# Report

# Project 2

# "Digitalization on seagoing vessels"

**Group name:**
Project group 3

**Place, date:**
Rotterdam, 14 April 2012
Netherlands Maritime University
Lloydsstraat 300 3024EA Rotterdam
Netherlands


| Name: | Student number: | Email address: |
|---|---|---|
| Don Bakker | 0843961 | bakkerdon@live.nl |
| Jacco van Heeren | 0835374 | jaccovh@gmail.com |
| Symon Boersma | 0833416 | symonboersma@hotmail.nl |
| Kevin de Reus | 0838895 | kevin_dereus@hotmail.com |
| Emiel Stroo | 0840203 | emielstroo@hotmail.com |

**Principals:**
Mr. van Kluijven
Mrs. van der Drift
Mr. Blankenstein

# Index


**1. Preface** **3**

**2. Introduction** **4**

**3. What is digitalization?** **6**

3.1 Automation 6
3.2 Digitalization 6

**4. Root causes** **7**

4.1 Procedures and regulations 7
4.2 Design and arrangement 7
4.3 Maintenance 7
4.4 On-board organization 8
4.5 Communication 8
4.6 Fatigue 9
4.7 Error- enforcing circumstances 9
4.8 Incompatible goals 9
4.9 Defences 9
4.10 Crew's negligence 10

**5. What already has been digitalized** **11**

5.1 Procedures and regulations 11
5.2 Design and arrangement 11
5.3 Maintenance 11
5.4 On-board organization 12
5.5 Communication 12
5.6 Fatigue 12
5.7 Incompatible goals 13
5.8 Defences 13
5.9 Crew's negligence 14

**6. Improvements** **16**

6.1 Procedures and regulations 15
6.2 Maintenance 16
6.3 Communication 17
6.4 Fatigue 17
6.5 Crew's negligence 19

**7. Conclusion** **21**

**8. Recommendations** **22**

**9. References** **24**
**10. Appendix** **25**

# 1. Preface

Every year the second year students work on a project.
This year this is also the case. The project group consists of Jacco van Heeren, Symon Boersma, Don Bakker, Emiel Stroo and Kevin de Reus.
This year the theme of the project is improvement and innovation.
Before starting with the project a subject had to be determined.
From this subject we then formed the main question.
Also a number of sub questions have to be thought of.

This paper is about: How can digitalization minimize the root causes that are related to the human factor?

Every root cause had to be researched. For this information desk research and field research in the form of interviews had to be done.
When reading further it will become clear which systems can be improved and for which root cause(s) we have found new automatic systems.

During this research we spoke with a lot of interesting people and even had contact with Professors of a university in America.
With the information we found ourselves and the information told be the people we spoke and emailed we were able to answer the questions we asked ourselves.
We believe that this research is a good source of information and can tell you more about how digitalization can help to minimalize the root causes that are related to the human factor.

Start reading and enjoy.

# 2. Introduction

**Digitalization**
Innovations and inventions provides technology to make sailing safer. Integrating new systems on vessels to minimize the risk of human factor, is an example of digitalization. Because technology is innovating fast, there are chances to improve or adapt inventions or systems on board of vessels. Digitalization in this project is about making the current systems on vessels more efficient, or develop new systems to minimize the risk of human factor.

**Human factor**
Accidents with vessels happen almost always because of the human factor. The Human Factor is related to several root causes, or latent causes as they are also called. The British Protection and Indemnity club (P&I) made a top 10* of the most common factors which cause collisions, loss of cargo, vessels on fire or other kinds of accidents. To minimize the consequences of these factors, different sorts of systems have been developed. The influence of the human element is one of the reasons why modern seagoing vessels are more and more becoming digitalized.

* Top 10 of most common root causes of accidents:

**1. Procedures and regulations -** are clear procedures and regulations available and applied for routine shipboard tasks?
**2. Design and arrangement** - is the vessel and her equipment suited for the job?
**3. Maintenance** - is regular and effective maintenance performed ("general quality of the ship")
**4. On-board organisation** - hierarchy of personnel, pre-arrival/- departure meetings, interactiveness, etc.
**5. Communication**
**6. Fatigue –** this root cause has replaced the original number 6 (training), because fatigue nowadays is becoming a common root cause.
**7. Error- enforcing circumstances** - factors that provoke the making of mistakes and errors, e.g. pressure of time, fatigue, working conditions, culture gap, etc.
**8. Incompatible goals** - conflicts of safety and productivity, differences between on-board and shore procedures, high demands, etc.
**9. Defences** - protection and measures (precautions to prevent and/or control hazards.
**10. Crew's negligence**

**Automation**
The discipline of this project is automation. Automation is using technology to let machines or mechanical parts do things that persons otherwise have to do. Automation is needed before systems can be developed. Digital systems would not exist without automation. On vessels automation enables the crew to operate their vessels more efficient and also safer.

**Problem definition**
The problem that is being dealt with is the large amount of accidents on seagoing vessels that are caused by the human element.
The goal of this project is to find out how digitalization can be used to prevent these accidents that are caused by the human element.

**Main question**
How can the Human Factor in shipping accidents be minimized by digitalization on seagoing vessels?

**Sub questions**
- What is digitalization?
- Which systems have already been adapted to minimize the consequences of the human factor?
- Which systems have not been digitalized yet?
- In which way can these systems be improved?
- Which root causes in human factors present the most problems?

To answer these questions we will use a qualitative research method, by doing interviews. Both the desk as the field research are qualitative research methods.

**Project boundaries**
The aim of this project is to come with methods which minimize the effect of Human Effects.
To prevent this project from becoming too big, project borders are set.
They show what the project includes and what is not included in the project.

The project includes:
- Systems that already have been digitalized on board of vessels.
- The pros and cons of a specific digital system.

The project does not include:
- A very detailed explanation of how a specific digital systems works.
- The exact costs of a digital system.

**Goal**
The goal of this project is to make a recommendation-report.
This recommendation is for ship owners that would like to improve the safety on board of their vessels.

# 3. Digitalization

**Introduction**

This project is about how digitalization can minimize the accidents caused by the human factor. Therefore it is useful to be familiar with what digitalization means. But before that, the meaning of automation will be explained.

## 3.1 Automation

The basic principal of automation is to measure and perceive process variables. For example the measuring of temperature from a furnace. The furnace is heated up by gas. Depending on the temperature the gas supply can be:
- Controlled by hand
- Automatically controlled.

