

Supporting Situation Awareness on the bridge: testing route exchange in a practical e-Navigation study

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ABSTRACT: In a simulator study parts of the ACCSEAS project's e-Navigation route exchange concept termed "intended routes" has been tested in a full mission bridge simulator using experienced bridge officers in port approach scenarios. By "intended routes" we mean a service where ships underway send a number of waypoints ahead of their present position, from their voyage plan; thus sharing their intentions with ships within radio range. Other ships "intended routes" become visible on the ECDIS screen on request and can be queried for where my own ship is when the other ship is at the cursor indicated point on the displayed "intended route". Observation, focus group interviews and questionnaires were used to capture qualitative data on professional acceptance, the concept, procedural changes, functions and interface. The tested service was very well received with high acceptance ratings.

1. INTRODUCTION

Sometimes people misunderstand each other's intentions. That happens at sea as well as in all walks of life. To prevent accidents at sea the International Maritime Organization (IMO) has established the International Regulations for Preventing Collisions at Sea (COLREGS). They are supposed to unambiguously determine which ship is to stand on and which is to give way in a collision avoidance situation. However misunderstandings occur, a collision in the English Channel in 1979 can serve as an example:

The Liberian bulk carrier *Artadi* was proceeding NE in the Traffic Separation Scheme (TSS) in the Dover Strait in restricted visibility (see Figure 1). The French ferry *St-Germain* was approaching from the east. She was spotted in good time on the radar of the *Artadi*. Coming from starboard, *St-Germain* was the stand-on ship according to rule 15 of the COLREGS, however, according to rule 19 both ships should give way in this case of restricted visibility. The pilot and master of the *Artadi* expected *St-Germain* to keep speed and course and started to make a starboard turn to give way. However, on-board the *St-Germain* the intention was not at all to cross the traffic separation scheme diagonally in front of *Artadi*, but instead to turn port and follow outside the boarder of the NE going traffic lane until the traffic cleared and she could make the crossing at a right angle (according to rule 10c). In the subsequent collision two persons were killed (Kwik,

1984; Office of the Commissioner for Marine Affairs, 1979).

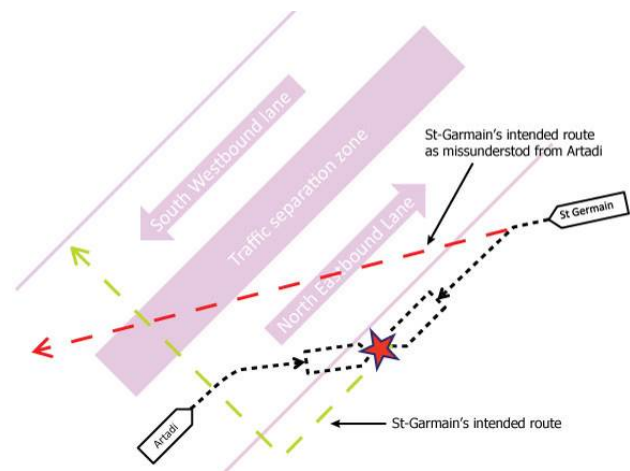


Figure 1. Misunderstanding intentions: The collision of French train ferry *St-Germain* with Liberian bulk carrier *Artadi* in the English Channel, 1979.

1.1 ACCSEAS

One of the surprising findings in the recently concluded EU project ACCSEAS (Accessibility for Shipping, Efficiency Advantages and Sustainability) was how the development of off-shore wind turbines would restrict shipping in the southern part of the North Sea in the future. Looking at the plans for future wind farms the project came up with the map in Figure 2 (ACCSEAS, 2013). The polygons are

planned wind mill parks in some stage of concession. We here see a clear trend: the shipping industry must in the future be prepared to share ocean space with a lot of new actors, not only wind energy, but different sorts of off-shore farming as well.

