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A plan for demonstration tasks and a description of test procedures

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Introduction

This document describes the methodology to be used when testing the HMI (Human-Machine Interface) and functions of the e-Navigation services to be developed in this project. The document describes both methodology for "live tests" conducted on participating vessels and in shore-based services as well as a methodology for tests carried out by using simulations/simulators. The methodologies should be as practical (i.e. non theoretical) since the test planning based on the methodologies should be carried out by non experts. The document does not concern technical testing. Suggest to add amount of time x persons needed to test all the suggested solutions to give a sense of how long it will take in total.

Usability testing of the HMI

The test methods presented below are selected from the domain of user-centered design (UCD) a design philosophy first introduced by Donald Norman in his book *The Psychology of Everyday Things* (Norman, 1998). The basic idea behind UCD is an iterative design process where gradually more refined prototypes are repeatedly tested on the intended users during the development process. This paradigm has necessitated a large variety of test methods that can be used at different stages.

Measures

There are several measures which can be used to approach the usability of a system.

ISO standard 9241

As a base for testing the ISO standard 9241 can be used. Here *usability* is defined as:

> *The effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in a specified context.*

Effectiveness and *efficiency* is then measurable parameters quantitatively and *satisfaction* assessed qualitatively. *Effectiveness* is if and to what degree a task can be accomplished/completed with the tested service, application or product. *Efficiency* could for instance be how fast, with what cognitive effort and/or with how many errors the task was accomplished. *Satisfaction* could be self-taxed ratings of for instance user friendliness.

The second part of the ISO standard stresses the importance of being specific when it comes to users, goals and context: who, what, where.

Who: Test on the target group

Use professional users from the intended user group in the test, for instance bridge officers, VTS operators or pilots.

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What: Scenarios and tasks

Care should be taken to construct trustworthy and relevant scenarios and tasks in which the service or feature is tested. Take advice from professional operators in constructing these scenarios and tasks. Instructions should never be given in general terms, e.g. “try out this application.” Instead the subject should be given a specific and realistic goal directed tasks to accomplish, e.g. “take this ship north through Drogden” or “anchor at anchorage B.”

Where: At sea, in a simulator or in a laboratory

For ecological validity (situation being true to real life) tests are best performed in the proper context of use, for instance on a ship at sea during ordinary operation (if possible, or otherwise during a test voyage). For practical and also safety reasons this might not always be possible.

Therefore simulator tests in a full mission bridge simulator using professional bridge officers in a realistic traffic environment can be a useful substitute for real-life settings (MarineBoard, 1996; Donderi, Mercer, Hong, & Skinner, 2004; Nilsson & Lützhöft, 2007; Nählinder, 2009).

In some cases laboratory settings might be the only option when the tested service cannot be made to function within a bridge environment or might need special technical arrangements.

In cases when control of the environment is needed, a bridge simulator is preferred compared to a laboratory setting due to a higher degree of ecological validity.

In cases where it is not possible to test a service or feature, for instance because it is not ready or it is too dangerous, surveys, interviews or focus groups can be used where the service or feature is described and the usefulness is discussed. This is however a last resort and should be avoided if possible.

Additional Measures

Derived from the User-centred Requirement Handbook (Maguire, 1998),there are several usability goals, besides effectiveness, efficiency and satisfaction, which can be used as measures for the usability of a system.

Usability goal	Description	Possibly measured by
Learnability	The ability to use a system help or manuals to perform the task	*Time to learn to conduct a specific task and number and type of errors conducted during the task execution*
Intuitiveness	Ability to perform a task with limited introduction	*Time to conduct a certain task in combination with number and type of errors conducted*

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		during the task execution, *Scale on which user can indicate the level of experienced intuitiveness of the system*
Helpfulness/supportiveness	Ability to overcome problems that arise	*Time needed to overcome a given problem*
Controllability	Perceived feeling of being in control	*Questionnaire with scales on which the user can indicate the level of control experienced during a task*
Avoiding excessive mental load	Perceived mental effort	*Questionnaire with scales on which the user can indicate the level of control experienced during a task*
Avoiding excessive physical load	Physical effort	Heart rate, respiratory measurement
Safety	To be able to operate the system safely	?