When the gas supply is automatically controlled, no operator is needed.
A temperature indicator controller (TIC) takes over the work. The control valve controls the gas supply and is controlled by the TIC. The TIC gets his information from a temperature transmitter (TT) which measures the temperature in the furnace.
The temperature transmitter converts temperature to an electric or a pneumatic signal, the height of the signal depends on the range set on the transmitter and the height of the temperature. In the table below the standard output signal strength are shown:

| | Minimum output signal | Maximum output signal |
|---|---|---|
| Pneumatic | 20 kPa or 3 psi | 100 kPa or 15 psi |
| Electric | 4 mA | 20 mA |

## 3.2 Digitalization

Digitization is a process that converts information into a digital format; it is a type of automation. So it converts analogical data to a digital medium. The binary data consists of only two digits, 1 and 0. The binary data is sent to a programmable logic controller (PLC). A microprocessor in the PLC decides which output ports are controlled. The decision of output ports depends on the information given by the input ports (1 or 0). The working of the PLC has been set in advance; it passes the same cycles over and over.

With these automated system you can detect a certain factor. Like for example fatigue. You can measure very simply how fast the hard beats. This information is then send to the computer that makes out his own conclusion that the hard beat is to slow and gives a warning to the captain that the officer on the bridge is fatigued. Than the computer can assign another person to the job according to the records of work hours. This is all done by the computer and is therefore all automated. Also the computer can come in handy to remind you of certain tasks that need to be done in time. When the time for a certain task is come he will give you a reminder on the screen.

Automated and digitalized systems can take over human labor, this can be cost efficient and reduces the failures due to the human factor. In this report attention will be focused on digitalized and automated systems which can decrease these failures.

# 4. Root causes

**Introduction**

This is a list of the most common root causes of accidents.

1 Procedures and regulations
2 Design and arrangement
3 Maintenance
4 On-board organisation
5 Communication
6 Fatigue
7 Error- enforcing circumstances
8 Incompatible goals
9 Defences
10 Crew's negligence

## 4.1 Procedures and regulations

The root cause 'procedures and regulation' refers to the fact that people do not keep themself to the rules or procedures that they have to follow or that there are no clear rules or procedures available. It often plays a role in ship accidents because a lot of actions on board of a vessel are performed with the help of procedures and regulations. Example: One of the vessel's navigational lights is broken and they have no second light installed or spare light on board. The problem is now, that other vessels could misinterpret the heading of the vessel in case.

## 4.2 Design and arrangement

By the design of a ship is also meant the type of ship in relation to the cargo which has to be shipped. When a bulk carrier has to load and transport containers on deck and loses both containers due to adverse weather, the root cause of this accident is design and arrangement. This is because a bulk carrier is obviously not designed to carry containers on deck.

## 4.3. Maintenance

Maintenance is one of the most important things to do on a ship.
Insufficient maintenance leads to damages in the system which in the best case slows the voyage down and leads to delays due to repairs that have to be done in the next harbour or in the worst case make the vessel unmanoeuvrable

Because of these reasons the maintenance on board must be well taken care of. However maintenance on ships is not always performed the way it should be done. This has several reasons.

Either because of access problems, or if dismantling of large parts of the system is necessary to reach the part that needs maintenance. Than the maintenance is said to be done in the future or won't be done at all.

To prevent this, the designers of ships today use CAD-programs (Computer Aided Design) taking this into account to ensure a good accessibility of the machines installed.

Secondly there are so many different systems on board that it is not always easy to keep track of the maintenance periods. And on top of that checking for eventual unexpected wear of all systems. To help the engineers with their tasks there are CMM Systems (Computerized Maintenance Management Systems) that keep track of the maintenance periods and inform the engineers.

An example of an accident with as root cause maintenance could be a vessel that grounds, because the anchor winch was not ready to operate in time, because of poor maintenance.

### 4.4. On-board organization

An organization is a social group with the same goal. An organization is based on the following three elements: knowledge, frame work and Monitoring.

Knowledge: All the knowledge needed to function well on the taken position. This concerns technical knowledge, organization and human behaviour. You also need to know what the consequences are of certain behaviour and decisions.

Frame work: Hierarchical classification of the organization, for example which level of the system takes which decisions. This is the most important power for teamwork. It has the biggest responsibility.

Monitoring: Everyone needs to check upon each other the best result is achieved. This way the person knows where he has to pay attention on the next time, so he won't make the same mistake twice
An organization is an accumulation of procedures, production factors and humans working together to reach certain goals. It is important that everyone knows what these goals are.

### 4.5. Communication

According to the British Protection and Indemnity club there are several factors that cause accidents due to communication. The most important factors are: language problems, inadequate structure of communication, erroneously transferred messages, incorrect information, inconsistently provided information and overflow of information.
We think that standardizing the English maritime communication language is the best solution to reduce the effects of these factors. The International Maritime Organization (IMO) had adopted the Standard Maritime Communication Phrases (SMCP). If everyone on board of a ship knows the SMCP, then several of the above root cause types can be eliminated. In 2001 SMCP became a mandatory part of the education of officers at all training institutions according to the STCW95. Mr. van Kluijven wrote the International Maritime Language Program (IMLP), with lots of exercises, theory and tests to reduce the basic risk factor communication, which is being used to educate future officers.

## 4.6. Fatigue

This root cause that leads to many accidents can best be explained as people being tired. When people are fatigued they should sleep for a period but instead they work too long.

In many reports or investigations about the cause of accident with vessels fatigue is part of the features that causes it. A study of the Dutch Ministry of Transport, Public Works and Water Management even says that in 11 to 23 percent of collisions and groundings fatigue is the root cause.

Fatigue is mainly caused by the 6 on 6 off schedule that is used often.
Also an excessive work load on top of the daily watch can lead to fatigue.

But also monotonous tasking, the movement of the ship, excessive noise or vibration as well as ingesting certain types of nutrients and chemicals can lead to fatigue.
This fatigue leads to problems with concentration and the response time increases.
Also the attitude of people needs to be changed. For example: A certain system needs to be checked, but the person responsible for it is fatigued and therefore thinks it will be alright.
This is why fatigue is one of the root causes of accidents these days and that is why it should be decreased to a minimum.
It is not easy to detect if another person is tired.
Especially when he is all alone on the bridge for a certain period of time.

## 4.7. Error- enforcing circumstances

Error enforcing circumstances can be quite various.
For example crew members from several parts of Asia will almost always answer with "Yes" when asked if they have understood what you said, even though they did not. This is because they find it impolite to answer with "No".
This is one example of cultural differences which can enforce errors.

## 4.8. Incompatible goals

The British Protection and Indemnity club has done research about almost every factor which could cause an accident related to the human factor. For the factor 'incompatible goals' the most important factors are; financial constraints, discrepancy between social and individual factors, time pressure, discrepancy between formal and informal practices, discrepancy between short and long term goals and indistinctness with management.