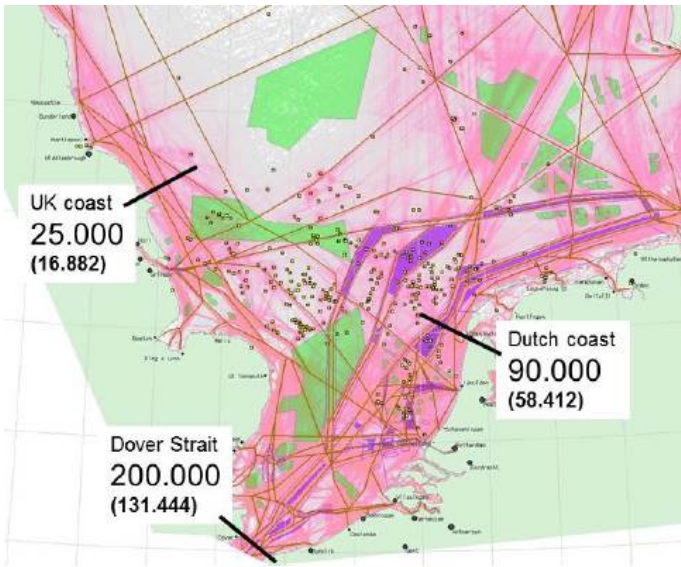


Figure 2. The south part of the North Sea. Number of ship predictions for 2020+ (2012 numbers in parenthesis). The polygons are planned areas for wind turbines. The fussy lines are 2012 traffic density plot summarized in the solid lines, darker polygons areas are TSS separation zones. (ACCSEAS, 2013)

The problems of navigation caused by one of these new installations might be exemplified with the newly constructed Thornton Bank wind mill park outside Zeebrugge on the Belgian coast (see Figure 3).

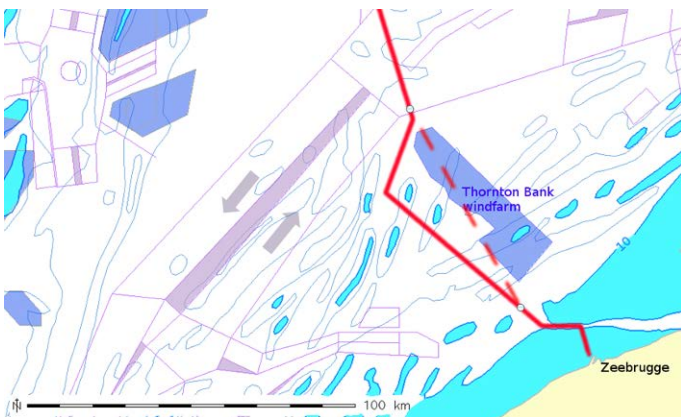


Figure 3. The newly constructed Thornton Bank wind mill park has forced the P&O ferry to change its route causing possible risks of misunderstandings.

The P&O ferry between Zeebrugge and Hull in the U.K. needed to change its route due to the newly constructed park. While the old track (dashed) gave some indications of the ferry's intentions, the new track (filled line) headed straight towards the main English Channel TSS at a right angle as if the inten-

tions were to cross straight over. This TSS is the most trafficked route in the world with 133 000 passing's in 2012 (ACCSEAS, 2013). Ships coming up the TSS towards the North Sea could potentially misunderstand the intentions of the big ferry approaching from starboard. And as more wind mill parks appear we are getting closer to the street-like situation we are used to in road traffic in cities. Only, cars have direction indicators which are something we do not have on ships. The only indication of the intent of the approach P&O ferry would be to see the destination through the AIS static message and try and deduce the intentions from there.

That is why one of the suggested solutions from the ACCSEAS project is a service aimed at showing ships intentions to other vessels in the vicinity.

1.2 Tactical and strategic route exchange

Situation awareness is a fundamental property for humans driving any kind of vehicle. Endsley defined it in 1988 as "the perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future." Not only knowing what is going on, but also being able to predict what will happen in the future is crucial for navigation ships with large inertia.

With regards to the future whereabouts we will use the following taxonomy when talking about ships future positions (see Figure 4).

