ABSTRACT

The present paper examines the extent to which ergonomic planning and the usability of bridge systems can affect navigational safety and help tackle a dangerous situation that arises during the life cycle of a ship in a more effective way.

A bridge is the most neuralgic place on a ship. It is here that the most important and vital undertakings of a ship take place. The global nautical community has acknowledged the importance of bridge ergonomics and it has also set regulations relating to equipment with the help of international conventions (SOLAS). In addition, it has issued guidelines for the ergonomic planning of the bridge with IMO (International Maritime Organization guidelines – MSC CIRC.982) and the International Organization of Standardization – ISO 8468.

Naval accidents in which the lack of ergonomic planning and of the usability of bridge systems was a determinant factor in the chain of errors are examined further down. These accidents could have had a different outcome had the bridge ergonomics and the usability of navigational systems been designed according to the ships’ particularities, their voyages and the features of the officers in charge of machine handling.

The results of a survey conducted in two coastal ferries sister vessels with integrated bridge systems and three ship masters (two of them were on duty in the course of the survey, while the third one was on land having previously served in one of the two ships) and different characteristics are also examined and analyzed. The ships of the survey fully complied with the guidelines provided by international institutional organs concerning ergonomic planning. However, at the end of the survey it was discovered that the usability of the up-to-the-minute navigational systems was not the expected one.

The survey into the ships which has been registered in this paper proves the need to apply more objective rules in what concerns ergonomics and the usability of bridge installed systems. These rules should be different in order to meet the ships’ particularities as well as those of the voyages performed and suit the features of those who are bound to use them.

Keywords: Human error, Usability, Behavior

1. INTRODUCTION

Till the end of the 70’s the bridge of the ship was equipped only with the necessary equipment in order to complete the voyage safely. The personnel of the bridge were trained to use these equipment and their duties were just all the necessary actions to preserve the safety of navigation.

Today with the progress of the technology all communication systems (digital selective call, satellite communications, distress systems) are designed and installed and operated on the bridge increasing the workload of the bridge personnel. In addition the limited space of the bridge created ergonomic issues with the installation of such equipment.

In the cargo handling sector new monitoring systems are installed on the ship’s bridge such as:

- Inert gas monitoring system
- Ballast monitoring system
- High level alarm system
- Cargo holds temperature system
All these systems are monitored and controlled by bridge personnel during ship’s voyage. With the implementation of new regulations new systems are installed on the bridge such as:

- Vessel Data Recording system
- Automatic Identification System
- Monitors of cameras installed on decks

With the installation of all the above mentioned systems arise that the role of the ship’s bridge today has transformed from navigation to operational center of the ship either the ship is in port or at sea. It is certain that technological developments are improving the level of the safety of the ship providing the officer on watch all the necessary tools during the whole context of operations.

Although the global maritime industry has brought in to force new regulations and guidelines for the ergonomic criteria on the installation of all these systems, before it comes to use the following questions must be answered:

- What happened when these systems conduct with the needs, the perceptions and the habits of users?
- How is evaluated by the users the installation of certain systems that they deny to use because they don’t trust?
- How the master of the vessel will improve the usability of the consoles of the bridge?
- How the master will acquire with more effective way the knowledge of size of force that applies with his handlings in the systems of control?

The answers to the above mentioned questions will be answered by the usability measures of the systems.

2. USABILITY

2.1 Usability – definitions – general

Usability is the degree in which a product can be used from specific users in order to be achieved specific objectives with effectiveness, efficiency and satisfaction in a specific framework.

Effectiveness is the accuracy and the completeness with which the users achieve specific objectives.

Efficiency is the degree of used resources concerning in accordance with the accuracy and the completeness with which the users achieve the objectives.

Satisfaction is the welfare and the positive attitude of users against the use of product.

2.2 ISO 9241-11 Guidance on Usability

At the planning and the evaluation of optical terminal draft (monitors) the main object that concerns on usability is the possibility that have the users of achieving objectives and satisfying needs in a specific framework. The directive of ISO 9241-11 explains the profits of measurement on usability with base the performance of users and the satisfaction that acquire from the use. Usability is calculated according to the degree in which the particular objectives are achieved, the resources that should be used for the particular objectives but also the degree which the users find that the product is satisfactory.