Accidents due to incompatible goals is hard to be solved by digitalization. For example: there is a discrepancy between ship and shore. Shore wants the ship to depart immediately, but the captain says it is irresponsible and dangerous to leave, because a heavy storm is underway. For this factor you can make an advanced system that calculate wheter is safe enough to sail. This way the captain can show with the data of the system that it is not safe enough.

## 4.9. Defences

Accidents can cause injuries or damage to the vessel, crew or environment. So defences are there to protect humans from accidents. Methods of defence are divided in two categories:

- Hard defences
- Soft defences

A hard defence is for example a fire alarm which warns people. The fire alarm is an engineered safety feature. Also a mechanical barrier is an example of a hard defence.
In some cases it is hard to make a hard defence or even cannot be made at all. In those cases the defence is provided by procedures. This is called a soft defence. An example of a soft defence is a fire fighting training.

Accidents can be explained with a simple formula:

*"Uncontrolled hazard + undefended target = unwanted event (accident)"*

Unfortunately most accidents are far more complicated.
Mostly the hazard consist of a series of events which cause it. The uncontrolled hazard can be caused by an active failure. The active failures are the failures that are close to the accident and form a direct cause of the accident. Most of the time the active failures are caused by humans.

## 4.10. Crew's negligence

The negligence of a crew can be crucial for a seagoing vessel and is very often linked to a maintenance problem due to the fact that a negligent crew will ignore several maintenance periods and alarms.
In the engine room this leads to major system failures which can once again make the ship unmanoeuvrable.
To this root cause you can also link the events like ignoring an certain alarm or even shutting the system down because you don't want to hear the annoying alarm.

# 5. What has already been digitalized

**Introduction**

This chapter will give an overview of which systems have already been digitalized and how the systems are working. So it becomes clear if these systems can be improved or maybe even replaced by a better system. The following sub question is asked here: What has already been digitalized on seagoing vessels?

## 5.1. Procedures and regulations

There is administration on board that is done digitally. When certain tasks that are done are not signed off an alarm or report will be given. This way it is visible that this task still has to be done. Especially in the engine room such a system comes in handy. Most of the time there are entire lists that have to be done. But now it is registered when one task is finished.
With this system it is also possible to see who did the task. So if there is any problem with it later on, the person responsible for it can be found easily.

A lot of the procedures and regulations have a protocol manual where it shows how to act in certain situations. Most of them are emergency situations that need to be dealt with in a special way. For example when the vessel is flooding. Then a certain list of tasks has to be done before disembarking the vessel. Like transmitting the location and making sure everybody is disembarking. Before this, the members on board need to be counted, because elsewise somebody could still be on the vessel.
These manuals also exist in "normal" situations. It is just to make sure everything is done right and nothing is forgotten. In this manual things that have to be done have to be signed off the same way the digital administration is done.

This administration and the manuals are all stored on computers. The computers are linked with each other so the system can be accessed at multiple points on the ship.

| **Advantage** |
| --- |
| Easy to check which tasks have been done and by who. |
| **Disadvantage** |
| It takes a lot of time to register every task in the system |

## 5.2. Design and arrangement

To minimize this human factor there are no digital systems that can be of any help.

## 5.3. Maintenance

The Digitalization of maintenance on board is very hard to digitalize.
This is because the digital systems implemented are only serviceable reminding the engineer of what each one of them has to do.
Also it can help making the design of the ship more practical to access all parts, but a digital system cannot do the maintenance itself.
The Cad-programs mentioned above have been very useful in improving the layout of engine rooms so that the systems needed are easier to access and the maintenance that is necessary to keep all parts running has become easier to perform.
The parts of the main engine which are most vulnerable are the ones rotating at high speed. The smallest misalignment can cause severe damages and immense

costs. By implementing a laser shaft alignment even smallest deflections can be monitored and taken care of in time.
All these measuring components together are referred to as CbM (Condition based Monitoring).
The Cmm-systems are very important for the good maintenance on board, too. As said before they keep track of maintenance periods and schedule them. Basically it is just a tool to simplify the scheduling of preventative maintenance. This whole process is known as Monitored Maintenance. It helps the engineers to keep a better overview of their preventative maintenance tasks.
The goal of this preventative maintenance is to prevent possible technical failure before it actually happens to keep the system running and the vessel going. This is much more efficient than waiting for the failure to happen because of obvious reasons. When a failure happens, the system does not work as a whole anymore and delays and even failure of the voyage can be consequences of it. To prevent this from happening everything is monitored as much as possible to detect simple mistakes in approach.
But the CMM systems can be of more value, they also help controlling and planning the maintenance budget and because the preventative maintenance is performed it becomes easy to schedule the budget so the shipping company will not be surprised by any big maintenance costs.
These systems make maintenance much more effective than it would be with a paper or manual system due to the fact that with these systems the paperwork is reduced to a minimum and it is possible to have an overview of the whole system rather than being overwhelmed by it. Also the danger of getting outdated copies of maintenance procedures is practically erased.

| **Advantages** | **Disadvantages** |
|---|---|
| Thanks to CAD-programs it is easy to get access to all parts in the engineroom. | |
| CMM-systems make sure all maintenance has been done on time. | Takes time to fill in what has been done. |
| Easy to process maintenance costs. | |

## 5.4. On-board organization

This information has been gathered by interviewing[1] mr. J.M. Sprong from the Dutch 'Loodswezen'. This company consists of 475 pilots and makes sure that every vessel enters Dutch harbours safely.
The on-board organization is different on every vessel according to mr. Sprong. The only thing every vessel has in common is that they are all focussed on shipping cargo without making unnecessary costs.
Mr. Sprong named a few examples of what he has seen on board of vessels;

*The Royal Dutch Navy:* Everything goes very disciplined, according to certain procedures and regulations.

*The Holland America Line:* This organisation consists of multiple small organisations with each their own interests. These smaller organisations have to function together and have to form one combined interest. Therefore internal communication is very important.

*Offshore:* In these organisations only one thing is important: Time is money. Because of this, all the work has to be done as quickly as possible. To accomplish this, the organisation has to be solid.

*Coastal trade:* In these organisations, carrying goods as quickly and safely as possible from A to B is the most important.

The conclusion you can make of the examples is: The organization is on every kind of vessel different. That is because every company is different and has an other vision. And because every person is different they fill the job in a different way in.
[1]The complete interview with mr. Sprong can be read in the appendix.

