MTO-sea report

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Abstract

The development of technical systems increasingly follows one or more of the following routes:

- Software changes with no visible effect on the interface.
- Automation where effects propagate through systems without being visible or understandable.
- Integrated systems with similar effects to automation but even more opaque to humans.

The objective of the project was to study these trends, by using a combination of field study methods. Experienced researchers were complemented by briefly trained cadets to aid in the collection of valid data. As this data collection was performed, some cases of problems with automation and integration were indeed found. However, as a whole, the data shows that the two most common problems on the ship's bridge were alarms and dimming. This shows that a focus on high-end technology only may be misdirected. We have still to solve very basic issues when it comes to human-machine interaction. The above examples show that we must put effort into designing a work system that resonates well with human vision and hearing, in combination with a demanding workplace.

Acknowledgements

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1 Introduction

Modern vessels are equipped with more and more complex and sophisticated technical systems which to a high degree tend to be integrated with one another. In addition to this the use of computer-controlled operations are becoming more frequent onboard. Software-assisted systems are used for a number of functions onboard both as navigational tools, cargo-handling appliances as well as control and operations of various machinery systems (Grabowski & Sanborn, 2003). It has been noted that the use of some of these systems have negative effects on the officers' and engineers' behaviour and their understanding of potential risks in their use (Courteney, 1996; Lützhöft, 2004). In some cases these shortcomings has been an important factor in serious accidents. The effects of these shortcomings and behavioural changes have not been taken into account in the training and education of future officers, nor has it been incorporated in shipping companies' policy documents or clearly identified by the authorities to a high enough degree. We also lack knowledge about other latent or potential dangers that may or may not be present within the systems (Rochlin, 1998; Sherwood-Jones, 2005). This study has the ambition to pinpoint and identify potential hazards and risks emanating from lack of understanding effects of integration of some of the modern systems and the way they are used. The knowledge thus gathered will be integrated into the training of officers and made available for all the various operators and parties within the shipping industry.

2 Background

With increasingly complex systems onboard, there is a need to identify risks that may follow from this. We also were guided by a wish to inform and motivate cadets towards a more active role in work environment evaluation and/or design. This study aimed at identifying problems with modern systems on ship's bridges. The general consensus is that most new aids also have deficiencies which have negative consequences on maritime safety. It is also the case that we need more proactive safety research. Reading maritime regulations, it is almost always possible to identify the ship accident that led to the regulation in question. Incident databases are all well and good, but there is a need to get the awareness into the system earlier, already at the training level. One benefit of this would be the possibility to identify previously unknown threats. Other domains are also reviewing their safety, as a recent example from aviation shows (Macrae, 2007). Some risks in the shipping domain are already known regarding bridge instruments, briefly discussed below:

AIS Even before AIS was implemented it was clear that seafarers did not want a system that demanded manual input (Atwell 1996). Several studies have now shown that there are large deficiencies in information presentation, both due to hardware, software and humans. Some results indicate that up to 25% of the information is faulty (Caka, A.[1]). This has a serious impact on whether users will trust the system. The SMA are now aware of this issue, and actively tries to get ships to correct their transmission, through their VTS stations. AIS also changes communication patterns and may in worst case scenarios lead to less insight into the traffic situation (Blomberg et al., 2005).

[1] Final year project at Kalmar Maritime Academy 2005.

Electronic charts ECDIS/ENC may be used instead of paper charts but the lack of ENC charts means that few are sailing “full ECDIS”. Behaviour changes have been observed on such ships, however, and should be investigated further. One example is whether officers know if and what has been corrected or changed after an electronic correction or update.

GPS Most ships today have a GPS, and rely heavily on it. The GPS signal is fairly easy to disrupt, jam or interfere with. Input of faulty information onboard may also lead to large errors, in comparison to the available accuracy. Faulty installation, integration or use of GPS has lead to a number of incidents and groundings around the world.

Autopilot Modern autopilots have a number of functionalities modes, and programming possibilities. This makes it difficult for the seafarer to fully understand their function and limitations. Adaptive autopilots, for instance, learns from previous performance, which could mean that this “knowledge” becomes inappropriate or faulty when a ship moves into lee or makes a large course change (cf Mariella grounding in Åland archipelago).

Automated systems Automation is introduced to reduce officers’ workload which means that they do less conventional bridge work. Many risks are known from the introduction of automated systems in other domains, such as understimulation because there is too little for the officers to do, low motivation and alertness since they may find the work boring, the erosion of competence due to lack of use and experience. There is also the possibility that the officers may not be able to handle situations that require take-over, since these situations will happens less often (Bainbridge, 1983). When workload is low it is easy to lower your watchfulness and start working on other tasks that have to be performed onboard, especially since the technology seems to be trustable (Sarter, Woods, & Billings, 1997; Sherwood-Jones, 2005). Another risk is changes in software which may be invisible on the interface with the human.

Manning and competence The present development may lead to a need for change of the current manning principles, with its traditional hierarchies and roles. A pilot study on this subject is ongoing at Chalmers Shipping and Marine Technology in cooperation with Högskolan Väst. The primary need is probably the ship’s crew but partly also the companies’ shore structures. It would involve training of those who plan, order and procure new equipment and new ships, to complement technical specifications.

To make a difference To complete the project it would further be necessary to study the curricula of the maritime academies, given the knowledge of the weaknesses and risks of new technology. We would also need to map out the stakeholders in the industry and discuss who is responsible for usability and where the processes can be impacted. These are issues that were partly, but not fully, researched in the present project.

3 Project goals

The development of technical systems increasingly follows one or more of the following routes:

- Software changes with no visible effect on the interface

- Automation where effects propagate through systems without being visible or understandable.
- Integrated systems with similar effects to automation but even more opaque to humans.

The objective of the project was to study these trends, by using a combination of field study methods. Experienced researchers were complemented by briefly trained cadets to aid in the collection of valid data.

The aims were to:
1. Validate earlier results, e.g. studies on the effects of new technology
2. Examine the interaction between humans and technology and find behaviour that is:
    a. unpredicted
    b. risky
    c. possible to influence
3. Have an effect on education, active mariners. Manufacturers and administrations.

4 Procedure

The project started with a number of meetings, the goal of which was to set out and focus the project, identify who the stakeholders were, and what their interest would/could be. A basic stakeholder analysis was performed according to the model in Figure 1. This was done in order to guide the work and identify those who would benefit the most from the project, and who could make a difference.

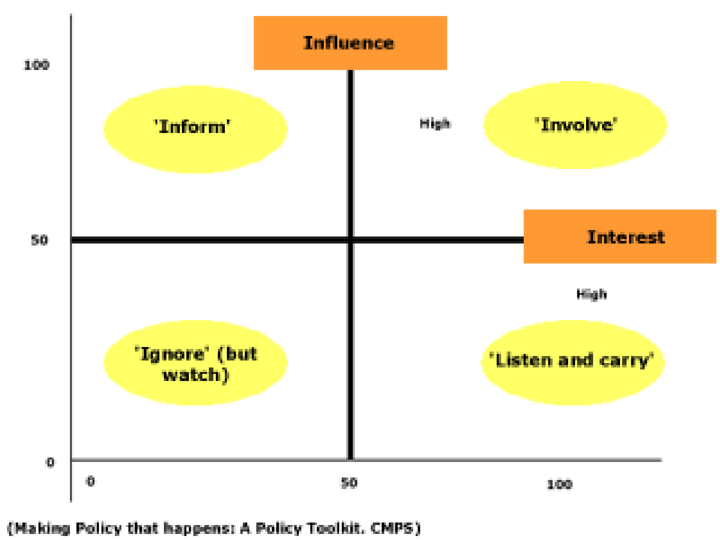


Figure 1: Stakeholder analysis model, adapted from the National School of Government, UK

The first results of this analysis are presented in Table 1. We see that those believed to have both a high interest and also possibly a high degree of influence were members of the project group. The next step was a refinement of the analysis, in which we discussed separate stakeholders and detailed their individual interests.

Table 1: Results of stakeholder analysis

	Interest Low	Interest High
Influence High	Owners Crews	Cadets Kalmar teaching Kalmar research Lloyds Register Nautical Institute
Influence Low		Manufacturers IMO

A summary of the interests of the stakeholders is presented below. These are useful both for focusing the direction of a project and in discussions with possible participants.