Directive ISO 9241-11 focuses on the dependence of usability from the framework but also in the particular conditions of use of product that affects the degree of usability. The framework is constituted by the users, the actions, the equipment (software, hardware) and the natural and social environment. The measurements of performance and satisfaction of user determine the whole system of work and when a product is to be evaluated these measurements provide information relative to the usability of the product in the particular framework. The results in the changes of other elements of work system as the number of users, the improvement of lighting can also be measured in the performance and satisfaction of users.

Having as main target the measurement of usability should be determined the objectives which seek after and analyzed the effectively the performance. The elements of framework should be analyzed in sub-elements with measurable parameters. The elements of usability and the relation between them are provided in the figure 1.
2.3. Usability On The Bridge

The main objective of measurement of usability on the bridge is the evaluation of ergonomic planning and how much this finally helps the personnel of bridge to execute his duties with effectiveness, sufficiency and satisfaction contributing with this way in the reduction of human error is.

In measuring usability on the bridge, it is extremely important to examine every factor in the bridge separately according to ISO 9241-11 for usability and to adjust the usability of the systems on the bridge and to measure the effectiveness, the performance and the satisfaction of them. The following steps must be followed in order to be measured the usability of the systems on the bridge with reference to evaluate the ergonomic planning of bridge.

Context of Use

According to the ISO, the following factors constitute the context of use:
- The users
- The jobs-missions
- The equipment
- The environment (organizational, technical and natural)

The users of bridge must be adjust to the model of ISO, from this adjusting results that the determination of users concerns the officers and generally the personnel of bridge that knows the equipment of bridge (systems of handling the ship, radar, navigation systems, communications) with sufficient knowledge of their duties. Also the natural characteristics of users are extremely importance as age, natural faculties, natural restrictions and weaknesses, attitudes, perceptions and motives. All the above characteristics determine the users of bridge and constitute a factor of context of use.

The work and the missions that assign in the users of bridge are:
- Navigation
- Route
- Attendance of trip
- Mooring
- Communications
- Management center of danger.

In the above jobs must be determining the following:
- Name of job - mission
- Frequency of implementation of job-mission
- The time where it is considered satisfactory for the implementation of job -mission
- Flexibility of job-mission
- Natural and intellectual requirements
- Risks due to errors
- Requirements of safety

The **equipment of bridge** should be analyzed separately according the following:
- Determination of mission of equipment
- Description of equipment
- Field of application
- Hardware
- Software
- Material
- Services

The environment must be separate in organizational, technical and natural. The segregation and the factors that should be determined with reference to prescribe the environment illustrated in table 1.

<table>
<thead>
<tr>
<th>ORGANIZATIONAL ENVIRONMENT</th>
<th>TECHNICAL ENVIRONMENT</th>
<th>PHYSICAL ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of work</td>
<td>Hardware</td>
<td>Atmospheric conditions</td>
</tr>
<tr>
<td>Group working</td>
<td>Software</td>
<td>Auditory environment</td>
</tr>
<tr>
<td>Job function</td>
<td>Reference materials</td>
<td>Thermal environment</td>
</tr>
<tr>
<td>Work practices</td>
<td></td>
<td>Visual environment</td>
</tr>
<tr>
<td>Assistance</td>
<td></td>
<td>Environmental instability</td>
</tr>
<tr>
<td>Management structure</td>
<td></td>
<td>Workplace design</td>
</tr>
<tr>
<td>Attitudes and culture</td>
<td></td>
<td>Workplace safety</td>
</tr>
<tr>
<td>Job design</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Guidance to Usability ISO 9241-11

**Effectiveness**
The measurement of effectiveness focuses on the precision and completeness with which are achieved the objectives from the user.

Example: if the expected objective from the use of ARPA–RADAR is the estimate of more near point of approach of ship that is examined and portrayed finally distance is 1 mile and the ship it approaches in the 0,6 miles, then effectiveness it is appreciated by the precision of measurement. In the example the effectiveness is not judged sufficient.

**Efficiency**
The measurement of efficiency focuses on the effectiveness that is achieved toward to the resources that were spent. Such resources can be considered the natural and case human effort, the time and the economic cost. According to the above results that the efficiency is be measured by the effectiveness of human effort in the time and in the economic profit.