## 5.5. Communication

Systems that already have been developed on board of vessels to decrease accidents due to communication are fax machines, computers, mobile phones, internet, Automatic Identification System (AIS)*, VHF with/without Digital Selective Calling (DSC)**

* AIS is a system based on transponder technology which provides information about the vessel on which AIS is installed. This information is used for interaction from ship-to-ship or shore to ship communication.
**DSC is a technique which enables a ship or coast station to make individual calls by using the VHF. Each ship or coast station has its own unique number, the Maritime Mobile Service Identity (MMSI).

| **Advantages** | **Disadvantages** |
|---|---|
| These systems make communication with other vessels/shore easier. | These systems do not reduce the language problems |

## 5.6. Fatigue

For fatigue there already is a watch alarm system that is installed on almost each vessel. This is basically a button that you have to push about every 15 minutes. The interval in between can be changed, but can't be too long.

This system ensures that the officer of the watch can't fall asleep. When the button isn't pushed on time a light will flash and then there will be sound. When the officer of the watch doesn't response when the sound goes an alarm will go off and the captain will be informed by it.

| **Advantages** | **Disadvantages** |
|---|---|
| System makes sure that the officer of the watch can't fall asleep. | This system does not warn you or others when someone is too fatigued to work. |

## 5.7. Incompatible goals

Digitalization of failure due to incompatible goals has not been done on board of vessels. Probably this is because incompatible goals can't be solved by developing a digital system. It can be reduced by other things like adapting procedures & regulations or by working with checklists to monitor how some progresses are going.

## 5.8. Defences

As said before the method of defence is divided in a hard and soft defence. A soft defence cannot be digitalized, because it is not possible to digitalize safety instruction or training. But a hard defence can be digitalized; in fact almost all hard defences are digitalized defences. For example a mechanical emergency door which automatically closes in case of fire. In this report the already digitalized systems are divided into the internal and external factor.

**Defences for the internal factor**
Fire is an example of an internal factor. To prevent the fire from spreading out, two different methods of fire protection are applied:

- Active fire protection
- Passive fire protection

Both are hard defences because they are engineered safety features. Examples for active fire protection are automatic fire detection systems and automatic fire extinguishing systems. Compartmentalisation of a vessel is one example of passive fire protection, but also a fire stopping wall in a vessel belongs to it. Passive fire protection is not interesting for digitalization, because it consists of pre-designed safety features which cannot be digitalized. For active fire protection however already a lot has been digitalized.

The most common type of active fire protection is extinguishing with water. Seawater is pumped up from the seawater inlet and is transported through the vessel. There is an unlimited amount of extinguishing material available. The only problem with it is that all the water, which has been used to extinguish the fire runs to lower portions of the vessel and may cause stability problems.

Another type of extinguishing is with the help of gases. In case of a fire the gas is led into the room and lowers the oxygen level. The fire will stop when the oxygen level is low enough. The extinguishing gas can be:

- CO2
- Halon alternative

A big advantage of this type of extinguishing is, that damage to equipment can be avoided. When extinguishing with water, equipment may be harmed. Also no water has to be pumped out of the vessel, so the clearing time is shorter.
The biggest disadvantage is, that it cannot be used when there are still people in the room, since they would suffocate.

**Defences for the external factor**
Adverse weather is a good example of an external factor. On board of vessels different systems are used to avoid adverse weather. By using these systems, damage to the vessels or loss of cargo can be prevented. Strong winds can cause damage to containers stowed on deck and it is mostly accompanied by a rough sea-state. This rough sea-state can be very dangerous. Depending on the height of the waves and the angle of entry the vessel can start to roll heavily and, as a result, get a dangerous list

A software tool which is applied on vessels these days is SPOS (Ship Performance Optimisation System). It is a weather routing system which is made by MeteoGroup and uses the latest meteorological information to calculate the optimal route. While calculating this route, the program takes the wind, waves, swell, current predictions and other elements into account. So SPOS increases the safety for the crew and saves money by calculating the most efficient route.

## 5.9. Crew's negligence

The problem of a negligent crew cannot be solved by warning system due to the fact that a negligent crew will ignore alarms concerning maintenance periods.

In our Interview with mr. Post of Post & Co we found out that crew's negligence is the most important human factor. According to him it was communication but continuously talked about the fact that people ignore systems, or even shut them down. This is a type of crew's negligence. You can find this back in the intervieuw with mr. Post in the appendix.

**'' Is the list of top 10 human factors right?**

The whole list of human factors can be shorten to 1 factor, the human himself. For example: One time a container vessel sailed on a beach. They did had a bridge sensor but the alarm went off too often so they blocked the view of the sensor with a spoon. This way they didn't had the annoying alarm all the time. A vessel can be equipped with good and right equipment but when the crew does not use it in the right way it is useless. ''

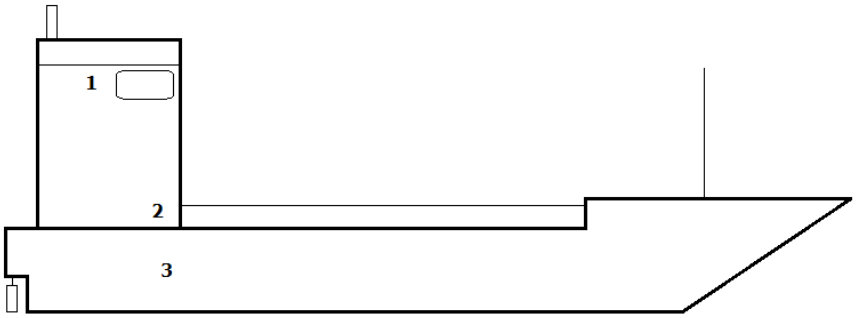
# 6. Improvements

**Introduction**

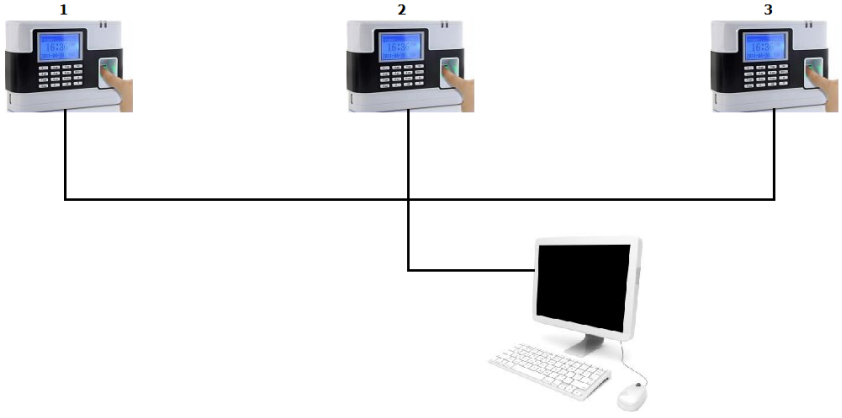
This chapter is about improving current systems and the new systems. This has been done according to the advantages and disadvantages of the systems.