Cadets

- Add interest to sea time.
- Start lifelong learning and professional development.
- Possibility of Nautical Institute membership

Teachers

- Teach that safety is something that is made, not given.
- Give awareness of BRM, risk assessment and ISM skills, and also superintendent skills.
- Build lifelong learning links, get operational feedback from their domain.

Researchers

- Get data on integration work. Get data on how people use bridge resources to make safety.

Regulators

- Get better feedback into regulatory system.

Manufacturers

- Get feedback on user aspects of their equipment.

Not all of these potential areas of interest were addressed in all cases, or for all participants. However, it was useful to discuss the issue that the two organisations, IMO (International Maritime Organization) and the manufacturers, most often believed to be the best way to make a difference have little influence, at least in the short term. IMO is slow to respond to human implications of new technology, as discussed in a project paper (Lützhöft et al., 2006) and the manufacturers respond slowly to IMO via the IEC (International Electrotechnical Commission).

During this time, possible methods were also discussed and evaluated. The methods were to be simple enough to use for a cadet after a brief instruction and at the same time powerful enough to yield useful results. A log book draft was prepared and lecture content was outlined.

An introductory and voluntary lecture for cadets was held. After this the researchers made two field trips on two ships to test the log book and to start data collection. The log book was found to work quite well, and minor revisions were made. The next lecture with the cadets was held and the log book handed out and discussed. This lecture also treated basic usability with maritime examples. A short practical exercise was performed in observation techniques, followed by visits to school ship and simulators to practice using what they had learned.

Before the cadets joined their ships, the shipping companies received notice of the study and information about its purpose. They were asked to spread this information to the relevant ships. This worked in all but one instance. The students left for their practice period in late spring and early summer 2006. When they returned in the new year of 2007, their log books were collected, and a debriefing session was held in February 2007.

Preliminary analysis was made of the data collected, and a presentation was prepared for the reference group meeting in March 2007. Students were encouraged to make their own presentations but there were no volunteers. There was some discussion during the meeting, which lead to revisions and ideas for future work. The participating students also received certificates from The Nautical Institute and Kalmar Maritime Academy as a token of appreciation.

After this meeting, further analysis was made, especially of the usefulness of the collected data and method problems. A presentation was held at the RINA Conference in March 2007, where methods were discussed. At this time we were approached by representatives of the Marine Accident Investigation Branch in the UK (MAIB) who were interested in using this approach. Therefore the log book was translated into English, after some revision work, where for instance one method was replaced. Thereafter, a second cycle began. Lectures were held in May 2007 for final year cadets of 2007 (again voluntary) and the revised log book was handed out. More analysis of the previously collected data was performed during 2007, of the log books and photos. A poster presentation was made at a Resilience Conference in the autumn of 2007. A decision was then made to use knowledge from the analysis to revise and refine the log books further and start working on design guidelines for shipping company representatives, as far as the project budget and time allowed.

5 Methods

The methods used in the field studies were the following:

1. For experienced researcher teams, observation and interviews were used in conjunction with a test of the cadet log book.
2. For the cadets, a group of easy-to-use instructions and methods were compiled in a log book, tested and revised by the researchers. This process is described in the following sections.

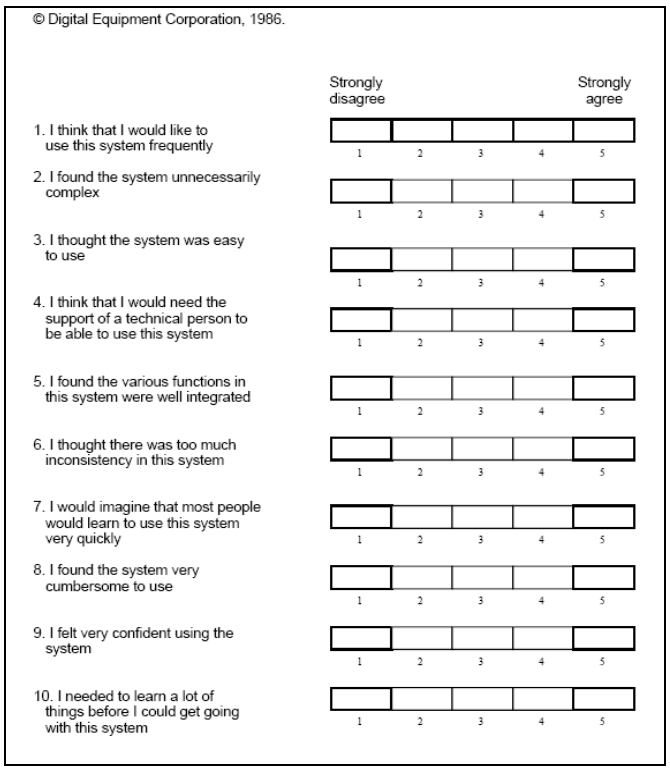
The log book, version 1

The first version of the log book was planned around three themes: observing, discussing and interacting. They were intended to be natural and pedagogically correct steps in a process, in which the cadet, or any newcomer in a system, would learn more and become a natural part of that system – in this case the man-machine system that is the bridge.

In the second step, observation, the task was to record basic data about the ship, and to draw or photograph the main layout of the bridge, and to fill in the various pieces of equipment and aids. We encouraged them to start thinking in functions, and to identify, if possible, areas where certain functions or tasks were carried out.

In the second step, cadets were to discuss the bridge with the officers, guided by a set of simple questions and follow-up questions. An example is “what is the newest equipment on the bridge?” followed by “when did it arrive”, “where is it placed and why”, “how do they get it to work” etc. We also included an SU (system usability) test, a standardised form to use to get a quantitative judgement of the usability of a chosen aid, see Figure 2. The student was asked to perform the SU test several times on different equipment, alternatively to ask several officers to evaluate the same piece.

The third step was about interaction, but very carefully worded. It is not to be expected that a cadet would be allowed to interact very much with bridge equipment. Therefore the questions focused on slightly more complex issues, which then could be discussed or self-experienced. For example: “Things that need unnecessary/extra work to function”, “when does this happen”, “for how long”, “how do they get it to work”.


© Digital Equipment Corporation, 1986.

	Strongly disagree				Strongly agree
1. I think that I would like to use this system frequently	1	2	3	4	5
2. I found the system unnecessarily complex	1	2	3	4	5
3. I thought the system was easy to use	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
5. I found the various functions in this system were well integrated	1	2	3	4	5
6. I thought there was too much inconsistency in this system	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
8. I found the system very cumbersome to use	1	2	3	4	5
9. I felt very confident using the system	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system	1	2	3	4	5

Figure 2: The SU test form (c) Digital Equipment Corporation

The log book, version 2

The log book was translated into English for the MAIB, and for future use with other interested parties. The SU test was replaced with a similar test, which involved some more thinking on the part of the cadet/student. This switch was done because it was shown that the SU test yielded results that were not useful for the project, and sometimes contradictory.

6 Analysis of data from onboard studies

Analysis of researchers' data

The data from the researchers' trips were richer than the cadet data, and naturally also easier to analyse, as the data were collected and analysed by the same persons. Short reports were written, summarising the issues found on the ships that were judged to be most risky or serious. These reports were first sent to the ship's crews for approval and thereafter sent to the shipping companies for their actions, if any. The data from these journeys was also incorporated in the total project data analysis.

Study of photos from bridges

Two independent persons without maritime background, one with experience from medical technical equipment and one with experience from defence aviation systems, were assigned to analysing the photos from the ship's bridges and the log books from the design point of view. The purpose with this choice of the analysts was that they were:

- ❖ Not used to the environment and therefore more objective
- ❖ Used to working with safety-critical systems
- ❖ Used to working with redundant systems

The aim of the analysis was to find design errors to the degree this was possible from photographs. A parallel issue was to judge how well analysis could be performed from photographs, i.e. data collected by others and largely uncommented. A third objective was to use the experience from the analysis to further improve the log book.

Analysis of log books

Log books were analysed by compounding information from the various stages and by collecting free comments.

7 Results

In the first part of the result section, data is presented in quite a "raw" manner, and briefly discussed. In the second section, a higher-level analysis is performed, where general trends and risks are discussed.

7.1 First-level analysis

The results of the project as a whole, from the perspective of the cadets, was that out of 42, 18 cadets volunteered for participation (42%). Out of these 18, 8 log books were returned (44%), and a large number of photographs. Some of the students commented that "It was a lot of work", but also we experienced that some students were thinking in a new way. This was obvious in comments like "the next ship I went on, I was looking at these things all the time". Several students collected redesign recommendations over and above the contents of the log books. In sum 8+2 ships were studied. The material from the two ships studied by researchers was somewhat richer.