In the example of ARPA – RADAR the efficiency can be measured in the effort that needed the user overwhelms in order to chartering the point of the ARPA but also in the time that needed from the start of process up to the reception of final result. The economic profit is be appreciated by the reject of unnecessary handlings due to doubts about the correctness of result.

**Satisfaction**
The measurement of satisfaction concerns in the extent in which the users are free from displeasures and in their attitude opposite in the use of system.

The satisfaction can be measured with subjective gradation in scales as displeasure, satisfaction or dissatisfaction for the system that is evaluated, acceptance of pressure of work when it should is executed also other work. Measurements of satisfaction can be considered also the positive or negatively comments of users at the use of system.

In the example of ARPA-RADAR, measurement of satisfaction is considered the eagerness of officer to impress the target with the particular system, his disposal at the effort, and his final comments after the use but also the certainty that inspires the use of system.

3. NAUTICAL ACCIDENTS

According to elements from files of nautical accidents the human error immediately or indirectly is accountable for the 80-85% of nautical accidents. The directness of human error concerns accidents which in the chain of errors or dysfunctions that finally caused the accident the first ring belongs clearly in the human error and includes about the 50% of the accidents.

By the researches that were carried out afterwards the nautical accidents in many of them observed ergonomic imperfections that contributed in the erroneous movement of person with final result the challenge of accident. In the following paragraph are reported accidents that the ergonomic planning of bridge and/or the lack of usability existed negative factor in the prevention of accident.

3.1. The grounding of M/V FINNCLIPPER

The background of trip
Passenger/Ro-Ro vessel FINNCLIPPER left the Kapellskär harbour on 20.01.2004 at 02.03. Master did take care of the departure arrangements by himself. Northeastern wind presses the vessel against the pier from the port side. Master took first the bow out from the pier by bow thrusters while the stern was lying on the last fender towards shoreline. Finally, the stern released by increasing the main engine power forward, the rudders being to the starboard. (Figure 2).

After this the master changed his steering position in the middle of the bridge, the rudder being in the middle, the main propellers output 23% forward and he didn’t activate the bow thrusters in the middle cockpit steering position. No one of the crew on the bridge did monitor that the vessel drifted toward to buoy. The passage resumed with similar propeller blade-and rudder adjustments, bow thrusters being in zero position. About 02.09 Master turned the rudder about 20° to the left leaving the other means of steering as they were. The vessel was continuing the drift due to lack of steering efforts towards to the before mentioned buoy (Figure 2).
When the stern was coming closer to the buoy at 02.09.50, master increased the propellers output to 32 % and turned rudder 15° to the starboard in order to avoid the stern to collide on the buoy. The vessels sterns did collide on the buoy at 02.10.30 and there after the vessel run on the ground located on the northeastern side of the island. The vessel’s bottom suffered many damages in the entire length. (Figure 2).

Factors that led to the grounding
According to the research that was carried out by the Finnish Authorities the factors that helped and/or could not they deter the accident they were the following ergonomic imperfections:

- Control panel for the bow thrusters in the centre console situated behind the officer’s chair. When one is changing the maneuvering place from the bridge wing to the centre console, one has to go behind the chair to activate bow thrusters control and then move in front on the chair to continue the handleings (see Appendix 2, picture 1). This it finally means lack of time in the total control of handleings. In the case of the vessel FINNCLIPPER the bow thrusters were not used.

- The bridge should be drawn so when is transported the control of handleings from one maneuvering place to another could be taken over with only one movement. The console of the vessel FINNCLIPPER provided this possibility with the MaKeVa joystick. The master didn’t use this joystick. According to the research masters don’t use or avoid the handleings with this joystick due to inaccurate operation.

The bridge of the vessel is manufactured and shaped ergonomic according to all the guidelines of international frame. The equipment of bridge is new with modern electronic systems. The existence of VDR helped a lot in the research of accident. The main reasons of the accident were located in the lack of familiarization of master with the particular bridge and in the lack of processes that concerns subjects of management of personnel of bridge (Bridge Resource Management –BRM).