## 6.1. Procedures and regulations

The time registration system is a system to make sure that the ship's personal isn't making too much working hours. It is a quite simple idea to reduce the influence of the human factor regarding procedures, regulations and fatigue. Special fingerprint sign in clocks will be placed at the positions 1, 2 and 3 in the picture below. These clocks are working hour registration clocks which identifies a person by fingerprint. Position 1 is before the bridge door, to enter the bridge. Position 2 is before the door which gives access to the deck, and position 3 is before the door to enter the engine room. In this way everyone is able to check in just before they have to start working and to check out after work.




The 3 clocks will send all the information to the computer in the Captain's cabin and will show the information in an overview. Thanks to this system the Captain can check the working hours of the entire crew and make sure that no one is making too many working hours.




This system can also be used as an authorization system, which will deny access to unauthorized people by not unlocking the door. We think it is best to only do

this at position 2, because the chance that unauthorized people try to get access to the accommodation is the biggest. There will be an overriding function to be sure the door always opens in case of emergency. This override will be activated at the moment there is a general alarm.
The last function of this system is to process the crew's working hours in a format according to the 'Formats of Records of Seafarers Hours of Work and Rest'[1]. This function will reduce the amount of administration related work, because the crew does not have to fill in the 'Work and Rest Hour' forms, and the captain does not have to make sure that these forms are being saved for at least 2 years, because the computer linked to the time registration system will save these forms automatically.

[1] See appendix 'Hours of Work and Rest'

| **Advantages** | **Disadvantages** |
|---|---|
| Easy to check crew's working hours | What to do when a crewmember has made too many working hours, but still has to finish his work/watch? |
| Work and Rest Hour registration. | |
| Can be used as an authorization system. | |
| Chance of fatigued crew is less. | |

## 6.2. Maintenance

The CMM System can be radically improved by adding several measuring components to it. The most important ones are Vibration Measurement and Analysis, Infrared Thermography, Oil Analysis and Laser Alignment.
The vibration of a certain machine, especially the main engine is measured by several sensors and stored in the central system of the monitoring system. A comparison of the recorded vibrations with older records provides information which is required to specify eventual problems. Basically the recorded information can give hints to find bigger issues. By monitoring the engine all the time, important information is gathered. This information is processed in the CMM system and compared to other measurements to make links between those inputs. It all comes down to the CMM-system linking certain frequencies to certain problems. The system actually recognizes problems. It sees a trend in vibration over a period of time and notice that a malfunction will be the outcome.
The infrared thermography is a way of imaging temperature differences, especially overheating. Such systems have already been implemented on vessels a long time ago, but now it is possible to process the temperatures in the central system. This helps monitoring even slight temperature changes which can indicate small damages. Once again all the data is stored in the main system which links it to other incoming data.
By analysing the oil, the presence of contamination in it is detected.
Such contaminations are mainly by water, small particles or carbon deposits.
The structure of the oil is monitored and recorded and it all comes together in the CMM- system to place it in perspective.
In automatic CbM there are predefined condition limits and if the monitored condition exceeds this limit the CMM Systems reacts instantly by automatically generating a work order for the engineers.
These work orders are the key point of the system. They are the transitions between the machine and the human engineer looking after it. The system organizes the orders so that the problems with the highest priority are also the ones that are taken care of first.
The CMM System combined with CbM can be the brain of a good functioning engine room.

## 6.3. Communication

We think that the communication systems mentioned above can't be improved to minimize accidents due to communication, because the main problem is that the ship's multilingual personnel is frequently unable, for various reasons, to communicate via radio or face-to-face using proper maritime English. One of the reasons is that the IMO Standard Marine Communication Phrases (SMCP) have only been available since 2001. It is therefore understandable that only those generations of officers having graduated after 2001 are familiar with them.

## 6.4. Fatigue

An accident can happen in a short period of time. So even in the time between pushing the button at the watch keeping system, it is possible to fall asleep and cause an accident.

This can be prevented by a system that really detects the fatigue and gives a warning to the person on the watch and perhaps to the captain. This way it is not possible to work on the bridge when fatigued, without anybody knowing. When the captain knows that the person on the watch is tired he will be replaced by another officer.
There are already systems that can detect fatigue.

### 6.4.1. System 1

For example there is the 'Human being presence' detection system. This system is actually designed to detect a person in a car seat or the presence of a human in a collapsed building. But it can also be used to detect fatigue. The system measures if there is a heartbeat in the area and how strong this beat is. When fatigued the heartbeat of a person will decrease and pulsate more slowly. This way you can detect when a person is tired.

This system can also be installed on the bridge with an automatic alarm system. It lets the captain know how many persons are on the bridge and how many are fatigued. Then he can go and see who is tired and send him to bed.

| **Advantages** | **Disadvantages** |
|---|---|
| It can detect fatigue by heartbeat | It is not designed for vessels |
| It can detect multiple persons on the bridge | Vibrations on the ship affect the measurements |

### 6.4.2. System 2

With the U.S. military navy, fatigue has become a major problem. By making a system which monitors fatigue and the alertness of the military shipboard personal the navy tries to improve the continuity of the crew. A personal work/rest schedule is made up by the system. The schedule is optimised by information received from the person. This system was a proposal for the U.S. Navy but they never showed an interest in using the system

**How does the system work?**

The hardware can monitor three things:
. Sleep and wake history
. Light exposure
. Alertness in key working stations

*Sleep and wake history*
The sleep record of crew members is measured by wrist actigraph measurements. The wrist actigraph measures acceleration and this way it can detect when the arm is or isn't moving when a person is asleep. This information is used in the software when the working and resting schedule is made up. When somebody is awake for too long an alarm in the computer goes off.

*Light exposure*
The light exposure is monitored in the crew living and works spaces. The light exposure is important for the biological rhythms of crew members. When shifting from time zones the biological rhythm is disarranged. The system can also control the light in the crew spaces.

*Alertness*
A crew member on board of the navy vessel wears a cap or an audio headset with dry electrodes in it. He will do this in the key work stations where the crew member simply cannot be fatigued because of the work that he must perform. The dry electrodes measure an EEG-signal. With the EEG-signal the alertness can be measured.

The software that makes the crew schedule is called the DWRS-software(dynamic work/rest scheduling). The data monitored with the hardware is used in the software. Also some personal information about education and training and the current mission of the navy vessel is needed.