Figure 1: Table of usability goals with description and possible test measure based on the RESPECT usability goals.

Test methods

As implicated above a full usability test should be strived for. However, early in the development process, before the interface has reached a stage when interaction is possible, simpler methods can be used. There are for instance several prototyping methods which can be applied at different stages in the design process of a system. The following paragraphs will give a brief introduction into the most common prototyping methods.

Card Sorting

Card sorting is an interactive participatory method which can be applied early in the design stage. This method is used to determine the information and navigation structure of a system (Arnowitz, Arent, & Berger, 2007). It helps the developers of screen based software systems to pick the right terms to put on menus and buttons and to determine a natural hierarchy of menu titles.

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1-3 users are equipped with a stack of cards where suggested menu and button titles are printed, one on each card. The person conducting the test and the user then discusses the appropriate terminology and when necessary the proper hierarchy of menus.

Wire framing

Wire framing is a narrative prototyping technique which is applied in the beginning of the design process. It helps the developers to visualize conceptual assumptions about the structure of the product and the general interaction. Unrefined sketches of the product are used to demonstrate the interaction flow and navigation(Arnowitz, et al., 2007). Wire framing is usually used as a step towards a prototype. The sketches visualize ideas the designers and developers present for each other.

Storyboard prototyping

Storyboards are narrative prototypes which are used to present the key moments of the user's interactive experience with the system (Benyon, Turner, & Turner, 2005). Based on a specific scenario the interface is sketched and the interaction is described. Storyboards can be used to visualize and discuss design ideas between designer, developer and user.

Paper Prototype

Paper prototypes are simple interactive prototypes representing the user interface as a paper mockup (Arnowitz, et al., 2007). They are based on broad ideas on the design and the user interaction of a system. Paper prototypes are normally used in the beginning of the development and allow the developer to test the system with actual user. Content, form and structure, key functionality requirements and the navigational structure can be tested with them. One major advantage with paper prototypes is the possibility to redesign a product during the testing with users (Benyon, et al., 2005).

The front side of the VHF casing might for instance be drawn up or printed on a piece of cardboard. A slot is cut out where the screen is and as the user tried different functions, different screens are inserted in the slot by the reviewer. This way many mistakes can be avoided at an early stage and at low cost.

Digital Prototypes

Digital prototypes are more or less a digital version of the paper prototype. They can range in their functionality from simple click-scenarios till an almost complete interactive system depending on when in the development process they are applied for testing with actual users. Digital prototypes can be used to represent the task flow and context of use, to validate assumptions on scenarios and user profiles and to test the visual design direction of a product (Arnowitz, et al., 2007).

Wizard of Oz Technique

In some cases prototype services or applications will not be fully functional or maybe not functional at all. A so called *Wizard of Oz* methodology could then be used, meaning that the functionality is faked or

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simulated by some manner. The expression comes from the scene in the book The Wizard of Oz where the small and fragile wizard hides behind a screen and uses a microphone and an amplifier to sound terrifying. In the same way behind-the-scenes-personnel can fake for example automatic features not implemented.

Expert Walkthrough

Human Factors experts can be used to "walk through" the interface of a system or service. This walkthrough can be done either systematically menu by menu, or in the order real tasks would be done. A so called "cognitive walkthrough" will focus on cognitive issues like necessary pre-existing knowledge, or things that the user needs to keep in mind. Some issues will be detected this way, but any person entering the design process will soon become too involved and thereby lose their ability to look at problem with a fresh eye.

Usability Test

A usability test is a test where the full (or as full as possible) application/feature/service is tested. A usability test involves real users in a preferable real environment (see the comments in the beginning of this report).

A test procedure is suggested below.

Test Procedure

1. Identify the product to be tested and its goals

Be specific about what product, feature or service that is to be tested. For instance is it a new hardware appliance on the bridge or in the VTS centre, or is it a new feature integrated in another product, e.g. a new layer on the ECDIS, or is it an extended communication service on the VHF or other communication channel. What are the goal(s) of the product/feature/service?