Conclusions - Proposals
The conclusions and the proposals that are exported from the stranded of the vessel FINNCLIPPER with respect to the ergonomic and the usability are:

- The transport of control of handleings by the station of moorages right and left in the bridge in the central station of navigation and reversely should become with one only movement. The point that should is placed the button or the lever that transports the control should be accessible in the operator from the place of work without he should moved. The last one is very important because if the operator needs some means of handling and should leaves momentarily the control of other handleings in order to activates what needs then it loses the control of situation, if again does not have all the means in the disposal then is lost the advantage of use of all faculties of maneuvers of vessel.

- The refusal and/or the unwillingness of masters to use the lever that could transport the control from bow thrusters in the central console are a subject that concerns clearly the usability of this mean. The masters that are also the users have thus located inaccuracy and big difficulty in the correspondence of lever in the orders and while his existence is critical finally it is decorative element in the bridge. Such researches of usability should become also afterwards the installation of systems in the bridge and should be evaluated the usability of them.

3.2. The Grounding of Motor Vessel GERDA
The German flagged motor vessel GERDA sailed from Helsinki to Kokta. In the channel that precedes the harbor of destination it is obligatory to have a pilot and indeed in the ship came a pilot in order to pass the channel.

The background of grounding
The vessel was on her way to Kokta (Figure 3). The pilot was steering the vessel. The vessel proceeded at full speed, but according to the GPS the speed was 6 knots. That happened due to ice that was in the sea and prevents the boost of speed. The visibility reduced to zero and navigation becomes with the radar. The pilot used range 1.5 mile and tried to tune out the interfering echoes caused by the ice. The pilot was steering on autopilot. He ordered heading 015° and waited the vessel to reach line 018°. The pilot reported turning the automat to course 360 °. All the target echoes had blended into the echoes formed by the ice. The pilot switched the radar back to range 1,5 in order to confirm the position of vessel from another point of land. He deduced that the vessel lay slightly east of the fairway and changed the heading to 340 °. The purpose of this change of heading wasn’t to direct the ship to heading 340 ° but to create a steep rudder angle in order to
speed up the turn to port. The speed was 7 knots and at 04:10 the vessel hit something. The ship listed violently to port from the force of the impact. The stack of containers in front of the bridge collapsed and four containers fell overboard and the ballast tanks No1 and No2 had serious damages.

According to the research that were carried out in the vessel after the grounding of M/V GERDA confirmed the facts that lead to the accident. The main reason was considered the loss of control of the position of the vessel in the start of the turn to heading 355°, there was a delay about a minute and half after the pilot had measured the distance. The cause of the delay was the wrong estimation of distance.

During the research had resulted elements that led to the contributing factors to the grounding of vessel and which were considered by the surveyors as the real causes of grounding. These factors are based on ergonomic imperfections and systems of low usability. The users who prefer the traditional methods do not use some operations of these not utilitarian systems. Analytically the factors that led to wrong handlings or estimates are:

- The system of automatic pilot as is drawn (figure 4) appears to be sufficient for the pilotage if the user uses the rate of turn tiller - ROT in order to control the speed of turn. This lever is ergonomic placed in the bridge but when the vessel needed to turn fast this lever was not used. The process for the change of course needs enough movements until the vessel begins really to turn. Analytically the user should SET COURSE button pressed and new heading set with the heading change knob and then he should pressed the SET button. Turning takes place according to the present rate of turn. In the case of vessel GERDA the turn was delayed about 1 minute 30 seconds. Also the vessel allocates system manually operated with the lever “NON FOLLOW UP”. This system is activated with a simple movement of lever, disconnects the automatic pilot and use manual steering. Moving this lever left or right turns proportionally the helm and this appears from the clue of angle of helm. The lever as soon as leaves the operator comes back in the middle but the helm remains in the last place without following the lever. Consequently, must be attended the angle of helm in order to avoid errors. This lever and this method are used in emergency cases. The case of vessel GERDA
was an emergency occasion but this method was never used. The pilot preferred use of the autopilot and he not used the systems of the bridge.

- The radar of vessel was the other factor that played decisive role to the grounding of GERDA. The radar that was installed in the vessel was an advanced system at the time where happened the accident. The complicated processes, however, that should followed the pilot is not functional for him as it differs from other radars, so the pilot preferred to use the traditional methods that are simple but not accurate. Particularly the pilot of vessel GERDA did not use the distance and bearing of radar. The advantage of this system is the absence of all buttons but for the pilot this means multiple functions. For the distance pilot used the method of rings(Figure 5).