7.1.1 Instruments evaluated in the log book

The number of times a certain instrument was chosen in one of the categories *Newest*, *Best*, *Worst* (assessment categories from the first parts of the log book) are shown in

Table 2. The table also summarizes the number of times an instrument was evaluated by SU, being perceived as the best or worst instrument onboard.

Table 2: Summary of log book data on assessment of instruments

Instrument/equipment	Newest	Best	Worst	SU best	SU worst
AIS	2	1	2	1	1
Alarms			1		
Autopilot		1		1	
Bridge layout		1	1		
Defibrillator (pax ship)	1				
Distress panel (GMDSS)	1				
GPS/DGPS		2		3	
ECDIS		2	1	2	1
ECDIS controls			1		1
Echo sounder & dimmer			1		1
ECS/ENC	1	2		1	1
Fin stabiliser				1	
Fire alarm control panel			2		3
MF/HF DSC			2		1
Napa cargo software	2	1		1	
PA system			1		
Paper charts					1
Piracy alarm	1				
Radar	2	13	1	12	
Remote mooring control			1		
Sound direction finder			4		4
Satlog	1		1		1
VHF					1
VMS	1	1		1	1

From the collected data it is not easy to classify the instruments/systems in “the worst” or “the best” with one exception, the radar is consistently considered the number one best piece of equipment. One conclusion is that systems that give off alarms often will be more often classed as ‘the worst’. A sensitive warning system with many alarms can undermine trust because the crew feels that the alarms do not reflect the danger of the situation. Lack of education on new implemented systems is another reason for this classification. The radar is the oldest and the most used equipment onboard and also often classed as “the best”. However, we do see in the log book that radar has been listed 5 times as negative.

The defibrillator (on a passenger ship), the GMDSS and piracy alarm were neither classified neither as worst nor as best by anyone. The reason could be that the systems have been used very seldom, or not at all, so the crew have little experiences of the systems. Four of the systems, ECDIS controls, a fire alarm control panel, MF/HF DSC and a sound direction finder were all classed as “the worst” and no one classed them at "the best". All other instruments were classed in both categories, about 50% in each. One reason for the spread of data is that the evaluation choice was free for the officers to make. This resulted in choosing anything from separate instruments to "systems" like alarms.

7.1.2 Part 3 in log book, dynamics/using it

This section summarizes in Table 3 the number of times an instrument was listed under the following categories (used in the log book):

1. Works well (to collect information on the positive as well).
2. No longer used (instruments that are no longer used but still installed or in place).
3. Broken or breaks often.
4. Needs work to work (e.g. passwords or unnecessary handling to get results).
5. Horrible or irritating to use.

Table 3: Summary of categories from part 3 in log book, dynamics

Instrument/ equipment	Works well	No longer used	Broken or breaks often	Needs work to work	Horrible or irritating to use
AIS			1		1
AIS/radar integration					1
Antiheeling system	1				
Bridge computer not on LAN				1	
DSC for VHF				1	2
ECDIS	1				
Echo sounder		1			
Electronic charts			2	1	
Engine info screen		2			
Fire alarm			1		
Fire control panel					1
Fixed VHF mic		1			
GPS			1		
Gyro compass			1	1	
Hand steering					1
MF/HF Telex		1			
Paper charts					1
Pedals for steering		1			
Pod joystick				1	
Radar	2		3	1	1
ROT display					1
Route planning (ECDIS/GPS/paper)				1	
Rudder indicator			1		
Satlog			1		
Screens			1		
Sound DF		1			

Instrument/ equipment	Works well	No longer used	Broken or breaks often	Needs work to work	Horrible or irritating to use
SSB radio		1			
Switch for deck lights					1
The whole bridge	1				
Tracings for paper chart corrections				1	1
VHF	1				
VMS	1				
Wind meter		1	(1)		
Windows-based equipment			1		
Window wipers				1	

We see the same kind of spread as before and few trends in this material. 9 instruments are listed as no longer used, which limits available space for, and may lead to suboptimal placement of, new instruments. One overarching trend is that a large number of instruments are difficult to use, in various degrees. It can be deduced that a lot of time is probably spent getting things to work in a helpful way, time that should have been spent keeping a safe watch.

7.1.3 Types of interaction issues

This section shows a summary of the free comments collected by cadets and researchers in interviews and discussion. The categories relate to known categories from other human-machine issues in other domains, and a few are ship-specific. The comments are mostly quotes or summaries of quotes, and most of them speak for themselves.

Unexpected events

- Steering: the steering tiller is interesting. Thank god there is a conventional wheel to choose. It seems to be a standard to have a tiller which is the wrong way. The AB and I do not like steering with it. Since the ship has a shilling rudder it does not feel safe to hand steer with a tiller that in the worst case can give a rudder angle of 70 degrees if someone happens to touch it. It is also illogical that you pull it to port but the ship turns to starboard. It has not been thought out in the same direction as you travel.

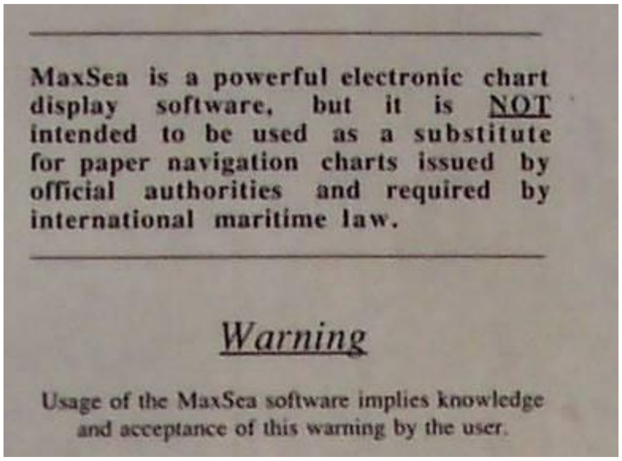
Issues regarding automated or remote aids

- There is remote control for the mooring equipment fore and aft. Placed on bridge wings manoeuvre panels. The camera surveillance gives no good overview/feeling when the winches are used. Some cameras are broken.
- Automated deck lighting can be troublesome. A photocell is used. In emergency we need to go to manual lighting, but the switch is hidden behind a curtain.

Integration issues

- Radar/electronic chart which cannot show AIS-info about a ship if it is plotted in the radar. To show AIS-info about a plotted target one therefore has to: remove the target, read the AIS-info and then re-plot the target. Very irritating.
- “When you integrate things you get alarms, but you don’t really know what is wrong”

- Work with route planning. Takes a lot of time to plan in paper charts, ECDIS and in GPS every trip. Takes 3-4 hours to plan a regular journey. Paper charts will be removed but for now nothing to do about it.
- A risk of modern systems is that it is all integrated in some way. If one instrument breaks it will have an impact on several others. We have had problems in the engine room with this.



MaxSea is a powerful electronic chart display software, but it is NOT intended to be used as a substitute for paper navigation charts issued by official authorities and required by international maritime law.

Warning

Usage of the MaxSea software implies knowledge and acceptance of this warning by the user.

Related to trade and type of ship handling
- Engine talkback system is good, but placed too far from engine controls.
- VHF handset cable is too short, and lengthened to be able to interact with relevant equipment.
- Flood light cable is too short. Want to walk around and spot fishing vessels.
- Ferries are sold often and change trades, therefore not invested in as much.

Training
- No training except safety issues.

Ergonomics/ usability
- We have ergonomic chairs but they are very heavy to move. A lot of work is done standing up. We got a mat for this but it then makes it even harder to move the chairs.
- Hand steering position is very uncomfortable. Can be for long periods of time depending on the pilot.
- Difficult to tell apart echo sounder and log on pilot console.
- Think about the design of e.g. trackballs for bridge wings, are they often used when going astern? You need to think backwards.
- Would like “page down” on AIS not just line by line.

Going from the old to the new…
- Paper charts are obsolete. ECDIS is easier to use and maintain, but lacks the possibility of plotting a position.
- Younger people are used to modern computer-based technology. Older people are experiencing this as a problem to a larger degree.
- When changes are made to the bridge, drawings are not updated.