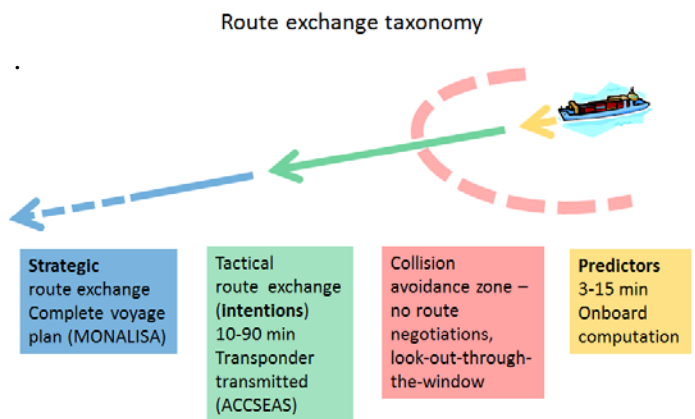


Figure 4. Taxonomy of route exchange based on how long in advance the service aims to predict vessels future positions. The levels are explained in the text.

1.3 Predictors

On the very close scale ships use *predictors*. Predictors may be able to look some 3 to 15 minutes into the future and are typically very reliable on short time ranges. They simply extrapolate present speed and heading a number of minutes into the future. This type of simple prediction is typically used by AIS and ARPA radar where targets show course and

speed by the direction and length of a vector, sometimes augmented by symbols for rate of turn (ROT) prediction extrapolating ships present turn speed when conducting a turn.

Because ships are heavy and cannot change course or speed very rapidly, predictors are reliable up to some 3 minutes. Longer predictions rely on the ships not making any course speed changes.

The predictor is often used to investigate possible close quarter situations by changing the time setting for own and other vessels course speed vector on the ARPA or the ECDIS onboard.

1.4 Strategic route exchange

In the other end of the scale we have long term strategic route exchange which is part of the Ship Traffic Management (STM) concept which is being investigated by the MONALISA project. Every ship is mandated to make a berth-to-berth voyage plan before leaving port. In the old days the voyage plan was a pencil line on the paper chart; today the voyage plan resides in the electronic chart system, the ECDIS. The main objectives for sharing voyage plans are safety and efficiency. By coordinating voyage plans collisions might possibly be avoided by awareness of upcoming congestions. By coordinating voyage plans with availability of port facilities, fuel and emissions might be saved and efficiency in the transportation chain increased.

Although it is easy to find the present position and destination of any ship through AIS data on the Internet, the voyage plan is considered to be of business interest and not to be shared with anybody. Strategic route exchange therefore involves a coordination center doing the route coordination.

1.5 Tactical route exchange

On a level between the short range predictors and ships entire voyage plans, we have the *Intended routes*. The idea here is to transmit a number of waypoints ahead of the ships present position with the AIS message (or some future system) and so show any ships intentions some 60-90 minutes ahead. Presently we have tested sending out 8 waypoints. The shown intentions will then differ in length depending on the density of waypoints.

The intended route should be integrated in the ECDIS and shown on demand not to clutter the screen with all ships intended routes.

1.6 Collision avoidance zone

In earlier tests with intended routes users intuitively started using the intended routes to negotiate behavior for collision avoidance (see Porathe, Lutzhoft, & Praetorius, 2013) it became clear that there needed to be a psychological cut-off distance where naviga-

tors stop using computer systems to negotiate evasive maneuvers and start using basic COLREGS based on visual observation and ARPA. The radius of that zone would be dependent on several factors like traffic density, vessel type, speed and weather. The range might typically be 6-10 miles.

However, having said that, it was found in the earlier study that negotiating by clicking and dragging waypoints in the intended route might be a way of avoiding to enter into a close quarter situation. Provided it was done in good time.

2 METHOD

Human (or User)-Centered Design is a design philosophy that aims to involve the user throughout the design process from early context enquiries on through prototype design and different level user tests (Norman, 1988).

In research projects like the ACCSEAS new solutions are tested in very early phases of the development process with the goal to investigate *professional acceptance* of a new service. Mainly qualitative data is collected with methods like Usability testing. Usability is defined as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use." (ISO 9241-11) Also learnability and safety are important aspects to investigate.