In order to become comprehensible the method of rings it divides the screen of radar in fixed rings and their beam portrayed in the screen with Display message. In this way and with optical approach calculated the distance of various targets that portrayed in the screen of radar. The calculation with this method is not absolutely precise and compared to the possibilities of calculation that provide the particular system are judged poor. However, the pilot preferred the most precise method and the limit of error of this method caused the grounding.

![Diagram of steering modes of M/V GERDA](image1.jpg)

**Figure 4: The steering modes of M/V GERDA**

Source: Investigation report of AIB Finland B/4 1998

![Diagram of radar scales](image2.jpg)

**Figure 5: Radar scales of 1.5 and 0.75 miles and distance rings on M/V GERDA**

Source: Investigation report of AIB Finland B/4 1998
Conclusions - Proposals
The grounding of vessel GERDA is a palpable proof of importance of ergonomic planning and usability of systems that is installed in the bridges of vessels. This accident have not resulted in damage to persons or the environment, however, it was important and decided to launch a common investigation because it was a completely equipped vessel with trained crew and an experienced pilot who had know the area and particular the conditions of pilotage as the navigation in the ice and in null conditions of visibility.

The results of research from the grounding of vessel GERDA are offered for the localization of drawing dysfunctions of systems of control in the bridge but also for the estimation of usability. Corrective energies should be communicated in the constructive companies of systems that were judged insufficient in order to correct the errors in all vessels that had their equipment. The corrective energies should be focused in following:

- In the systems of steering the elements of control should be simple and only with one movement to change from automatic to manual and reversely. All the operational capabilities of vessel should be developed when is necessary. This can be done easily if all these capabilities are simplified and become with complete attendance and preference of operator.
- In the systems of follow-up of trip and specifically in the use of radar. In the case of vessel GERDA the pilot didn’t use the more precise method of calculation of distance knowing that it should be an error. Due to complexity of use of radar he preferred the second solution. The constructive company should re-examine the usability of the particular device, upgrade and to propose in vessels that have devices similar to GERDA to replacement their device with new and evaluate them about their usability from the users.

4. CASE STUDY
In this chapter are reported the results of research that were carried out in the bridges of sisters ships of passenger/car-ferries that sailed from Piraeus to the islands of Eastern Aegean and reversely. This research focuses on the evaluation of usability of installed systems in the bridges of vessels that have direct relation with the safety of handlings at the trip and the moorage. This evaluation became with criterion the mission and the special requirements that result from the operation of vessel. The two masters of the ships and the former one cooperated during the evaluation of usability of systems of handlings in the vessels in order to recorded their attitudes and perceptions according to the use of systems of bridge. During the interviews recorded proposals for the improvement of effectiveness of performance but also facility of handlings in the vessels.

4.1. Ergonomics of the ships
Bridge layout
The age of the ships is three years and one year old. The service speed of the vessels is 28 knots. The vessels are connecting the hinterland of Greece and the East Aegean islands. The vessels daily are proceeding 4 ports. The docking system is crucial for the safety of the ships during the port maneuvers.

The bridge layout as shown in the Figure 6 is fully integrated and is complied with the international guidelines of IMO and ISO.
The docking workstation

The docking workstation is an integrated console equipped with all vital subsystems needed for the safe maneuvering of the ship in limited spaces as the ports. The scope of the research is to measure the usability of these subsystems and the workstation.

The subsystems examined by this survey were the following:

- The steering subsystem
- The engine control subsystem
- The bow thruster subsystem

The steering subsystem

The steering of the vessel in the docking workstation is controlled by two knobs which are controlling the rudders of the ship. The rudders are controlled by independent steering (the rudders can turn port or starboard independently) or by synchronized steering (both rudders turn port or starboard). The synchronized steering mode is mostly used at sea and the independent mode in limited spaces like ports. The steering system is clearly shown in Picture 1.
The engine controls subsystem – bow thrusters handling

The engine control handlings are constructed in the traditional shape of engine telegraph. The user is handling through two levers the power of the engines. The ship is constructed with two main engines and two pitch propellers. The engine telegraph is equipped with a scale from 1 to 10 in order to provide the user the power control in both motions (ahead-astern).