2. Identify the context of use (users, tasks and environment)

The *who*, *what* and *where*. Who are the intended users? Be specific. Creating *personas* can help to mentally visualize the user. A *persona* is a fictitious character with all the attributes of a real person (e.g. name, age, profession, salary, education, history and maybe even a photo). Develop the tasks according to what was said in the section "What" above. Which task is it supposed to facilitate or solve? Be specific about the goal criteria for a task successfully completed. Identify the environmental conditions during which the product/feature/service is to be used, e.g. indoor, outdoor, lighting conditions, stable or dynamic environment etc. If applicable consider also the social environment, e.g. privacy, stress factors, etc.

3. Check that the product is compatible with intended user characteristics

In a maritime environment this could for instance be: is equipment placed on an overhead console reachable for short people? Is an interface usable also for color blind persons (in positions that do not

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demand full color vision)? Is audio alarms, or voice communication possible in the intended environment, e.g. in engine rooms wearing hearing protection?

4. Decide whether to test one or more groups

Go back to the intended users. Are there more than one group?

5. Identify what to measure

Identify which measures are required, whether there are required values for the measures, or whether two results are being compared. How do you measure *effectiveness*, i.e. a successfully completed task? Is a partly completed task possible? How do you measure *efficiency*? How long time, or how many errors, or can you measure workload? Do you need to measure *satisfaction*? How? Using a questionnaire after the test?

6. Select the test subjects

Select a group of users that represents the intended user group of the product. It is important to decide on their previous experience level. Both professionally and their experience with IT tools. 5 persons from each user group is often enough in product development when the aim is to find serious usability issues(Nielsen & Landauer, 1993). However, remember that in scientific studies where statistical significance is required 5 subjects are not nearly enough. In formative studies (during the development process) a low number of test subjects will do, but in summative studies (to evaluate the success of a finished product) often an 80 % successfully completed task rate with 95 % confidence level is required. Then many more test subjects will be needed. (How many depends among other things on the variance of the results).

For subjects doing the test on their free time a small incentive, e.g. a cinema ticket or a small gift (coffee cup, t-shirt) could be appropriate. For professionals that need to take leave off their work an incentive comparable to lost salary is OK (if resources for consultants are available in the WP).

7. Design the test scenarios

Design a test procedure that includes a representative group of users using the products to achieve the main goals of use. A test scenario shall be specified for each main goal that has been identified. The test scenario must be concrete and specific. Make sure that it is possible to monitor when the goal is achieved. Establish a maximum time allowed to achieve the goal if necessary. If there is no natural order in which tasks should be completed, decide on such.

8. Conduct test

Record demographic data such as professional position and age but also previous experience, not only professional but also with similar systems from other domains. Measure success rate and, optionally, task time/error rate and satisfaction (using a questionnaire). Record the number of design issues. One or more observers might be present to record the findings. It is preferable to video record the test session. The

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overall setup and/or a close-up of the screen (if it is a screen based application). The video recording is good for the analysis, but also for the presentation of findings.

9. Analyze results

Calculate effectiveness (percentage success rate) and, optionally, efficiency (mean task time, mean number of errors) and satisfaction (mean questionnaire scores). Grade the severity of the recorded design issues and prioritize the order in which these need to be fixed.

10. Prepare a full report and/or a short summary.

Interacting with the users

During any usability test it is crucial to derive information on the system and its design from potential future users. Therefore the interaction between the test moderator(s) and the test participants is especially important. The following paragraphs summarize the most important aspects of the interaction between moderator and participant based on rules suggested in "Moderating Usability Test. Principles and Practices for Interaction" (Dumas & Loring, 2008).

Informed Consent

Before any testing all participants should receive sufficient information on the test, on how and why it is taking place and on how the collected data is going to be used. Further, all task included in the participation should be explained thoroughly to each participant. After the information the participant should give his/her informed consent. This is usually done by signing a form.

Confidentiality

It is the responsibility of the moderator to protect the identities of the participant to make sure that that the data cannot be mapped to the identity of a participant. The full names of the participants should not be used anywhere, e.g. on forms or labels. Instead of using any names, give each participant a number which can be referred to during the data analysis and reporting.