The DWRS-software (dynamic work/rest scheduling) will help in the following ways:
- When the current schedule of a crew member is incompatible, because of fatigue, the DWRS system will alert the commanding officer.
- The measured alertness will be compared with crew members sleep record. When the alertness is too low for time of sleeping the system will advise the commanding officer to give the crew member an extra rest or a medical intervention.

| **Advantages** | **Disadvantages** |
|---|---|
| When the fatigue of a person is measured different elements are used, the fatigue measurement is more reliable. | It is not sure that this system works, it has never been adapted on board of vessels. |
| The system not only detects fatigue, but also helps to avoid it. | |

### 6.4.3. System 3

The third system detects fatigue by using detectors that measure eye movement and expressions on a person's face. This system is for detecting fatigue when somebody is driving a car or truck.
So it has one or two detectors placed on the dashboard to see the expressions on the person's face.
These are basically little cameras linked to a computer that can measure the different expressions.
You could also place a detector on the brake pedal and one to monitor the road. This way the system can measure your response time. It measures when you see the car in front of you and when you actually press the brake.

| **Advantages** | **Disadvantages** |
|---|---|
| This system can really detect fatigue and is already tested in modern cars. | It is not applicable on the bridge of a vessel. For the Automatic Fatigue Detection System a person needs to be in one place for the camera's to detect the different expressions on your face. |
| It can detect your reaction time. | |
| It could be applied when the captain can stay in one place. | On the bridge everything has to be operated at one single position. |
| This system could work when the camera is following the captain or first mate. | If a camera constantly follows your movement it could be annoying |

## 6.5. Crew's negligence

Although it is not possible to completely erase negligence by any means of a system, there is a way to at least detect negligence and take care of the crew in question.
This is by linking the CMM system described above to a neutral party which receives the data from the ship and warns shipping companies whose ships are poorly maintained.
It is then up to the shipping companies to take action for example by performing psychological tests before hiring a person and monitoring if necessary maintenance is performed in time.

## 7. Conclusion

We have innovated 4 new automatic systems. 1 for procedures and regulations and 3 for fatigue. And we improved the CMM system, which you can use for maintenance and for crew negligence. With these innovations and improvements we have answered our main question: How can the Human Factor in shipping accidents be minimized by digitalization on seagoing vessels? You can't minimize all the route causes related with the human factor, but yes, there are route causes we can minimize by digitalization.

Our final conclusion is that the human himself is always the weakness link on a vessel. This also can be seen in the interview with Post & Co. Most of the accidents is not because of the failure of an automatic system but because of the mistake of a human. So the automatic systems can only make it easier for the human. In the end you can develop the most innovating systems that can help on the job. But when the personnel on board don't use it, is it worthless. So we believe that you have to work on the factor, Crew's negligence. If you change the people's mind-set and let them know how important it is to use the systems, and use them in the right way. Only then can u achieve a real change in number of accidents.
It is very simple. You already have great systems on board. But u have to use them to let it work an minimalize the chance of an accident.

You have to improve the way of thinking of people to really minimalize the accidents on board of vessel.

# 8. Recommendations

The goal of this project was to discuss digitalized systems which can minimize the Human Factor in shipping accidents. The recommendations in this report can be used by ship owners to improve the safety on board of their vessels.
The recommendations for four Human Factors are summarised below:

*1 Procedures and regulations*

A system which can be used for procedures and regulations is the time registration system. Special fingerprints sign-in clocks are placed on 3 positions on the vessel. The crewmembers have to check in with their fingerprint when they start working and check out after work. The system gives an overview of the working hours of the entire crew and make sure that no one is making too many hours. Also you can see if the bridge is under command of the right personnel.

| **Advantages** | **Disadvantages** |
|---|---|
| Easy to check crew's working hours | What to do when a crewmember has made too many working hours, but still has to finish his work/watch? |
| Work and Rest Hour registration. | |
| Can be used as an authorization system. | |
| Chance of fatigued crew is less. | |

*2 Maintenance*

The already existing Computerized Maintenance Management Systems (CMM systems) can be improved by adding measuring components to it like a vibration measurer. The data from the measurers is stored in the main system and will be compared with older measurements. The system actually learns to recognize problems. This is called condition based monitoring (CbM).

*3 Fatigue*

One of the possible systems is the human being presence detection system. This system measures the strength of the heartbeat. When an officer is fatigued the heartbeat of a person will decrease and pulsate more slowly. The system can be installed with an automatic alarm system which can alert the captain.

| **Advantages** | **Disadvantages** |
|---|---|
| It can detect fatigue by heartbeat | It is not designed for vessels |
| It can detect multiple persons on the bridge | Vibrations on the ship affect the measurements |

The second possible system is a system which monitors fatigue and alertness. The monitored date can then be used to make a personal schedule for a crewmember. Three things are monitored: the sleep and wake history, light exposure and alertness. With that information a software program called DWRS makes a schedule for each crewmember.

| Advantages | Disadvantages |
|---|---|
| When the fatigue of a person is measured different elements are used, the fatigue measurement is more reliable. | It is not sure that this system works, it has never been adapted on board of vessels. |
| The system not only detects fatigue, but also helps to avoid it. | |

Another possible system is the system that detects eye movement and expressions on a person's face. Two detectors placed on the dashboard measure the expression on the person's face.

| Advantages | Disadvantages |
|---|---|
| This system can really detect fatigue and is already tested in modern cars. | It is not applicable on the bridge of a vessel. For the Automatic Fatigue Detection System a person needs to be in one place for the camera's to detect the different expressions on your face. |
| It can detect your reaction time. | |
| It could be applied when the captain can stay in one place. | On the bridge everything has to be operated at one single position. |
| This system could work when the camera is following the captain or first mate. | If a camera constantly follows your movement it could be annoying |

*4 Crew's negligence*

By linking a system to the CMM system (see maintenance) crew negligence can be detected. It is then up to the shipping companies to take action for example by performing psychological tests before hiring a person and monitoring if necessary maintenance is performed in time.

# 8. References

'IMLP' by P.C. van Kluijven, page 341

Human being presence detection system. Patented in the USA

The International Maritime Human Element Bulletin Issue No. 6, 13, 14, 24 January 2007

http://www.praxis-automation.nl/products-bnwas01.html

http://www.pemms.co.uk/

http://www.plant-maintenance.com/articles/ConMon21stCentury.shtml

http://nl.wikipedia.org/wiki/Automatic_Identification_System

http://www.frequentieland.nl/maritiem/dsc.htm

http://sccn.ucsd.edu/~scott/intmodel.html

http://www.lightshipgroup.com/techservice/techservice.htm

http://www.plcs.net
Procesautomatisering, Grondslagen meet- en regeltechniek. I.J. Breimer

Source: http://www.ukpandi.com/loss-prevention/risk-management-advice/the-human-element/

# 9. Appendix

**Hours of Work and Rest**

**1.** All persons assigned duty as an officer in charge of a navigational or engine room watch, or a rating forming part of a navigational or engine room watch, or any seafarer whose duties involve designated safety, prevention of pollution and security duties have to be provided with rest periods as follows:
**a.** A minimum of 10 hours rest in any 24 hour period;
**b.** 77 hours rest in any 7 day period; and
**c.** The hours of rest may be divided into no more than two periods, one of which shall be at least 6 hours in length and the intervals between consecutive periods of rest shall not exceed 14 hours.
**d.** Reduction of rest hours to 70 hours in any 7-day period is allowed for not more than two consecutive weeks.