In this test users (ship officers and VTS operators) were asked to use the Intended route service during different port approach scenarios. The testes had a high level of ecological validity through the use of full mission bridge simulators and VTS simulators. During the test observers on the bridges and in the VTS filmed and asked questions to the participants who were encouraged to think aloud. After the scenarios a debriefing session was held. The participants were also asked to fill in a survey rating their *professional acceptance* of the Intended route service.

2.1 The e-Navigation Prototype Display

To be able to test the Intended route service an ECDIS-like test platform had been developed by the Danish Maritime Authority: The EPD (E-navigation Prototype Display). The platform contained enough ECDIS features to be able to replace the ordinary ECDIS in the full mission bridge simulators used.

An EPD Shore system had also been developed for use in the VTS center. All systems had the ability to exchange route information such as the Intended route service (but also Suggested routes from shore to ship and strategic route exchange as explained above).

By right-clicking on an AIS target and selecting “Show intended route” in the EPD the intended route of the vessel was shown (if the vessel indeed had the Intended route service, which was not always the case, as was thought realistic). There was also a choice of “Show all ships intended routes”. In Figure 5 the portrayal of the Intended route service is shown.

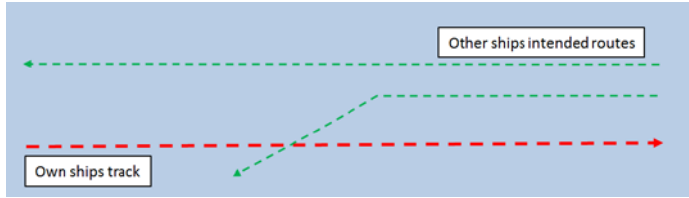


Figure 5. This is how the own ships route (below) and two ships intended routes (top) was portrayed in the EPD.

There was also a feature that allowed the navigator to query other ships intended routes based on the planned speed that had been entered into the voyage plan. By moving your cursor over the other ships intended route a *CPA Guidance Line* would appear connecting the cursor with the point on your own ships track where you would be when the other ship was on the position of the cursor (given planned route and speed was kept). The portrayal of this feature is shown in Figure 6.

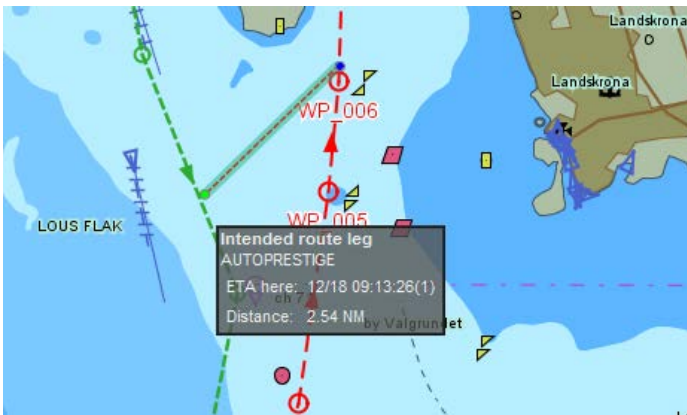


Figure 6. The CPA Guidance Line connecting the point the cursor is at on another vessels intended track with the position the own vessel is calculated to be at the same time.

The same feature is used for the *CPA Alert* feature. If the calculate CPA of any vessel transmitting Intended routes becomes less than a predefined distance, e.g. 0.5 mile, CPA Guidance Lines calculated for each minute becomes visible highlighted in yellow together with the risk vessels intended track and an audible alarm(see Figure 7).

2.2 Simulator study

The study took place during four days in the end of September 2014 at the Simulator Centre at the Department of Shipping and Marine Technology at Chalmers University of Technology in Sweden.

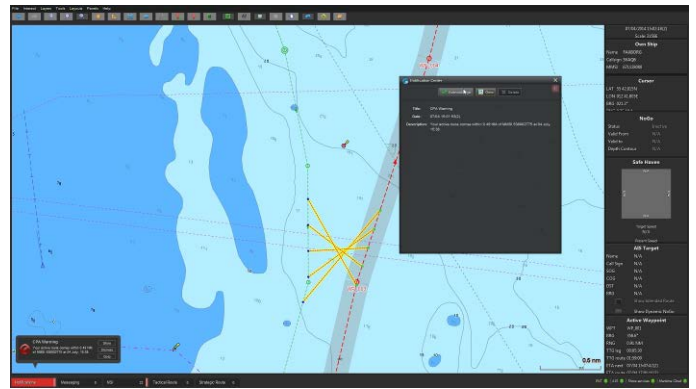


Figure 7. The CPA Alert feature warning for a possible future close quarter situation. Note here the difference between ARPA CPA (based on present route and speed) and Route CPA based on the Intended route.