Further, the use of the data must be restricted to what is described in the consent form the participant has signed. One should also be especially careful with the use of video recordings to make sure that the identity of a participant is not uncovered. However, it may be useful to ask participants if you are allowed to use photos and/or video snippets for demonstration purposes, and when publishing information about the project (it is always useful).

Let participants struggle

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As usability tests are supposed to test how usable a product is, it is sometimes necessary to let participants struggle. Normally, when participants start to struggle, one or more usability problem is highlighted. Rather than interfering directly by helping the participant, let him/her try to cope with the problem and observe what he/she does. The observed behaviour can give good indications on what needs to be done to prevent future users from having the same problem. Further, one can always make use of probes to get insights in why the participant is struggling and to assist him/her. Following probes are common:

- Tell me what is happening
- Tell me what you think about the task
- Is this what you expected, or not what you expected
- So, you are thinking .....?
- What would you like to do (next)?

Let participants teach you about their knowledge and experience

Although that this sounds obvious it is important to keep in mind that the moderator is the one supposed to learn from the participants. They are therefore the ones that should be in charge of the communication. About 80% of the talking should be done by the participant. Further, it is important not to interrupt the participant in any way.

Think aloud is a common practice to make participants talk during usability testing. It simply means that the participant is asked to verbalize his/her experiences during the interaction with the product. This also includes describing expectations regarding each feature and sharing personal preferences and comments.

As the think aloud technique might not always come natural to all participants, prompts such as

- “So...?”,
- “What are you looking at right now?”
- “What are you thinking right now?”
- “What did you think was going to happen”
- “Did you expect that?”

can be used to remind them of continuing talking. Avoid questions such as “Why did you do that?” as they can indicate to the participant that he/she has made a mistake.

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Plan describing test procedures and methods

METOC

WHO: 5 officers from the three participants, DFDS, Scandlines and DaMSA buoy -tenders.

WHAT: The task could be to ask the navigator what e.g. the current is at his position. This info should be placed on the screen. Info should be shown on screen if it is important.

There is a lot difference in which kind of vessels are participating; the current has different meaning for different vessels

Where: The METOC services are most appropriate to be tested in a simulation because here it is possible to give different currents in different situations, and thereby test different situations.

SSPA Dynamic Predictor

WHO: VTS and two vessels in each scenario. This can be repeated with other participants.

What: Two scenarios: The mooring and close quarter would be interesting to test. This does not require separate laptop because it will be in the radar/ECDIS already on board the vessels.

Where: Live test onboard vessels. We have to decide where we would like to test. VTS and a vessel passing the VTS and perhaps one more vessel so they can exchange the predictions ship to ship and to VTS.

Exchange of routes

We should take a look at the FMA's report on route exchange, since they have already tested this in some extend.

Who: VTS and vessel – True sail

What: Close Quarter situation – Ship-ship

Deviation scenario, the vessels deviates from the planned route and the VTS suggests another route *(The VTS suggesting another route might be a problem as the information and assistance of a VTS operator should, according to present IMO regulations, be result-oriented leaving all details of the execution to the Master of the vessel).*

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SAR scenario could be a god test to perform.

Where: Live tests on board ships and simulation in close quarters situation.

Exchange of route on radar and ECDIS, but must be put on a separate computer that we put on board when we perform the tests.

Virtual AtoN's

Who: True sailing with ship's wreck and being marked by AtoN or a polygon with a message telling the navigator that he is steering for danger.

What: Scenario: Temporary wreck or obstructions. It has already been done in the Sound 2008. Previous scenarios could be used to obtain more data and re-evaluate previous results.

Ice-scenario: Areas with a lot of Ice like lake Vänern in Sweden, where they remover the buoys in winter due to ice.

Must be shown on a separate monitor on live vessels but if conducted in simulator it can be done as a unit in the simulator.

Where: This test can be conducted both in simulation and in live. It could be interesting to see how the navigator will react when he see an AtoN on his ECDIS.

Maritime Safety Information

Who: All participants, VTS and navigators.

Where: MSI is shown on an ECDIS and there for it must be faked, since we cannot send out fake messages on EDIS.