Other

- ECS update CD is difficult. Lack of time and no training. Is done every week. Have to take a chance, and suppose "It probably was ok". There is "a lot of shift changes, many people, it gets messy, everyone is working with this".
- Often have to restart ECS, takes a few minutes, is a safety risk.
- Business cards are attached to some equipment (to call service/support).
- No bridge wings means that taking manual bearings is not optimal.
- We were warned by the previous crew not to use long sleeves, it could get caught in engine levers, with unwanted results.

7.1.4 Alarms

- Sometimes too many alarms which disturbs normal navigation.
- Extremely many alarms which have to be acknowledged. And because of bridge design this is irritating when workload is high, such as navigation in restricted waters or arrival in port.
- The only thing to complain about is the GMDSS alarms… It is disturbing. You have to leave the conning position to acknowledge. Alarms for safety message should not be necessary.
- It gives off many alarms and often we have to restart it.
- There are many alarms, it is situated far away and the menus are funny.
- Black box (VDR) gives off alarms.
- DSC (Digital SelCall), often placed far from operator's seat.
- We had to modify the fire alarm panel. Before the alarm went to the whole ship, which is a ropax. Now it goes in 3 stages (1. bridge & engine, Master & Ch. Eng, 2. crew, 3. Whole ship).
- Radar alarm has been silenced "permanently".

7.1.5 All ships have dimming problems

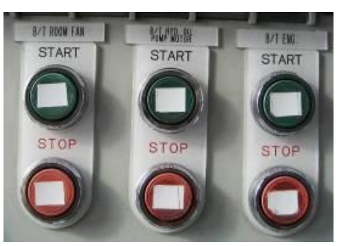
A very clear trend throughout the study is dimming problems. All the ships' data shows that dimming of screens, displays and single instruments is at times a bother and an irritation, and at times a real threat to safe navigation. Below is a selection of the home-made dimmers made by the crews on the studied ships. Note the span from the very simple (a piece of paper) to very sophisticated solutions.

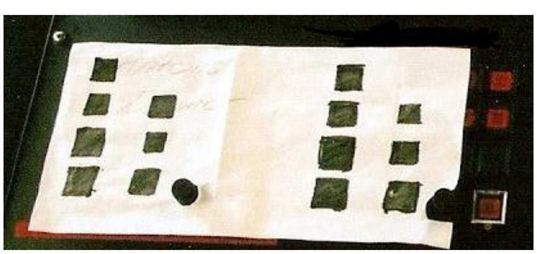

TELEGRAF I CENTER
ETU/AC
AHEAD
ASTERN


SKIPPER


UDDA


MAGNETIC COMPASS


START
STOP
START
STOP
START
STOP



7.1.6 Evaluation of cadet photos

In this section, a brief description of the issues visible in the photos taken on the various ships is presented. They were taken both by researchers and cadets. No photos were available for one of the ships.

Opinion ship 1
The bridge looks well planned, but it fails in the smaller details when inspected closer.

- No foot support to the chairs
- Panels at and below knee height
- No consistent layout concept for all panels
- No good place to place the printer

Opinion ship 2
A large mix of layout concepts in the panel design; old and new technology together

- Panels at and below knee height
- Many own modifications

Opinion ship 3
A very large mix of layout concepts in the panel design; old and new technology together

Opinion ship 4
A large mix of design concepts in the subsystems: new and old technology

- The panels are cluttered with unorganised displays and controls

Opinion ship 5
Good basic concept, but

- Mix of design concepts in the subsystems
- Many own modifications

Opinion ship 6
A large mix of design concepts in the subsystems: new and old technology

- Panels at and below knee height

Opinion ship 7
Good basic concept, but

- The panels could probably been organised in a way more consistent with the tasks

Opinion ship 8
A large mix of layout concepts in the panel design; old and new technology together

- It seems that there is limited space on the bridge

Opinion ship 9
A very large mix of layout concepts in the panel design; old and new technology together

- The panels are cluttered with unorganised displays and controls

7.2 Second-level analysis

In the following, what could be called a second-level analysis is presented. Data has been analysed in relation to possible risks. This section also contains a few cases, presented in more detail than the earlier data.

7.2.1 Risks

This section summarizes the risks judged to be inherent in these bridge systems, considering the problems and issues found. In Table 4, a limited but typical list of operational states for ships is presented. In Table 5, we suggest three levels of risk, coupled to three levels of actions needed. This is a simplified model, often used in work environment assessment. In Table 6, these two are combined with a summary of the errors found in this study. The errors are categorised into common human-machine interaction terms, after which the operational states are listed in which we judge that the design error could pose a risk, followed in turn by an assessment of whether actions are needed to reduce the risk. No suggestions are made regarding what kind of solutions are needed, since this will strongly depend on for instance the users, the available resources, trade of the ship and the design of the bridge in question.

Table 4: Operational states

	Operational states
1	At anchor or moored
2	Cargo operations
3	Release moorings, start engines
4	Port area manoeuvres (w&w/o pilot)
5	Passage with pilot, if applicable
6	Disembark pilot
7	Coastal passage
8	Sea passage

Table 5: Codes for risks and actions

Code	Description	Action
G-Green	No major risk	No action
Y-Yellow	Possible risk	Action may be needed
R- Red	High risk	Action needed

Table 6: Errors found, operational states in which they may be a risk, and actions needed.

#	Design errors and other problems that can cause risks (from the study)	Operational state/s in which risks may be present	Risk level & actions
1	It is not obvious and clear where the operator shall be located when using controls and displays	4, 5, 6, 7,	Y
2	It is not obvious and clear that the workplaces is possible to adapt to the anthropometrics of the operator group	3-8	Y
3	The panels are placed under waist-height (or knee-height when seated). Controls could be unintentionally activated	2, 3, 4, 5, 6, 7, 8	Y
4	The operator needs to lean over some controls to reach other controls	2, 4, 5, 6, 7	Y
5	There are cords hanging on the panel that hide displays and controls	4, 5, 6, 7	Y
6	There is no supplemented area at the operator workplace	4, 5, 6, 7	Y

#	Design errors and other problems that can cause risks (from the study)	Operational state/s in which risks may be present	Risk level & actions
7	There is not enough space to use a computer mouse, if a mouse is used	ergonomic problem, all states	G
8	There is not space for supplemented equipment	4, 5, 6, 7	G
9	The panels for starboard device are not placed on the correct side compared to the panel for port device	4, 5, 6, 7	R
10	There is a mix of mirroring and not mirroring in panels (for starboard and port devices)	4, 5, 6, 7	R
11	The information on the panels is not prioritised so it is difficult to see what is most important	4, 5, 6, 7	Y
12	The panels are not designed with grouping and mapping	2, 3, 4, 5, 6, 7, 8	Y
13	There are loose control boxes on the panel	2, 4, 5, 6, 7	Y
14	The displays and controls are not marked	2, 3, 4, 5, 6, 7	R
15	The markings are not placed above the display and control. Could be hidden by the hand	4, 5, 6, 7	Y
16	The size and intensity of the markings do not correspond with the importance of the display and the control	4, 5, 6, 7	Y
17	Controls and displays that are used together are not placed together and marked as a group on the panel	4, 5, 6, 7	R
18	There is not a clear and unambiguous visual connection between displays and the controls that affect the display	4, 5, 6, 7	R
19	Texts are not correctly translated	2, 3, 4, 5, 6, 7, 8	R
20	The use of mapping of the ship on panels is inconsistent	2, 3, 4, 5, 6, 7, 8	R
21	The use of colour coding is inconsistent	4, 5, 6, 7	R
22	Some buttons have more than one function	ALL	R
23	It is impossible to dim bright lights on displays and panels	2, 3, 4, 5, 6, 7, 8,	R
24	There are disturbing reflections of light	2, 3, 4, 5, 6, 7, 8	R
25	Alarms are activated too often, are hard to find and cumbersome to acknowledge	2, 3, 4, 5, 6, 7, 8	R

It is obvious that many risks are indeed present, and many situations are possible in which they could come into play. This is not by any means a complete risk analysis, but to be regarded as an indication of possible risk areas. Below the operational modes are listed with a few comments on each about the risks regarding bad design or ergonomics issues.

At anchor or moored

When in the mode ‘at anchor or moored’ most of the navigation equipment/systems are in non-operational mode and there will be few alarms, few dimming problems nor any handling errors that can cause any major risk. Mainly, the work is to check that the own position is unchanged, keep a lookout for other ships and keep a radio watch. Office equipment is often installed where there is any free space on the bridge, in this mode the crew could be tempted to work with administration and if the equipment is ‘hidden’ somewhere they can lose attention on what is going on outside. Bad design always is a problem but in this mode it will not cause any major problems or risks.