Two Transas 5000 bridges and one VTS station were used, using parallel worlds so that the two ships could not see each other but interacted instead with target ships controlled by the simulator instructor station. The VTS could see both ships on different screens.

Two other e-Navigation services (the Suggested route, and the NoGo area services) were also tested. These results are presented separately.

2.3 Scenarios

Five scenarios in the river and approach to the Humber Estuary were suggested by experts from ABP Humber. The area was chosen because high ship density and changing tidal situations. The area had also a VTS service.

Own ship in all scenarios was a 180 m long ro-pax ferry. An overview of the geographical limits of the 5 scenarios can be seen in in Figure 8.



Figure 8. The image shows an overview of the five scenarios in the Humber River areas in eastern U.K.

In the first scenario the ferry was bound for Hull approaching the Sea Reach TSS in northerly gale. In order to avoid heavy rolling with beam seas the vessel was to re-route using the Rosse Reach TSS.

The second scenario involved a special transport (wind turbine propeller) with extensive width. Thus requiring an exclusion zone according to port regula-

tions. Own vessel was re-routed by the VTS using the Sunk Dredged Channel (see Figure 9).

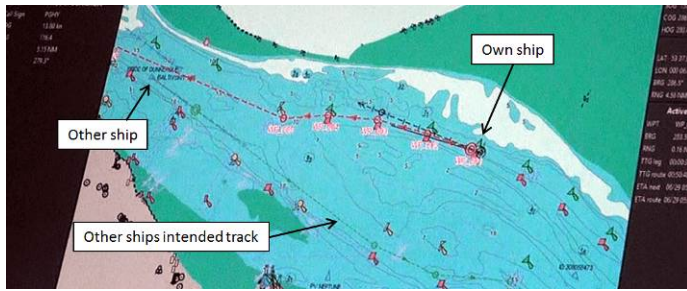


Figure 9. Screen shot from the EPD during scenario 2: own ship in Sunk Dredged Channel outbound ship passing through the main channel.

The third scenario was traffic congestion outside Immingham Oil and BulkTerminals. Several large ships was maneuvering in the area and the ferry was re-routed by the VTS using the Foul Holme Channel.

The fourth scenario was a contravention scenario in the TSS off Spurn Head. A deep draught vessel needed to use the inbound TSS and the ferry was asked to use “the southern part of the inbound TSS” when passing.

The final scenario involved a vessel leaving Anchorage A for Immingham with a strong south bound current. This situation has several times caused ships to hit the North New Sand N-cardinal light buoy.

Most of the scenarios involved the VTS at Spurn Head sending out route suggestions (which is disseminated in a separate conference paper), but all scenarios involved several other ships. Thereby reflecting the Humber area being one of the busiest ports in the UK.

The five scenarios took two days with familiarization, briefings and debriefings between all scenarios and the final discussion at the end.

2.4 Participants

11 professional British, Swedish and Danish bridge officers, harbor masters, pilots and VTS operators with experience from traffic in the Humber area were used for the test. All the participants were male from age 32 to 58, with a mean age of 47 years. They all had a sea time ranging from 12 to 30 years, mean 22 years.

Each bridge was manned with two bridge officers, which would be realistic considering that the situation was approach to port with restricted waters and heavy traffic.

The Spurn Head simulated VTS was manned with two VTS operators from the actual VTS center. The VTS operators were available from the whole test except on the last day when a Gothenburg VTS

operator took over the chair (after having worked together with the Humber operators the day before).

3 RESULTS

The comments from the videos and discussions were analyzed and the results are below presented in four levels: conceptual, procedural, functional and HMI (Human-Machine Interface). Quotes are from the video recordings.