**2.** Masters shall post a table of shipboard working arrangements (i.e. information on scheduled daily hours of work/rest at sea and in port) in an easily accessible location in the working language(s) of the ship and in English, for the benefit of all crew members. Records of seafarers' daily rest hours shall be properly recorded and be duly authenticated by the master or by an officer designated by the master.
A copy of the records of rest hours and schedules pertaining to seafarers, duly endorsed by the master or a person authorised by the master, shall be made available to the seafarer.
Companies are recommended to use a standard format for preparing tables of seafarers' shipboard working arrangements and watch schedules and record of rest hours to show compliance with STCW requirements. Companies are advised to use the IMO/ILO Guidelines[1]
In preparing the duty schedules and rest hours records and these records (which may be computerised) shall be retained on board for at least 2 years to enable monitoring and verification of compliance in accordance with the provisions of Section A-VIII/1. Companies should incorporate the procedures for preparing the watch schedules and recording of daily hours of rest in the ship's safety management system.

**[1] Records of Seafarers Hours of Work and Rest**
IMO/ILO Guidelines for the Development of Tables of Seafarers' Shipboard Working Arrangements and Formats of Records of Seafarers Hours of Work and Rest, 1999. Developed by a joint working group of the International Labour Organization and IMO, these guidelines are designed to help Administrations, shipowners and seafarers meet their obligations under ILO Convention N. 180 (Seafarers' Hours of Work and the Manning of Ships Convention) and IMO's STCW Convention, 1978, as amended. They provide a standardized table showing shipboard working arrangements, a standard format for records of seafarer's daily hours of work and rest and guidelines for monitoring compliance.

## **Appendix Interview "Loodswezen"** with mr. Sprong

In the Netherlands are a total of 475 pilots, which are all educated to HBO Maroff. The pilots together have three main goals; The Dutch 'Loodswezen', the environment and working in an economic way. The most important thing the 'Loodswezen' stands for is safety. The structure of the 'Loodswezen' consists out of multiple sections, which are all supporting this company. A important law that protects the pilots is 'the pilot law'. This law makes sure that the 'Loodswezen' is protected against all kinds of accidents.

On the moment 9 persons are being trained to become pilots. These 9 where selected out of 12. To become a pilot you need at least 5 years of sailing experience. Also you have to pass certain tests. These 9 persons where selected at different seafaring companies.

At every seafaring company you have to deal with a different organisation, and different people. Because of this there are big differences between companies, because every person will complete tasks on his or her own way. A few examples of organisations according to mr. Sprong;
*The Royal Dutch Navy;* Everything goes very disciplined, according to certain procedures and regulations.
*The Holland America Line;* This organisation consists out of multiple smaller organisations with each their own interests. These smaller organisations have to function together and have to form one combined interest. Therefore intern communication is very important.
*Offshore;* In these organisations only one thing is important; Time is money. Because of this, all the work has to be done as quickly as possible. To accomplish this, the organisation has to be solid.
*Coasting trade;* The most important things in these organisations are carrying goods as quickly and safely as possible from A to B.

The economic recession is responsible for many maintenance related accidents. Less money is available because of this recession, and the easiest way to save money is to reduce costs on maintenance. This breakdown maintenance method eventually is much more expensive, because bigger, more expensive parts fail to work because of smaller parts which haven't been replaced on time.

Like everywhere there is a difference in needs, this also is the fact in shipping. Mr. Sprong gave us the following example;
A brand new dock was built in Rotterdam to receive gas carried by tankers. Every week a gas tanker would arrive, but because of the disaster in Japan, Japan is in serious need of gas. Because of this, Japan is willing to pay much more for gas then Holland. The gas tankers are all sailing to Japan instead of Holland because of this, leaving the brand new dock almost unused. This is an example of not fulfilling appointments made earlier, because of economic interests. This could even be the cause of a conflict between people with different interests. This is why people in an organisation have to be well prepared to act appropriate in all kinds of situations.

The Loodswezen;
Cooperation between the 'Loodswezen' and the Rotterdam port authorities is very important, because they have to rely on each other. This is why communication between other companies is important, to make sure everything goes according plan. Communication error can cost both companies a lot of time, which eventually is money. In the pilot branche everyone needs each other, so communication has to be good to make sure everything will go as efficient as possible.

Systems;
There are 2 automated systems related to organisation which the 'Loodswezen' uses.

Administrative;
SAP 3 and Microsoft. These 2 systems have to work together, but every system has its own application. This is why each system contains different information. These systems can only share information. The disadvantages of these systems are the fact that it takes more time to work with 2 systems instead of 1. These 2 systems have to be adapted to work better and faster together to avoid this. Using 1 of the 2 systems instead of both is not an option because each system has functions the other system does not have. Opinions are also divided between pilots about which is the best system.

Pilot;
Navigator. This is a program which works on a laptop and acts as nautical support for the pilot. All information is gathered together (positions of vessels etc.) and uploaded, this information is received by the pilot on board with 1,5sec delay. This information gives an overview of the traffic in the specific area where the vessel is. Thanks to this information a pilot is able to look around corners. This way he has more time to deal with, and anticipate on, dangerous situations. All this information is uploaded by the port authorities. One of the things pilots receive on their laptop is the water depth. The port authorities make sure the 'Loodsweze' receives a weekly update of these depths. These depths are very accurate and reliable. Thanks to this information a pilot can see in one overview what a safe route is.

The pilots also have another 'bigger' system. This version is suited for bigger vessels.
Navigator martional ship.
The basic options are the same as with the Navigator software. The only difference is that this system is even more accurate and can be used to moor a vessel without looking away from the laptop screen. Pilots even say this system is more accurate than the human eye.
Mr. Sprong gave an example when this system is used by pilots;
Half January the biggest bulk carrier is planning to moor in Rotterdam. The problem is that the quay along the water is designed for a vessel which is 20 metres shorter. So in theory this bigger vessel would have a free space of 5cm fore and aft. With the human eye this is impossible to see. This is when the 'Navigator martional ship' software is used, this tells the pilot exactly what to do.