Cargo operations
In 'Cargo operations' all of the navigation equipment/systems is in non-operational mode and there will be no alarms and no dimming problems that cause any major risk. Cargo operations are performed around the clock, for dedicated cargo control rooms, and sometimes from the bridge. During loading or discharge handling errors can be performed if the design is bad, e.g. if there is a mix between calculated and displayed volume and filled. Also misunderstandings and/or loss of information can occur if the design is bad, e.g. displays that are difficult to read.

Release moorings, start engines
The work being performed here is for example supervising the release of moorings, cooperate with a pilot, supervise and control the use of tug boats. When starting the engines there can be a short loss of power, which can cause alarms from the equipment on the bridge especially from office equipment. Dimming problems can occur especially if it is dark and some displays and panels have a bright daylight mode. It is easy to perform handling errors if there are mirrored and non-mirrored panels, this is a problem both daytime and night-time.

Port area manoeuvres (w&w/o pilot)
This mode is one of the most risky modes. Handling errors easily happen if the design is bad e.g. if there are a mix of mirroring and not mirroring in panels, especially if you are not used to working in the environment. This could be true both for pilots and for new crew members, or if you have been off-duty for some time. Another problem is if the panels are not designed with grouping and mapping. Dimming problems and alarms could be a safety problem in this mode.

Passage with pilot, if applicable
The pilots are onboard when the ship leaves the port, passes through the fairway out of the port and for some distance thereafter, depending on local conditions. To be a pilot and work on different ships might be a problem because the bridges do not look the same and there is no standard mode to rely on, if the bridges have a bad design it makes the work even more difficult and handling errors could easily occur. Dimming problems and alarms in this mode are also disturbing for both the pilot and the ordinary crew.

Disembark pilot
When disembarking the pilot is another risky situation on ships. The pilot has had the responsibility for taking the ship through restricted waters and then the ordinary crew is to take over. In the situation with a pilot onboard it is easy to lower the attention and when taking over mistakes or handling errors can occur if the design is bad.

Coastal passage
This mode often takes place in archipelagos or restricted waters and there could be a lot of traffic and shallow waters. Full attention on both traffic outside and the displays on the bridge is needed. Bad design can cause accidents if it is easy to perform handling errors if due to misunderstanding information on the displays. Dimming problems and alarms might also cause a lack of safety.

Sea passage
In the open sea the major problem will be alarms that are very disturbing. Dimming problems are also disturbing especially in the night. Mistakes and handling errors can also be performed in this mode but the risk is not as high as in many other modes.

7.2.2 Cases

Case "bow thruster"

Some collected images were in themselves striking. Whole scenarios of risk are inherent in them. The clearest example of this is the tape strip in Figure 3. Reminder notes may be regarded as a pointer to equipment that is not optimised for the task and the context. Reminders like these indicate that the system is not well-designed. In this specific example one can easily imagine the consequences of not performing this action, firstly leading to a mechanical failure, costly in itself, and secondly in the worst scenario leading to a grounding or collision (after the bow thruster fails).

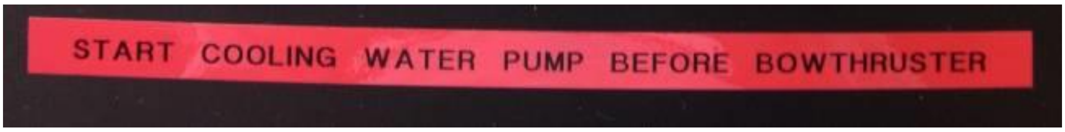


Figure 3. Reminder notes can reveal bad system design

A short story from one of the log books discusses a radar which has trouble seeing and locking on targets and get a acceptable tendency on long distances. It also has problems with false echoes and to staying locked on targets. This ended up with this radar set being used very little, and the other available set used more. This is an expensive problem, equipment not being used, and a risk, since that formally, redundancy is present but real redundancy is not.

Case "the hub of all evil"

In this case there is richer material to analyse. The ship had a home-made integrated system, and its centre was the VMS (Voyage management system), which was called "the hub of all evil". The most serious problem on the ship in question was this integration. Several instruments were connected to the VMS, such as GPS, AIS, echo sounder. Normally an integrated system is demanding to work with as it is hard to understand how systems are connected to each other, to understand what error sources may be present and how system integrity is influenced by the failure of a subsystem. In this case it was even worse, as the connected subsystems seem to be unstable in themselves. Most of these subsystems cause VMS alarms to go off much too often.

The quality of one of the sensors for the echo sounder was one reason. The possibility to solve this was to program a set depth, to silence the system, with the obvious result that no depth information is available and the risk that someone actually believes the set value is a real value. The GPS gave off alarms when the number of satellites was too few to give an accurate position. This alarm also went off too often and the solution was to override the GPS and force it to "believe" that the number of satellites was sufficient. The AIS signal to the VMS was often lost for unknown reasons and it also gave off a disturbing number of alarms. Furthermore, one of the ARPA radars connected to the VMS dropped out when the electronic map system failed, which happened quite often and means a number of minutes have to be used to restart the system.

Alarms also emanated from other systems, such as the watertight doors (being opened and closed for passing), fire alarms (including false alarms), VDR and Navtex. Some of these were placed at a distance from the normal working position, for example the Navtex. Often, officers have to leave the conning position to reset the alarms, to fetch and evaluate of the information given is relevant to their navigation.

The amount and frequency with which alarms sound on this bridge is inappropriate for safe navigation. The risks with too many alarms have been discussed by among other Lloyds Register recently. A few of them are:

- A system may not give off trustworthy information.
- Lack of trust may mean that one or more systems are not used, are uncoupled or in other ways incapacitated.
- This may mean that information is incomplete or faulty.
- Alarms disturb the concentration and alertness of seafarers.
- Time must be used to identify, acknowledge, evaluate and handle alarms.

Both the VMS and AIS get low usability scores but are used since the information is needed. The layout is a traditional side-to-side console bridge. This has both mental and physical consequences. Partly because many aids are far from each other which makes handling and operation more difficult, and partly because information is located in separate positions which is demanding for memory and attention.

One example is the VHF which is placed too far from the engine controls. This has led to a home-made solution of lengthening the VHF handset cable. In itself, it is a simple and cheap solution. However, this leads to extra work (the cable must be coiled well) and risk (when the cable is coiled in place, it may get in the way of the handset engaging properly in the holder. This in turn leads to rendering the VHF sets on the bridge wings useless. This type of VHF installation has lead to at least one grounding in Sweden.

Another risk is the distance between radar and autopilot. Information must be kept in memory when moving from one to the other (for example when performing an avoidance manoeuvre) and in close encounters a lot can happen in the time it takes to move back and forth.

7.3 It's not all bad

People will find good solutions to problems they identify. Sometimes an issue is not a large problem but finding a solution may afford working easier, finding information quicker etc. These solutions are interesting as they contain clues to ways of working which the users like and want to use. Below we show a few pictures as examples of this.

Two control knobs have been chipped in order for them to be found with the hand without looking at them. This means you can keep your attention on, for instance, looking out.

The RPM display has been modified with small pieces of tape indicating percentages. This makes it easier to immediately decide when the engine is running at 25, 50, 75 and 100% without mentally transforming the RPM into those percentages.

A rudder control has been adapted for use, again, without looking. The piece of plastic has been added to aid in finding the control for “master” rudder when manoeuvring the ship with your back turned to these controls.

A clock has been customized, to help the operator to judge which points on a ship correspond to the hours of the clock face (a method often used in English-speaking countries).

We also received a few comments on what was good. One such comment was: “A cockpit bridge raises the modern officer’s attention and overview. You get good control of the ship’s navigation with all panels close by. If all the equipment comes from the same manufacturer and is installed as a unit, it is my view that the system is safer.” Such comments, coming from cadets or officers, are of course positive, but do not eliminate the need for analysis by ergonomists looking at the effects of human preference and overall system safety in all tasks.

8 Spreading the word

A discussion was held within the project concerning who to provide feedback to, how, and in what form. Although not all these parties have been contacted, the list is presented here as it represents some of the difficulties of making an impact on this kind of problem in a business with global regulation and diverse stakeholders.