What: MSI could be tested together with the SAR testing.

This could be tested in combination with virtual AtoN's but can also be tested individually. There are two types of interface to be tested, one interface for the VTS and one for the navigators onboard. Therefore at least two scenarios should be tested either in a simulator or onboard a vessel.

One scenario should deal with the VTS who sends out MSI to one or more vessels. The scenario can test both the functionality of the MSI sending and the interface of the application.

At least one important MSI should be tested by pop-up information on an ECDIS. This seems more suitable to test in a simulation.

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We could use the track of the messages already been send out, history from the sound and feed it into the simulator, so the simulation could be as live as possible.

No-go areas and maybe-go areas

Who: all participants perhaps not the VTS.

Buoys sending water levels are relevant for this simulation.

What: One scenario: A aversive (dangerous) manoeuvre, e.g. A situation where a vessel is forced into a maybe go areas or no-go area.

Another scenario is a normal situation where the areas are shown on the display for information.

Lighthouses and conspicuous landmarks + 3D

These come together. 3D charts are most valid in an archipelago, e.g. outside of Gothenburg. In the Sound these might not be as useful except when passing outside of Copenhagen.

Who:

What: Scenario: Testing the windmill park outside Copenhagen to see if you are on the right track off the Drogden. A good scenario could be in a dense fog at this area, because you can see the windmill on you display and not out of the window, but the navigator will get a picture of how it looks like.

Where: Probably easiest to test in a simulator.

VHF communication and identification

Who:

What: Scenario: The vessel is listening on the wrong channel and the pilot calls him on another channel. The channels that the vessel is listening to, will be listed on the screen directly. This can also be tested ship to ship. This can be tested as a two step testing with a pre-test on the interface.

Where: Test in the simulator and also in real life

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Proposed solutions to be tested, including plan describing test procedures and methods

Mandatory services and features:

Meteorological and Oceanographic information (METOC)

This is relevant for all test participants in the whole testbed area. The test proceeding will be an isolated process, which can be carried out independently. The focus area will be at the Drogden, Helsingoer – Helsingborg and Flinterende. Water depths are relevant for through-going vessels and VTS. Test of broadcast, transmission and reception of METOC data. It will be presentation on ee-INS and mostly communication and presentation.

Test procedure and method:

The METOC services are most appropriate to be tested in simulation because here it is possible to give different currents in different situations, and thereby test different situations.

WHO: 5 officers/NAVIGATORS FROM THE THREE PARTICIPQANTS, DFDS, Scandlines and DaMSA buoy - tenders.

WHAT: The task could be to ask the navigator what e.g. the current is at his position. This info should be placed upon the screen. Info should be shown on screen if it is important.

There is a lot difference in which kind of vessels are participating; the current has different meaning for different vessels

Exchange of routes (ship-ship, ship-VTS and VTS-ship)

This is something that was rated high in our user feedback. This testing is relevant for all the participants especially the VTS. The testing will be a coordinated process; it depends on the other participants at all times. Routes are transmitted to other vessels and to shore based users. Vessels may receive route suggestions from VTS Centers.

As an addition to route suggestion vessels participating in Search and Rescue operations may receive search areas and search patterns from Search and rescue Coordinators.

A more advanced form of route exchange/suggestion is the Ship Assigned Passage Plan (SAPP). This may be tested late in the project. This test will include the proposals from SMA and will be integrated in the tests.

This is a test in communication and presentation

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Test procedure and method:

Method: Live tests on board ships and simulation in close quarters situation.

We should take a look at the FMA's report on route exchange, since they have already tested this in some extend.

Exchange of route on radar and ECDIS, but must be put on a separate computer that we put on board when we perform the tests.

Who and what:

VTS and vessel – True sail

Close Quarter situation – Ship-ship

Deviation scenario, the vessels deviates from the planned route and the VTS suggests another route.

SAR scenario could be a god test to perform.

Maritime Safety Information (MSI)

This testing is relevant for all participants and it will be performed isolated. It will be broadcast/transmission and presentation of MSI on ECDIS.

National Coordinators (e.g. DaMSA) will have to consider and transmit more information than today.