3.1 Conceptual level

All the participants agreed that this service was valuable. “I might not have said so three days ago, but now having used it: Yes, the concept is very good. Provided the data that is displayed is correct.” (said by Humber pilot with 12 years’ experience). On a question if someone in the group was against the concept, there were head shakes and silence. Several of the participants soon got used to the service where they could see ships intentions; one said “after having used the system for six hours I find it annoying not being able to see ships intentions.” (He was referring to the fact that some of the target vessels did intentionally not send out Intended routes.)

Training

Several participants talked about the importance of “correct data”: that the voyage plan was updated and correct and from berth-to-berth. It is necessary that the bridge personal are trained and can handle the system. Generally today, the Humber participants explained, the tankers coming into river have very good passage plans because they are heavily vetted. The general cargo and bulk carries, however, generally tend to have a voyage plan that either stops at the pilot station, or – if it goes all the way to the berth – do so by a couple of haphazard waypoints. If the displayed data is not correct it could be a dangerous concept: you think you know where someone is going, but instead they are going a completely different route. E.g. there might be a change in the voyage plan and because the 2nd officer responsible for voyage planning is not on watch, the new intentions are not displayed.

One of the pilots said: On a big ship like the P&O ferry they have the time and people to do the voyage plan prudently with the right speed on all legs, etc. But on a small coaster they will just click out the waypoints, they don’t have the time or the people to do anything else. “So my concern is not so much the quality of the proposed system, much more so, the quality of the people onboard that must be able to use the system.”

Cluttering

Going into details, the participants felt that it is important that rather than displaying all ships Intended routes all the time (which would clutter the display) you can (as indeed was the case) “interrogate” the display for intentions of vessels of interest.

Turning off transmission intended routes

A discussion took place of what to do if a ship for some reason had to deviate from its route. One suggestion from the developers was that there should be an easy (or maybe even automatic) way of turning off the transmission of the Intended route if the vessel for some reason deviated too far from its intended voyage plan. One of the pilots answered “Yes, having no data is better than having the wrong data.” There was an agreement that it could be a good thing if the system stopped sending route intentions if the ship was some predefined distance from its intended route for a predefined amount of time. But for minor deviations from the intended route, like overtaking, or giving extra space in a meeting situation, no one in the group felt it was necessary to stop sending, or changing the intended route. It would be obvious why the deviation was made.

There was also an agreement that the Intended route service should not be used as a collision avoidance tool in close quarters situations.

Use in approaches and open sea

It was felt that the Intended route service was probably being more important in open seas than in port approaches like the Humber River, because there is already a risk mitigation service like pilot onboard and VTS that keeps an eye on things. But for ships coming to the pilot station it is good, but there are also uses on the river. Approaches to junction points is an example where the Intended route service can be very valuable, for example a small ship leaving the Baltic Sea destined for Rotterdam may equally well take a route via The Sound, the Great Belt or the Kiel Canal. Being able to see the intended route makes it possible for an overtaking ship to place itself on the proper side of the other ship.

Trust

One of the participants said on a question if he would trust an Intended route, that he would trust it in the same way that he today trusts the AIS information. “I will not trust 100 percent, but it is helpful.”

Planned speed vs. current speed

There was a major discussion on whether planned speed or current speed should be used when calculating a ships future position. The Intended route service as it was implemented in the prototype system was using the planned ETA in all waypoints to calculate where own and other ships would be at a

certain time. The planned speed was based on the notion that ships should be at their final destination precisely in the planned arrival time. However, one of the pilots commented that in reality ships will not be following their planned speed exactly why the ETAs in different waypoints (at least the closest ones) instead should reflect the actual, current, speed of a vessel. “You always want to go a little bit faster to make sure that you can make your ETA Rush to wait. You will burn a little bit more fuel, but it cost more to let the stevedores, the lorries, etcetera wait.”