- CHIRP
  - About safe operation, low-level issues, operational and equipment
  - Onboard personnel should report themselves, if relevant
- Manufacturers
  - Not too general
  - Not pages of inconsistencies
  - information to feed into their fault tracking system, their format – one form, all defects
  - Suppose many reports on one piece of equipment, project group could do it for individual manufacturers
- Operators (maybe if open to it)
  - Onboard personnel: Have you told the operator?
  - Project group will analyse and look at issues across several operators
- Manning companies (yes but they may not know what to do with it)
  - Training, competence issues
- Owners - more work needed on arguments for this to work
- Yards (most useful on retrofit or new build)
  - Consultants can act as “build captains”
  - If you become a build captain, think about ergonomics, not about yourself

- ❖ Classification (only during inspections and then no defined route for change)
- ❖ Flag (only during inspections and then probably not encouraged by ship)
- ❖ Professional societies, IFSMA and NI
    - o How can they be involved? Collecting feedback, sending it on?
- ❖ IMO circular 1091
    - o Immediate feedback about introduction of new technology – did it work?

These issues should be addressed in future studies, to keep working on "closing the loop".

8.1 To manufacturers

One meeting has been held with a manufacturer whose equipment was evaluated in the log book. They were pleased with the feedback, but want even more detailed comments. Most important was that the make and model of a piece of equipment was stated. This information was used to revise the log book for the 2007 cadet group.

8.2 Publications

This project has produced a number of publications and papers.

- A poster presentation and proceedings paper for the 2nd Symposium on Resilience Engineering, Juan-les-Pins, France, November 8-10 2006. (Lützhöft et al., 2006).
- It was presented at RINA, London, in March 2007. (Lützhöft et al., 2007).
- A paper for IMO was drafted but it was considered that we needed to get more experience and data before submitting it.
- A basic checklist for use by those who wish to evaluate ship's bridges (appendix 1).
- A brief checklist for cadets or crew to use onboard if they find a problem (appendix 2).
- A log book, tested and revised is available for use by deck cadets (appendix 3)

9 Discussion

The discussion section contains two parts, one on methods and one on results.

9.1 Methods discussion

This section discusses the methods used in the collection of data.

Starting with the SU (system usability) test, which was included in the first version of the log book, a number of interesting findings were present. Many of them, however, pertain to the method as such, rather than the collected data.

- Absolute numbers seem to have little significance. A score of 50/100 does not mean a system is "half-good".
- The separate answers are more interesting, for instance why a system gets low points on usability but still is judged the best equipment.
- Closer inspection of SU result shows for instance:
- Something can be easy to use but useless. An example is a Sound Direction Finder: 82,5 points. This implies a high degree of usability (in fact there was only one switch; on/off), on the other hand the crew claim not to use it at all. So a system can be usable but not needed for the task at hand.
- Something can be hard to use but essential. Many instruments are rated low, but also commented on as being systems they cannot do without.
- Things can be useful and usable. Some answers indicted that a few systems were indeed both useful and usable.

- The worst and the best equipment get similar results, which means that further information is needed to analyse these data. For instance, could the difference be due to experience?
- It may depend on experience? The same radar got 42 and 90 points from two officers on the same ship. This could be due to personal preference, education, training or experience with the system.

Analysing photos
It is rather difficult to analyse photos taken by someone else, and the lack of comments about the pictures are also a problem. In order to improve this, we will consider further improving the log book by:

- Defining in which order photos should be taken
- Ask students to make some brief comments to the pictures at the time
- Use the checklist (attached to this report) to find bad design.

9.2 Result discussion

Conclusions/summary from the photo study
<u>A summary of bad design seen on the photos that can pose problems for the crew and pilots</u>.

- *Dimming problems*. During the night a low availability of dimming could cause a lot of problems, it is easy to miss information if you are blinded both from displays and indicators. It is also easy to perform handling errors if you can not see well..
- *Reflexes*. Reflexes from lights and the sun can cause temporary blinding and it will be easy to perform handling errors.
- *Mirrored and non-mirrored panels*. If you are under pressure or is not used to the equipment onboard it very easy to perform handling errors when there is a mix of mirrored and not mirrored panels.
- *Office equipment*. There is no natural place for office equipment onboard, and printers, computers etc. are placed in any free space. Loose control boxes and cords can hide displays with needed information and also cause activation of equipment by moving controls. Disturbing alarms from e.g. faxes and copiers (out of paper) is unnecessary information for the crew especially in modes where their full attention is needed.

10 Conclusions and future work

The results of this study are on a very high level twofold:

- We have educated a number of cadets and prepared them to be better at giving feedback on their own workplace. This project could be expanded to incorporate life-long learning.
- We have collected useful information on the status of human-machine interaction on ship’s bridges of today.

The aims of this project were to:

- Validate earlier results, e.g. studies on the effects of new technology
- Examine the interaction between humans and technology and find behaviour that is:
  - unpredicted
  - risky
  - possible to influence
- Have an effect on education, active mariners, manufacturers and administrations.

Although many of these aims are not fulfilled to a large degree, or in a concrete fashion, the effects are still discernible. The persons involved in this project are now also involved in several other undertakings to make maritime systems safer and more useful. Four notable such projects are:

1. Researching the concept of S-mode in cooperation with, among others, The Nautical Institute and SSPA. The S-mode is imagined to be a standard interface mode or layer, common across all manufacturers.
2. User-centred development of bridge and automation equipment is being performed in cooperation both with manufacturers and with shipping companies.
3. Alarms. A project is being planned in order to make progress on this important issue.
4. Feeding the findings into standards and regulations.

As this data collection was performed, some cases of problems with automation and integration were indeed found. However, as a whole, the data shows that the two most common problems on the ship's bridge were alarms and dimming. This shows that a focus on high-end technology only may be misdirected. We have still to solve very basic issues when it comes to human-machine interaction and bridge ergonomics. The above examples show that we must put effort into designing a work system that resonates well with human vision and hearing, in combination with a demanding workplace.

Furthermore, the log book is being revised for use with engine cadets as well. This means that we are working on integration of the initiative into the curriculum of cadets both deck and engine. The long-term effects of this are hard to measure in the short term. We see that the industry is presently interested in Human Factors issues and we are preparing our cadets to be more knowledgeable in the subject. We plan to make this concept into a model course…the logbook used by the cadets is being constantly developed and improved.

A new and somewhat sensitive issue is the "office equipment" on the bridge. Computers (including mouse and screen), faxes and copy machines are often used on the bridge. This equipment is not constructed for the environment (factors such as sensitivity to vibrations and moisture and lack of dimming facilities). Neither is there a natural place for this equipment and this often cause problems regarding ergonomics. Furthermore, this equipment may give off alarms that sound just like the other alarms on the bridge, which increases workload and stress. The most important issue is that the operator can be far from able to keep a good lookout both mentally and physically. The issue needs to be discussed; is this equipment to placed on or close to the bridge? Is it to be used during the watch (we know it is…)? If yes, should we place it up front? If we must, how do we integrate its safe use?

Bad design interferes with human abilities, performance and limitations in most operational conditions. For instance, automation tends to eliminate many routine tasks and the operator therefore experiences less mental workload. On the other hand the equipment/systems will be poorly understood and the operator will lack in practice and experience so the risk of human error in emergency situations will increase. In this study we found a mix of mirrored and non-mirrored panels - in an emergency situation where the operator already is under stress, the mental workload is increased and the situation awareness decreases it is obvious that handling errors are easy to perform which will be detrimental for safety. Individuals under stress are likely to make more errors and to make poor decisions because of psychological factors such as 'tunnel vision' and failure to consider critical information. On many ships we found panels that are cluttered with disorganised displays and controls. This could also cause high mental workload since it is hard to get an overview of the equipment. Another major risk is the alarm system. Alarms have impact on both mental workload and situation awareness, there have been serious accidents e.g. in aviation when the pilots were concentrating on figuring out what was wrong in the system and they 'forgot' to fly the plane. Bad design incurs costs both regarding human capital and in real money, and poses a risk under all operational conditions.