- Which type of vessel is the message relevant for,
- Which vessel draughts are the messages relevant for.
- Advise on passing distance to obstruction for presentation of No-go area.
- Symbols to be used on charts, small and large scale
- Precision, accuracy, reliability, integrity, etc.

This is a test in communication and presentation

Test procedure and method:

This could be tested in combination with virtual AtoN's but can also be tested individually. There are two types of interface to be tested.

One scenario where the VTS sends out the MSI and should perform a usability test and the functionality should also be tested. The sender is the interface, the receiver is the functionality.

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We must test one important MSI information, that can pop up in a situation. This service would be better to perform in a simulation.

Where: MSI I s shown on the ECDIS and there for it must be faked, since we cannot send out fake messages on ECDIS.

MSI could be tested together with the SAR testing.

We could use the track of the messages already been send out, history from the sound and feed it into the simulator, so the simulation could be as live as possible.

Notices to Mariners (NtM)

It will be broadcast/transmission and presentation of NtM on ECDIS.

National Authorities (e.g. DaMSA) will have to consider and transmit more information than today.

- Which type of vessel is the message relevant for,
- Which vessel draughts the messages are relevant for.
- Advise on passing distance to obstruction for presentation of No-go area.
- Symbols to be used on charts, small and large scale
- Precision, accuracy, reliability, integrity, etc.

This will be a test in communication and presentation.

Test procedure and method:

This section will be added in P3.

AIS and AtoN's – priority, presentation and symbols

Priority messaging and distress:

Test of priority messaging (distress, urgency, safety) and alarms. AIS-SART / AIS transceiver in distress status

Virtual and synthetic AtoN's and real AIS AtoN's, including presentation and symbols:

Transmission, reception, use and appearance of virtual and synthetic AtoN's are tested.

Work on type and appearance of symbols for virtual AtoN's and other virtual graphics. This can can be performed in workshops, simulation sessions and possibly in live tests.

This is a test in the use of real AIS AtoN's .

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Test procedure and method:

This test can be conducted both in simulation and in live. It could be interesting to see how the navigator will react when he sees an AtoN on his ECDIS.

Scenario: Temporary wreck or obstructions. It has already been done in the sound 2008.

ICE: Areas with a lot of Ice like lake Vähnen in Sweden, where they remover the buoys in winter due to ice.

Who: True sailing with ship's wreck and being marked by AtoN or a polygon with a message telling the navigator that he is steering for danger.

Must be shown on a separate monitor on live vessels but if conducted in simulator it can be done as a unit in the simulator.

Virtual AtoN's
This test can be conducted isolated and over a long term period. This is also a feature that we see as an important new area within e-Navigation. This is something that could have both financial, safety and environmental benefits. This testing is relevant for all the participants and can be conducted isolated.

High priority services and features:

SSPA Dynamic Predictor info exchange or similar (ship-ship and ship-VTS)

The exchange of this information would be a unique feature, and we thus give it a high priority. This testing is relevant for all vessels participating. It will be coordinated in relation to own ships manoeuvrability compared to other vessels. The predicted position/track is today kept on board own vessel for information to vessels navigators only.

The idea in the project is to share this information with other vessels, VTS centers and others by sending predicted track to vessels in vicinity and thereby give them an idea of intentions.

Test procedure and method:

Two scenarios: The mooring and close quarter would be interesting to test. This does not require separate laptop because it will be in the radar/ECDIS already on board the vessels.

WE have to decide where we would like to test. VTS and a vessel passing the VTS and perhaps one more vessel so they can exchange the predictions ship to ship and to VTS.

WHO: VTS and two vessels in each scenario. This can be repeated with other participants.

Method: Live test onboard vessels.

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No-go areas and maybe-go areas

This testing is relevant for all participants and it will be performed isolated. If the no-go areas and maybe-go areas will be shared, it must be coordinated. Instead of showing depth contours and soundings on display No-go areas and Maybe-go areas adjusted for specific vessels' data is introduced.

Maybe-go areas include inshore traffic zones, Traffic Separation Schemes, Nature reserves, other Special Areas, regulations, etc.

The areas are interactive and change with changes in tidal level, vessels' draught, etc.