Pre-checked Alternative routes

An interesting issue brought up was use of *alternative routes*. When you are doing you berth-to-berth voyage plan you may make e.g. two alternative routes on either side of e.g. an island or a bank. Both of them will be checked for UKC etc. One of them would be the preferred one (visible as the Intended route) but the officer could easily change to the alternative route if the weather or traffic situation so demands

3.2 Procedural level

Workload

It was discussed if the Intended route service would increase workload compared with today to a point where you would need to have an extra person on bridge just to run the system. Observation during the test scenarios showed that the usability of the system was not optimal yet and the participants were given help when they did not know how to activate a feature. Several participants commented however that they would expect the handling of the service to be smooth once they mastered the system. The test scenarios took place close to port or in the approach and this is where you would normally be two persons on the bridge. In a deep sea passage there would be only one officer on the bridge, but then the situations would normally be a lot calmer. “The workload remains the same, but the system will increase the quality of decision making,” was one comment.

The Intended route service might lessen workload for the pilot as the rest of the bridge team can see the intentions and future whereabouts of other vessels. One of the pilots mentioned that he spent a lot of time explaining to the captain or watch officer what was the intentions of other ships in the area leaving berth or entering into the approach channel.

One of the VTS operator said that, given the VTS had Traffic Organization Service (TOS) authority, the Intended route service would greatly increase the opportunity and possibility to organize the traffic. This would be of great value but would also increase the workload in the VTS.

3.3 Functional level

Normally you have your ECDIS off-centered with most of the space in front of your ship and very little space behind you. But sometimes you are overtaken by a much faster ship. If you use route CPA as a filter for turning on Intended routes automatically you might get too many intended routes visible cluttering the screen, but it would be nice if you could have a “guard zone” astern which would turn on Intended routes only from overtaking ships. It would probably be necessary to have a “harbor” and a “sea” mode with different route CPA filter settings.

An issue could be that you are making an approach. You investigate the other vessels intended routes and you make a strategy for how you want to deal with upcoming meetings. Then one of the vessels changes his intended route. The chance is that you will not notice that. It might be useful with some form of highlighting of changed intentions.

3.4 HMI level

Intuitive use

The user friendliness of the system was discussed. It was pointed out that it was important that all watch officers onboard could use the system so that updates of Intended routes did not have to wait for that the responsible navigation officer (normally 2nd mate) was on watch. “But I think if we were here for another week we would be a lot quicker and comfortable with it. It is not a difficult system to use. It is more a question of familiarity, rather than the system being complicated.”

Cluttering

During the first round of tests users commented on the HMI that it was difficult to distinguish intended routes from each other as they all had the same light green color, and also to know which track belonged to which ship (the label with ship information was only shown on mouse-over on the vessel AIS target triangle). Because we had the programmer present during the tests the interface was updated for the next set of trials starting the day after. In the new HMI an Intended track could be queried by pointing at it with the cursor. The track would then become highlighted in a darker green color, the vessels icon would become highlighted with a circle and the position on the intended track line where the cursor pointed would be connected to the own ship’s position at the same time by a CPA Guidance Line (see Figure 6). These lines could be used to query another ships track about the closest point of approach (CPA). The second round of participants found these new features useful and de-cluttered the interface somewhat.

Overtaking another vessel on a similar route is still difficult because the intended route of the other vessel may be hidden by your own route.

It was also mentioned that routes needed to be transparent so that they did not hide e.g. depth figures.

“The green color of the intended routes makes them difficult to see; especially if you got more than one. Maybe you could use different colours; you need to be able to separate one vessel from another.”

The text and symbols are too small in the EPD. “When you get to our age you cannot see such small print”

3.5 Survey

The participants were asked to summarize their impressions about the service in a survey with three questions. Only 9 of the 11 participants answered the survey as 2 had to leave early.

1. What is your opinion about the tested Intended routes concept? All the 9 answering participants answered Good or Very good. No-one answered I don’t know, Bad or Very Bad.

2. Do you think a similar Intended routes concept will become reality in the future? On this question all 9 participants answered Probably or Most probably. No one answered I don’t know, Probably not or Most probably not.