Poor usability is almost like it is broken
Non-use is a complete waste of money

11 Future work

- We must incorporate more manufacturers in the study
- We must devise a good way to stay in touch with students while on board
- We also need a good way to stay in touch after school is over
- We must find ways to "Close the loop", for instance by creating correspondence groups

Abbreviations

AB	Able-bodied seaman	**MAIB**	Marine Accident Investigation Branch
AIS	Automatic Identification System	**MF**	Medium Frequency
ARPA	Automatic Radar Plotting Aid	**MTO**	Man-Technology-Organisation
DF	Direction Finder	**PA**	Public Address (system)
DSC	Digital SelCall	**RINA**	Royal Institution of Naval Architects
ECDIS	Electronic Chart and Information Display System	**ROT**	Rate Of Turn
ENC	Electronic Navigational Chart	**SSB**	Single Side Band
GMDSS	Global Maritime Distress and Safety System	**SU**	System Usability (test)
HF	High Frequency	**VDR**	Voyage Data Recorder
IEC	International Electrotechnical Commission	**VHF**	Very High Frequency
IMO	International Maritime Organization	**VMS**	Voyage Management System
LAN	Local Area Network		

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Appendix 1

Checklist for evaluation of workplace

- It shall be obvious and clear where the operator should be located when using controls and displays
- The workplaces shall be possible adapt to the anthropometrics of the operator group
- The panels shall be place above waist-height (or knee-height when seated). Can otherwise be unintentionally activated
- The operator must not have to lean over some controls to reach other controls
- There shall be no cords hanging on the panel that hide displays and controls.
- The shall be a supplemental area at the operator workplace
- There shall be enough space to use a computer mouse, if a mouse is used.
- There shall be space for extra equipment
- The panel for starboard device shall be placed on the right side compared to a panel for port device.
- There shall be no mix in mirroring and no-mirroring in panels (for starboard and port devices)
- The information on the panels shall be prioritised so it is easy to see what is most important
- The panels shall be designed with grouping and mapping
- There shall be no loose control boxes on the panel

- The displays and controls shall med marked
- The marking shall be placed above the display and control. Not be hidden by the hand.
- The size and intensity of the markings of shall correspond the importance of the display and the control
- Controls and displays that are used together shall be placed together and marked as a group on the panel
- There shall be a clear and unambiguous visual connection between displays and the controls that affect the display
- Texts shall be correctly translated

- That shall be a consistent use of mapping of the ship on the panels
- The use of colour coding shall be consistent
- One button shall only have one function
- Its shall be possible to dim bright lights
- There shall not be any disturbing reflection of light

Appendix 2

What to do if you find a problem – before you fix it

- Hazard identification
- Risk assessment
- Safety meeting
- ISM
- Contact superintendent/manufacturer/NI
- Use MARS
- Is there training available?
- Do something ,and make it permanent

Appendix 3

Inside cover

How and when to use this log…

Do step 1 & 2 within first month
Do observation, step 3, dynamics part every watch on bridge if possible

A couple of tips:
If you do not fill in every box or question, make a comment as to why
When you take a picture of something, cross-reference it in the log book ("worst equipment – xx, took a picture of it" and/or add a comment so that it will be easier to analyse your material when you return)

Remember to note some details about the ship

Built, year, where	
Size	
Ship type	
Cargo type, originally and now (if converted)	
Trade, built for and now?	
Number of crew, nationality (to discuss ergonomics for different nationalities)	

Part 1: Description part (seeing it)

What: Describe bridge.

Why: Learn to see it as workplace. To understand that mistakes that happen may not be someone's fault but a fault in the workplace.

When: Do when come onboard

How: Draw it (or copy blueprints, GA) or both

Photographs

- Details
- Whole, layout, view from bridge
- CRTs (sometimes try switching flash off)

A numbered list of bridge equipment is attached, please mark the equipment present on your bridge on a drawing of the bridge. You may also:

i. Draw in where work is performed
   a. Passage planning
   b. Mooring/unmooring
   c. Conning
   d. Navigation
   e. Traffic surveillance
   f. Manoeuvring
   g. Hand steering
   h. Safety surveillance
   i. Safety operations
   j. Communication
   k. Security work
ii. Are there spaces adjacent, where work is performed (e.g. radio cabin)
iii. What's not working?
iv. Mark out equipment which is not used anymore
v. Are there modifications (wood, paper, notes, tape)
vi. Where is the bridge placed on the ship?
vii. What is the view from the bridge? What can you see?
viii. Layout, does it work? Compare to link analysis example

Part 2: Discussion part (talking about)

What and why: look for integration work: evaluate equipment, think about functions critically – "Dimensions of badness". Archaeology on the bridge

A) newest, best and worst
B) Questions based on SOLAS V/15
C) Modifications
D) What works well and why?
E) What is not used anymore?

When: When out of restricted waters, early in trip. You do not need to fill in a whole table at once, comments may turn up as time passes.

A. How: choose three pieces of equipment, the newest, the 'worst' and the 'best'. Talk to bridge officers to help you choose and to answer the questions. Details below.

A 1 The newest piece of equipment on the bridge
What is the newest piece of equipment, name, make and model
When did it come, was it expected (did the officers know)?
What is the meaning and purpose of it?
How was crew prepared, trained?
Where is it placed? Why?
How is it used, how do they get it to work, manuals?

A 2 The best piece of equipment on the bridge
What is the best piece of equipment? name, make and model
Why is it considered the best? In which situations is it helpful or useful?
When did it come, was it expected (did the officers know)?
What is the meaning and purpose of it?
How was crew prepared, trained?
Where is it placed? Why?
How is it used, how do they get it to work, manuals?

A 3 The worst piece of equipment on the bridge
What is the worst piece of equipment? name, make and model
Why is it considered the worst? In which situations is it not helpful or useful?
When did it come, was it expected (did the officers know)?
What is the meaning and purpose of it?
How was crew prepared, trained?
Where is it placed? Why?
How is it used, how do they get it to work, manuals?
How would they like it to work?

B. Comparison, performed with all officers "SOLAS V/15"

Choose a few of the best and worst pieces of equipment on the bridge (discuss with officers). Ask the below set of questions to compare them.

This page is just an example.

These questions are based on SOLAS V/15, which deals with bridge ergonomics. Just use 1-7 for additions to the bridge. Use 1-10 for whole bridge. If the equipment does not pass, ask follow-up questions like

Why?
How?

Start - pick a piece of equipment on the bridge. Then ask:
1. Does this ever cause you problems when you are trying to do your job? (n=pass)

2. Does it help the team on the bridge to do their job? (y=pass)

3. Is the information you want ever hard to get at or confusing? (n=pass)

4. Is it clear what it is doing? (y=pass)

5. Does what it tells you ever get in the way of making a decision? (n=pass)

6. Does having to use it ever piss you off? (n=pass)

7. Is it obvious when you make a mistake with it? (y=pass)

Then pick another couple of pieces of kit and ask the same questions.

Finally ask:

8. Does it all work the same way? (y=pass)

9. Would you like to throw it all over the side? (n=pass)

10. Do you all get training in how to sail with it all working? (y=pass)

These questions are based on SOLAS V/15, which deals with bridge ergonomics. Just use 1-7 for additions to the bridge. If the equipment does not pass a question, ask follow-up questions like

Why?
How?

Start - pick a piece of equipment on the bridge.

Write down name, make and model

………………………………………………………………..

Then ask:

1. Does this ever cause you problems when you are trying to do your job? (n=pass)

2. Does it help the team on the bridge to do their job? (y=pass)

3. Is the information you want ever hard to get at or confusing? (n=pass)

4. Is it clear what it is doing? (y=pass)

5. Does what it tells you ever get in the way of making a decision? (n=pass)

6. Does having to use it ever piss you off? (n=pass)

7. Is it obvious when you make a mistake with it? (y=pass)

Then pick another couple of pieces of kit and ask the same questions.

These questions are based on SOLAS V/15, which deals with bridge ergonomics. Just use 1-7 for additions to the bridge. If the equipment does not pass a question, ask follow-up questions like

Why?
How?

Start - pick a piece of equipment on the bridge.

Write down name, make and model

………………………………………………………………..

Then ask:

1. Does this ever cause you problems when you are trying to do your job?
(n=pass)

2. Does it help the team on the bridge to do their job? (y=pass)

3. Is the information you want ever hard to get at or confusing? (n=pass)

4. Is it clear what it is doing? (y=pass)

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(n=pass)

6. Does having to use it ever piss you off? (n=pass)

7. Is it obvious when you make a mistake with it? (y=pass)

Then pick another couple of pieces of kit and ask the same questions.

These questions are based on SOLAS V/15, which deals with bridge ergonomics. Just use 1-7 for additions to the bridge. If the equipment does not pass a question, ask follow-up questions like

Why?
How?