Test procedure and method:

Who: all participants perhaps not the VTS.

Buoys sending water levels is relevant for this simulation.

One scenario: A aversive (dangerous) maneuver, e.g. A situation where a vessel is forced into a maybe go areas or no-go area.

Another scenario is a normal situation where the areas are shown on the display for information.

Radar/AIS positioning system (GNSS backup)

This Radar/AIS positioning system may be used as a back-up system for satellite positioning (GNSS).

Position information for AtoN or conspicuous radar target is transmitted to vessel via AIS (synthetic or real). Vessel's ee-INS automatically associates the AIS information with the radar target and measure range/bearing to fix the position.

Test procedure and method:
This section will be added in P3.

Chart corrections

This test can be conducted isolated and over a long term period. It is an automatic reception of chart updates for vessel's planned route. Some companies do provide this service today, but it is only proprietary solutions, not standardized.

This is a test in standardization and communication.

Test procedure and method:

This section will be added in P3.

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Lighthouses / conspicuous landmarks

This testing is relevant for all participants and it will be performed isolated. Information from List of Lights is incorporated and additional information like pictures, status, and contact details if observed unlit or unreliable, etc. is added.

Pictures of conspicuous landmarks are also added.

This will help the navigator with his perception of position relative to objects around the vessel.

Test procedure and method:

Testing much similar to '3D view and presentation of objects'.

Scenario: Testing the windmill park outside Copenhagen to see if you are on the right track off the Drogden. A good scenario could be in a dense fog at this area, because you can see the windmill on you display and not out of the window, but the navigator will get a picture of how it looks like.

CPA/TCPA and collision avoidance tool

This testing is relevant for all participants and must be a coordinated test between the participants.

Graphic presentation of CPA/TCPA is tested.

Trial maneuver function:

- Automatic by clicking riskmeter.
- Automatic by changing CPA/TCPA on screen
- Manual by changing course on autopilot
- Automatic trial maneuver takes into account all relevant data, i.e. COLREG, depth, buoyage, other traffic, etc.
- In aviation automatic collision avoidance systems are used. System may be copied.

In our opinion, the proposed solution is a significant improvement to the available solutions today

Test procedure and method:

This section will be added in P3.

3D view and presentation of objects

This test is relevant for all participants and it will be coordinated by Ship-ship communication and ship-VTS communication. However, the tests will be performed isolated when navigating close to lighthouses and land marks.

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Mental rotation theory and tests performed in Sweden by Thomas Porathe show that a 3D head-up presentation is easier to understand for both experienced navigators and people not used to perform navigation tasks.

This is a test in presentation techniques.

Test procedure and method:

Testing much similar to 'Lighthouses and conspicuous landmarks'. 3D chart most valid in the Archipelago, in the Sound it may not be that useful except just outside Copenhagen Harbour.

Scenario: Testing the windmill park outside Copenhagen to see if you are on the right track off the Drogden. A good scenario could be in a dense fog at this area, because you can see the windmill on you display and not out of the window, but the navigator will get a picture of how it looks like.

AtoN's - theoretical visual observation range

This test is relevant for all participants and can be performed isolated. Meteorological and geographical conditions have influence on visual observation of AtoN's. The range is shown numerically and graphically on display.

This is a test in presentation techniques.

Test procedure and method:
This section will be added in P3.

Display of Radar information – target sharing

This test is relevant for all participants and can be performed isolated and coordinated. Radar image or targets from shore based radar sites are transmitted to vessels.

This service may be used in places with radar shadow or as a tool to guarantee that vessels have sufficient information on other vessels.

This is a test in communication, presentation and functionality.

Test procedure and method:
This section will be added in P3.

Risk assessment tool (for VTS)

WP4 will not be developing any risk algorithm, but if we can use an existing algorithm, or get one from WP6, then it would be an obvious feature to implement as an e-Navigation service. However, the test can

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be performed by all participants as isolated tests. If the vessels/participants have a need for more input from other vessels, the tests will be performed coordinated. This is relevant at route exchange tests.