3. What is your professional opinion about the system tested? On this question the participants were asked to rank their acceptance on a scale between 0 and 5 where 0 was “Totally unacceptable”, 1 was “Not very acceptable”, 2 was “Neither for, nor against”, 3 was “Acceptable”, 4 was “Very acceptable” and 5 was “Extremely acceptable”. The mean acceptance score from the 9 answering participants was 3.7, somewhere between “Acceptable” and “Very acceptable”.

4 DISCUSSION

It is of course of outmost importance that “intended routes” are understood as just “intentions” and not as a deterministic future. This was discussed very much during the 4 day test, but the concept of intended routes (as indicated by the very name of the service) seemed to be fully understood by the participants. There was an agreement that there should be a function that allowed ships to stop sending Intended routes if they for some reason had to change their intentions and did not have time to change the voyage plan on the chart display, but for minor offsets, like overtaking another vessel, or giving extra room in a close quarter situation, they did not feel it was necessary to turn off the Intended route. What was going on would be obvious to everyone.

The scenarios chosen were normal everyday situations and they were based on real scenarios that were either described to us by the Humber pilots and VTS operators on a previous focus group meeting

held in Hull several months before. In one case (The number 4 scenario, contravention in the TSS) the scenario was based on a AIS video provided by the Spurn Head VTS. In no case did we see what we considered any dangerous behavior by the participants onboard or ashore.

Planned versus current speed

The discussion on planned versus current speed was interesting. One major idea with route exchange on the STM level is to make a new energy and emission saving paradigm with slow steaming and just-in-time-arrival replace the old wasteful full-speed-ahead, then anchor and wait paradigm. To make such a system work ships would be expected to follow their planned voyage plan exactly. This will be necessary in order to calculate safety feature using *dynamic separation* where no two ships would be allowed to set out on a voyage plan where they would be at the same place at the same time. So both from a fuel and emission saving, as well as a safety perspective, it would be essential that current and planned speed was the same. This is not the case today, where the present paradigm is “rush to wait”, as was mentioned by one of the participants. Keeping a very exact speed down to a tenth of a knot, according to the voyage plan, would be difficult manually and would require a *speed pilot*. (Which like an autopilot automatically keeps the set speed.) The advanced speed pilots needed are today only used by some ferry lines, and are not common in the merchant fleet. A ships speed is also depending on being within a limited window of propeller revolutions and the speed resulting from the number of revolutions will depend on wind, sea state and depth. So while waiting for engines and speed pilots that will allow an exact voyage plan to kept, the use of current speed to calculate ETA in all waypoints except those designated as “critical” (e.g. final destination, arrival at a lock or passing a congested area where traffic management is essential) might be a solution.

Alternative routes

The alternative route suggestions brought up during the test is maybe more relevant to the strategic route planning of the MONALISA project than the tactical Intended route of the ACCSEAS, but never the less very interesting. If the Ship Traffic Coordination Centre suggested in MONALISA would be aware of both the preferred and the alternative routes, they could, if need be, use the Alternative as a new strategic route suggestion. That way the shipping companies would retain more control of the suggestions made by the STCC (which was mentioned as imperative by a cruise ship captain during another simulation in 2013).

Workload

It was unclear whether the Intended route service would increase or lessen the workload on the bridge. In the scenarios tested the situation was port approach with two officers on the bridge. At times one of them would be occupied handling the chart system. To a large extent this could be because they were not proficient with the system (and several also said that the system felt easy to learn given ample time to practice). The system lends itself to making intentions clear and could be used for meeting and overtaking situations, but the system must not be used for collision avoidance in close quarters situations.

The user interface seemed to be intuitive and relatively easy to work with: A participant added a new WP and dragged it to starboard to indicate to a stand-on vessel from starboard that he had the intention to go astern of him. First time user, 50 sec.

5 CONCLUSIONS

The Intended route service was considered a valuable concept.

Intended routes should be displayed on a need to know basis, being able to customize and not to clutter the screen

The green, dashed representation was considered OK if the route of a particular vessel was highlighted on rollover to make its track more salient. The routes should also be transparent not to hide important information.

Use current speed to calculate the next 8 waypoints used for the intended route service (unless one of the waypoints is the final destination or otherwise designated as “critical”, e.g. arrival at a lock).

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