Start - pick a piece of equipment on the bridge.

Write down name, make and model

…………………………………………………………………..

Then ask:

1. Does this ever cause you problems when you are trying to do your job? (n=pass)

2. Does it help the team on the bridge to do their job? (y=pass)

3. Is the information you want ever hard to get at or confusing? (n=pass)

4. Is it clear what it is doing? (y=pass)

5. Does what it tells you ever get in the way of making a decision? (n=pass)

6. Does having to use it ever piss you off? (n=pass)

7. Is it obvious when you make a mistake with it? (y=pass)

Then pick another couple of pieces of kit and ask the same questions.

These questions are based on SOLAS V/15, which deals with bridge ergonomics. Just use 1-7 for additions to the bridge. If the equipment does not pass a question, ask follow-up questions like

Why?
How?

Start - pick a piece of equipment on the bridge.

Write down name, make and model

………………………………………………………………..

Then ask:

1. Does this ever cause you problems when you are trying to do your job?
(n=pass)

2. Does it help the team on the bridge to do their job? (y=pass)

3. Is the information you want ever hard to get at or confusing? (n=pass)

4. Is it clear what it is doing? (y=pass)

5. Does what it tells you ever get in the way of making a decision?
(n=pass)

6. Does having to use it ever piss you off? (n=pass)

7. Is it obvious when you make a mistake with it? (y=pass)

Now, do the whole bridge…

These questions are based on SOLAS V/15, which deals with bridge ergonomics. Use 1-10 for whole bridge. If the equipment does not pass a question, ask follow-up questions like Why? and How?

Questions for the whole bridge.

1. Does this ever cause you problems when you are trying to do your job? (n=pass)

2. Does it help the team on the bridge to do their job? (y=pass)

3. Is the information you want ever hard to get at or confusing? (n=pass)

4. Is it clear what it is doing? (y=pass)

5. Does what it tells you ever get in the way of making a decision? (n=pass)

6. Does having to use it ever piss you off? (n=pass)

7. Is it obvious when you make a mistake with it? (y=pass)

8. Does it all work the same way? (y=pass)

9. Would you like to throw it all over the side? (n=pass)

10. Do you all get training in how to sail with it all working? (y=pass)

C. Modifications
What: You will perform “archaeology” of the bridge. Look for homemade solutions.

Why: They give hints of things that do not work optimally and also hints of how people would like it to look or work.

How: It can be anything which was not originally there, even short instructions and notes. Choose one or more to fill in details below. You can find them yourself but also ask the others onboard.

What did you find? Is it permanent or temporary? What materials were used?
Why was it done?
Who did it? Was the person alone, or in a group? Were others in crew told or left to figure it out?
When did it happen?
Where is it placed? Why?
How is it used?
Other comments

What did you find? Is it permanent or temporary? What materials were used?
Why was it done?
Who did it? Was the person alone, or in a group? Were others in crew told or left to figure it out?
When did it happen?
Where is it placed? Why?
How is it used?
Other comments

What did you find? Is it permanent or temporary? What materials were used?
Why was it done?
Who did it? Was the person alone, or in a group? Were others in crew told or left to figure it out?
When did it happen?
Where is it placed? Why?
How is it used?
Other comments

D. something which works well
What: Discuss the equipment they like to use.

Why: Find out why they like it, this provides clues to how they wish to perform their work and what they want to be able to do.

D Equipment on the bridge which works well
What is the piece of equipment? name, make and model
Why is it considered to work well? What is useful about it?
In which situations is it helpful or useful?
When did it come, was it expected (did the officers know)?
What is the meaning and purpose of it?
How was crew prepared, trained?
Where is it placed? Why?
How is it used, how do they get it to work, manuals?

E. Equipment which is not used (anymore)

E Equipment on the bridge which is not used
Which piece of equipment is no longer used (or has never been used)? name, make and model
Why is it not used? (does not work, is not needed, info is found elsewhere, is difficult to use)
When did it come, was it expected (did the officers know)?
What is the meaning and purpose of it?
How was crew prepared, trained?
Where is it placed? Why?
Have they used it, or tried to? Did they get it to work? Are e.g. manuals used?

Part 3. Dynamics part – to use and observe use

What: Watching others do their job and perhaps using equipment yourself.

Why: think about how you interact with equipment – how much work is put into getting it to work – how much effort is made for things not connected to your task or job.

When: preferably every bridge watch
You may wait to fill in the below tables until the end of the trip, when you have had time to observe and evaluate.

How: find things:

1. That are broken, or break down regularly
2. Things that need (unnecessary) work to get them to work as wanted or wished
3. Things that are horrible or irritating to use

You may note more than one in each category, small and large issues
You are welcome to note your own thoughts on loose pages.

1. Instrument or aids that break down often

What is broken or breaks often? name, make and model
When does this happen, for how long? In what situations? Why is this a problem?
How is this solved, or worked around?
Other comments

2. Things that need unnecessary/extra work to function. For example: Passwords, restart, manuals, crew discussions, updates, repairs.

What needed work to make it work as wanted or wished? name, make and model
When does this happen, how often, and how long does it take to make it work?
How is this solved, or worked around?
Other comments – how would they like it to work?

3. Something which is irritating or horrible to use. This example may be one selected in the earlier SOLAS V/15 evaluation. You may use your personal opinion to choose.

What is horrible to use? Irritating, slow or time-consuming? name, make and model
When does this happen, how often, and how long does it take to make it work?
How is this solved, or worked around?
Other comments – how would they like it to work?

Inside back cover.

From keeping this log I conclude:

- the most unexpected use of …. that I saw was….

- The most impressive use of technology I saw was….

Equipment list for log book

1. Radar
2. ARPA
3. ECDIS
4. ENC
5. Paper charts
6. Automatic identification system (AIS)
7. VHF radiotelephone
8. Heading and/or track control system
9. Engine and thruster controls or telegraphs
10. Magnetic compass display
11. Conning information display
12. Rudder angle indicator
13. Gyro or THD repeater
14. Speed and distance indicator
15. Rate of turn indicator
16. Propeller revolution indicator(s)
17. Pitch indicator
18. Wind speed and direction
19. Depth indicator
20. Main engine revolutions
21. Torque
22. Starting air
23. Lateral thrust
24. Air and water temperature
25. Steering control override
26. Steering position selector
27. Steering gear power unit selector
28. Steering gear power unit start/stop
29. Electronic position-fixing system
30. Central alarm panel
31. Watch alarm acknowledgement button
32. Alarm reset control
33. Sound reception system
34. Intercommunication systems (including specifically to emergency steering position)
35. Whistle and fog signal controls
36. Searchlight controls
37. Night vision equipment (if provided)
38. Morse light keys
39. Window wiper and washer control
40. Emergency stop controls
41. Clock
42. Binoculars

b) Workstation for manual steering:

43. Manual steering device
44. Gyro repeater
45. Rudder angle indicator
46. Rate of turn indicator
47. Magnetic compass display
48. Course indicator

49. Talkback device to bridge wings

c) Workstation for docking

50. Engine control
51. Thruster control
52. Rudder control
53. Steering position selector
54. Conning information display
55. Rudder angle indicator
56. Gyro repeater
57. Speed
58. Rate of turn indicator
59. Propeller revolution indicator(s)
60. Pitch indicator
61. Wind speed and direction
62. Depth indicator
63. Main engine revolutions
64. Torque
65. Starting air
66. Lateral thrust
67. Air and water temperature
68. Communication (external and internal)
69. Whistle control
70. Morse light keys
71. Pelorus (alternatively located near the centre-line)

d) Workstation for voyage planning

72. Chart table
73. Navigation planning station (backup ECDIS)
74. Weather facsimile
75. Compass corrections

e) Workstation for safety:

76. Alarms
77. Monitoring systems
78. Fire alarm panels
79. Remote controls for fire-extinguishing system
80. Monitoring panel and remote control for watertight doors/fire doors (open/closed)
81. Emergency stop controls for air condition, ventilation and refrigerating installations
82. Main station for VHF or UHF radiotelephones (walkie-talkie)
83. Ballast controls
84. Clinometer
85. Bilge monitor
86. Strength monitor
87. Ship’s safety plans
88. Navigation light panel

f) Workstation for communication

89. GMDSS equipment as required for the applicable sea area
90. Weather facsimile
91. Writing space

g) Workstation for additional functions

92. Cargo monitoring and controls
93. Power panels