The risk assessment tool should check input from all electronic equipment like radar, AIS, echo sounder, ECDIS, etc. and alert the navigator if there is a risk of collision or grounding.

Test procedure and method:

This section will be added in P3.

Automatic and/or simplified exchange of administrative information

This test can be performed as coordinated test between the participants; vessels, pilots and VTS. Exchange of administrative information can also be a financial benefit for the shipowners, because the vessels can learn from the previous vessels at a given place and/or port. The information to be optimized and automatically send could be information for customs, port authorities, immigration, agents, etc. and it will be send automatically before vessel arrival and reporting during voyage is done automatically. The vessel will only have to submit all information once per voyage, and thereby save a lot of time.

This test is testing new ways of communication and exchange of information.

Test procedure and method:

This section will be added in P3.

S-mode

This is one of the cornerstones of the e-Navigation concept. Would hardly be e-Navigation without an S-mode. However, the test services to be developed in this project will be so simple, that the presence of a S-mode perhaps will make little sense. All the participants can take part in this test and it can be performed isolated from the other participants and therefore be conducted whenever wanted.

We would like to give input to the international work on S-mode through the project. This could be done by gathering navigators and experts in the project (e.g. SSPA, Chalmers University, SMA, FORCE Technology, DaMSA and others) for workshops, discussions and possibly simulations.

Test procedure and method:

This section will be added in P3.

VHF communication and identification

We got very positive feedback from potential users on this feature. This test is relevant for all participants and can be performed isolated. By clicking on vessel or shore station on display communication link is established automatically.

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When transmit button is activated onboard a vessel the vessel will be identified on ee-INS's on vessels in vicinity.

Synthetic voice messages may be tested – e.g. when passing reporting lines.

This is a test in communication and exchange of information.

Test procedure and method:

Scenario: test in the simulator and also in real life. The vessel is listening on the wrong channel and the pilot calls him on another channel. The channels that the vessel is listening to, will be listed on the screen directly. This can also be tested ship to ship. This can be tested as a two step testing with a pretest on the interface.

Other interactive functions – Pilot

It should be possible to book a Pilot by click on ee-INS display.

Information on arrival time is automatically transmitted to Pilot station. If there is changes in boarding time this is transmitted to vessel.

Pilot may change or accept boarding time and add information on pilot boarding position, wanted height and position of pilot ladder, boarding speed and other relevant information.

Vessel is marked on display when pilot is on board – e.g. Pilot flag.

This is a test in communication and presentation.

Test procedure and method:
This section will be added in P3.

Graphic display of reliability and precision

This section will be added in P3.

Test procedure and method:

This section will be added in P3.

References

Arnowitz, J., Arent, M., & Berger, N. (2007). Effective Prototyping for Software Makers.

Benyon, D., Turner, P., & Turner, S. (2005). *Designing Interactive Systems. People, Activities, Contexts, Technologies*. Harlow: Pearson Education Limited.

Marine Board (1996). *Simulated Voyages: Using Simulation Technology to Train and License Mariners.* . Washington D.C.

Part-financed by the European Union

Donderi, D. C., Mercer, R., Hong, M. B., & Skinner, D. (2004). Simulated navigation performance with Marine Electronic Chart and Information Display Systems (ECDIS). *The Journal of navigation*(57), 189-202.

Dumas, J. S., & Loring, B. A. (2008). Moderating Usability Test. Principles and Practices for Interaction.

Maguire, M. C. (1998). *RESPECT User Centered Requirements Handbook Wp5 Deliverable D5.3*.

Nielsen, J., & Landauer, T. K. (1993). *A mathematical model of the finding of usability problems.* Paper presented at the ACM INTERCHI'93 Conference, Amsterdam.

Nilsson, R., & Lützhöft, M. (2007). *Fairway Navigation – Observing Safety-Related Performance in a Bridge Simulator*. Paper presented at the 7th International Navigational Symposium on Marine Navigation and Safety of Sea Transportation.

Norman, D. (1998). *The psychology of everyday things*. New York: Basic Books.

Nählinder, S. (2009). *Flight Simulator Training: Assessing the potensial. Linköping Studies in Science and technology.* Unpublished Dissertation, Linköping University, Linköping.

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