## Appendix Interview "Post & Co"

with mr. Post, director of Post & Co

**What does Post & Co exactly do?**
Post & Co is a Protection & Indemnity specialist and manager. You can compare a P&I Club with an insurance company. The insurance can be compared with a liability insurance for the car. The P&I club will pay when the policyholder causes problems for others, for example when a vessel leaks oil in the water. The P&I club is also an insurance company for injuries to the employees. And it will also pay out when there is damage to a vessel and the captain can't be blamed.

**What exactly is a P&I club?**
The P&I club is a non-profit mutual insurance. There are also commercial vessel insurances company, a quarter of the ship-owners is insured by commercial insurances companies. The rest is insured by non-profit P&I clubs. Totally there are 13 P&I clubs. Post & Co is a manager which manages the insurances. It gives ship-owners an advice which P&I club to choose.

**Do P&I club have special demands for vessels?**
The P&I clubs have a preference of the vessels they want to insure. This can be al sort of things. This preference can be:
- Year of manufacture of the vessel
- Classification
- Flag state
- Management

For example Post & Co prefers small and inland vessel. Often the P&I clubs themselves have a survey on board of a vessel. But the P&I clubs mainly look at the classification of the vessel. This is a good indicator of the condition of the ship and this way they don't have to do an expensive survey.

**Is the list of top 10 human factors right?**
The whole list of human factors can be shorten to 1 factor, the human himself. For example: One time a container vessel sailed on a beach. They did had a bridge sensor but the alarm went off too often so they blocked the view of the sensor with a spoon. This way they didn't had the annoying alarm all the time. A vessel can be equipped with good and right equipment but when the crew does not use it in the right way it is useless.

P&I companies are doing investigation to shipping disasters. This way they can look at the trends in types of disasters and see where things go wrong. When you know where things go wrong you can improve this and eliminate certain kind of accidents.

**Are P&I clubs doing investments to the nature of disasters?**
After 70 years trends can be seen in the cause of disasters. For example: nowadays people from Bangladesh cause more problems. This due to bad communication.

A lot is written about the results of the investments, newsletters appear about the latest disasters. This way people can learn from the mistakes of others and less accidents will happen. The investigations are paid by P&I companies.

**Are there happening lesser disasters in the last years? Is this because of automation?**
Compared with 15 years ago the nature of accidents has changed. Because nowadays a lot is shipped in containers and the number of personal injuries is decreased. But the volumes are larger, this causes a greater total risk.
But the number of accidents also decrease because of systems which warns the crew, for example an overflow alarm on an oil tank. This kind of systems were not implemented on vessels 15 years ago.
But not all the crew on board of vessels are able to use this systems in a correct way. For example a person in that grew up without electricity is not that able to use the difficult automated systems on board.
The greatest risk are the people not the equipment. An example is that a crew member cut the wire of a bridge alarm because he did not know how it worked and wanted to stop the annoying sound.

**What do you think is the most important root cause?**
Communication is the most important on the list of human factors, automated systems are less important because proper use of these systems is more important. But these systems must also be used the right way. For example when the fatigue system of this report is implemented in a vessel and the system reports to the captain that an officer of the watch is fatigued. But there is a chance that the captain ignores the alarm and let the officer continue his watch, stopping the vessel to let the officer rest is simply not an option. P&I companies have no influences on this at all. The captain and the ship-owner want to make money, and if they have to big risks to do so they will certainly do it.

**Which systems are already adapted to reduce the influences of the human factor?**
There are already systems equipped on board of vessels to minimalise the human factor for example a bright alarm system. But also an alcohol test, Ukrainian captains are notorious for drinking too much.
A load master, which helps with the calculation when loading the vessel is very common these days. But 15 years ago this calculation was done by humans, and the chance of making a mistake is much bigger.

**How can the current systems be improved?**
The best solution to reduce the human influences is not equipping a vessel with automated systems, but by education seafarers better.

**Which systems are not automated yet but must be in the future?**
Some things cannot be automated, like legal safety things. Sometimes signatures are required or the number of alcoholic drinks and cigarettes on board must be counted by the local authority.
Automated systems are expensive and that is the biggest disadvantage, because now it is not attractive for ship-owners to install those systems.
They will simply take the risk that an accident won't happen than installing an expensive system that eliminates the treat of an accident.

## **Appendix Interview "Stena Line"** with mr. Knipscheer

**About Stena Line**
Stena Line is a company which has different kinds of transportation services. One of those transportation services are the ferries. The ferries are divided in three sailing areas:

. Scandinavia
. Ireland sea
. North sea

The ferries in the sailing area North sea are sailing between Hook of Holland, Killingholme and Harwich. Between Hook of Holland and Killingholme only freight is transported, but between Hook of Holland and Harwich also passengers and freight are transported.
The headquarter of Stena Line is in Sweden, but the settlement in the Netherlands is almost independent except for financial and other administration. All the vessels are owned by the Swedish headquarter, due to the fact that the vessels are sometimes switched between sailing areas.
Six vessels are sailing between the Netherlands and Great Britain.
Three of these vessels are under Dutch responsibility and the other three are under British responsibility. The three Dutch vessels are manned with a Dutch crew.
In the hierarchy five main tasks can be distinguished:

- General Manager Ship Operations & Port Services
    - Responsible for maintenance, crew and the daily contact with the vessels.
- Port Operations Manager
    - Responsible for accidents.
- General Manager Onboard Services
    - Responsible for catering.
- General Manager Travel NL/UK/Ire/Ger
    - Responsible for passengers marketing
- Freight Commerica; Mgr
    - Responsible for freight marketing

**On board of vessels**
The communication between vessels is mainly done by E-mail, for example a crew list is mailed from the vessel to the shore.
In terms of evacuation the captain is leading. evacuations are practiced regularly, there is a boat drill every week for example.
Certificates of the crew are checked every yea. If necessary the certificates are renewed, this is done by a company called DNV.

Special crowd management training are refreshed every five years. Even though these trainings are held, in case of evacuation everybody will react different.
There are no digital systems on board which support the crew in terms of emergencies.

Because the North sea is one of the busiest waterways in the world, the ferries are manoeuvring a lot and the voyage is different every time.

In terms of emergency, the portable VHF's are used to inform the crew. For informing the passengers broadcasting systems are used. The crew can use the cameras to visualize the streams of people on board.
Mr. Knipscheer did not know of everything is being monitored.

When a ferry is not being loaded or offloaded, sometimes a fire training takes place. The first officer, chief engineer and deckhands are the fire fighting crew. In some cases the training even involves the fire brigade of Hook of Holland. Of course Stena Line tries to be trained as good as possible.

There are books for the procedures for example by emergencies. Every year those books are checked by the DNV.
The following procedures can be found in the book:

- Safety procedures
- SOLAS (Safety Of Live At Sea)
- Security plans
- Cargo plans
- Responsibilities of the captain and crew
- How to hold performance reviews.