperienced boaters.

The application was tested on a small group of six Norwegian, all male, all experienced, leisure craft mariners. The size and configuration of the test group limits the generalisability of the results, but the group had highly positive views of the tested prototype, which encourages continued work on this project.

Future work includes adding some limited features asked for by the user group while still maintaining a simple and easy-to-use app. The most prominent new feature will be the ability to import a pre-planned route from a nautical chart application (or an official route from the Coastal Administration) and show this route in the AR layer overlaid in the camera image, thus not only showing dangers to navigation but also offering way-showing.

The intention of this experiment was user experience (UX) and to find out if such an egocentric AR application would be beneficial and would potentially be used by leisure mariners in an archipelago setting. Precise technical benchmarking and testing of different smartphone brands potentials and problems were not undertaken, but is the task for an ongoing project.

The intention is not to replace the normal navigation procedure, but to add an extra safety layer.

The initial goal with this design project was to see if we could manage to develop a safety tool that would allow fast leisure boaters to benefit from the digitalisation of navigation that has been going on for many decades. This digitalisation has resulted in a dramatic decrease in accidents with commercial ships. The exposed environment in many small and fast boats has prevented sensitive and voluminous equipment to be installed and read during voyage. And if such a tool would be found beneficial by the user group, the proof-of-concept with a very limited user group was quite successful and the project has commenced in a second iteration in the Tønsberg area in southern Norway in 2020.

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