The bow thrusters’ handlings are located in the middle of the docking workstation console. Bow thrusters are small propellers constructed in caves under the sea line. These propellers are vital for the side motion of the vessel especially the bow. The handlings of the under research vessel are levers which in the 0 power are in vertical position and in full power are formed a 20° angle with the flat level of the console. During the handling of these levers the user must know that when he forcing power to the bow thrusters to port the bow is turning to the starboard.

In the following Picture 2 the engine telegraph and bow thruster handlings are clearly shown on the docking console.
The users
As mentioned in previous lines two of the users who participated in the research were the masters of the ships. The research carried out during the docking procedures of the ships, one during daytime and the other during nighttime.

The third user was on land having previously served as the captain in one of the two ships. The characteristics of the users are presented in the following table 2:

<table>
<thead>
<tr>
<th>Master A</th>
<th>Master B</th>
<th>Master C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience</td>
<td>5 years As master on coastal line ships</td>
<td>7 years As master on coastal line ships</td>
</tr>
<tr>
<td>Hardskills</td>
<td>License A</td>
<td>License A</td>
</tr>
<tr>
<td>Softskills</td>
<td>High training standards</td>
<td>High training standards</td>
</tr>
<tr>
<td>Physical characteristics</td>
<td>Height : 1.70 Weight : 70 kgs Age : 40</td>
<td>Height : 1.65 Weight : 70 kgs Age : 44</td>
</tr>
<tr>
<td>Familiarization with the bridge</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

4.2 Evaluation of systems - Usability
It is a fact that the systems in the vessels are new, the companies that construct them are leaders in their sector and they meet the specifications of international institutions with regard to the ergonomic planning. These systems are navigable and safety at the duration of moorages.

The vessels are specially designed and constructed to berth by the stern. Bridge systems are designed and oriented to the ship’s bow. Masters during docking procedures prefer to have the physical perception of the ship’s motion instead the readings of the electronic navigational aids. In the following Picture 3 is clearly shown that during docking masters prefer to have visual contact with the berth and they turn their back to the instruments on the docking console.
Usability measures in all elements of usability is presented in the following table 3:

<table>
<thead>
<tr>
<th>Usability measures</th>
<th>Master A</th>
<th>Master B</th>
<th>Master C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Efforts</td>
<td>80%</td>
<td>60%</td>
<td>80%</td>
</tr>
<tr>
<td>Efficiency Time</td>
<td>60%</td>
<td>60%</td>
<td>80%</td>
</tr>
<tr>
<td>Efficiency Cost</td>
<td>70%</td>
<td>50%</td>
<td>80%</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>50%</td>
<td>30%</td>
<td>40%</td>
</tr>
</tbody>
</table>

5. CONCLUSIONS – PROPOSALS
The human error is the cause for the 80% of nautical accidents. The 50% of the nautical accident have begun from human and a 30% of them have been affecting by human. In the first therefore case the person created the conditions of accident while in the second case his intervention did not accomplish to deter the devastating consequences of situation that were created by other causes.

The ergonomic planning of vessel is one of the factors that help in the restriction of human error providing a friendly environment of work where the person has the possibility of executing his duties with effectiveness.

Despite these accidents continue happening even in new vessels with complete conformity in the guidelines of international institutions.

Specific operational needs of the ship should be considered when designing bridge systems. Masters prefer to have the physical perception of the ship’s motion instead of instrumental readings. Masters want to feel the power they force by handling the control elements of the docking system. Usability of bridge systems is achieved at the maximum level when the design of the systems is providing all the desired options to the users.

The perceptions of users and their habits are important factors in the measurement of usability of systems. The example of master that has turned his back in the systems of control of bridge so that it has the bigger strong sense of force that applies in the vessel is characteristic.

The systems of bridge that are drawn according to the beliefs of ergonomic must be evaluated in experimental stage before their installation in the ships as regard their usability. The future users should evaluate the systems before their installation in the ships and must be the measurement of usability in acceptable levels.

For the systems that already exist in the ships and have been proved the low degree of usability should be special training programs for the users in order to use them effectively.
The research in the vessels and the accidents that were recorded in this study illustrate the need of application of more objective rules regarding the ergonomic in the bridge. However, these rules should be based on an acceptable model of rules for all the users. In this direction should be done more research.

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