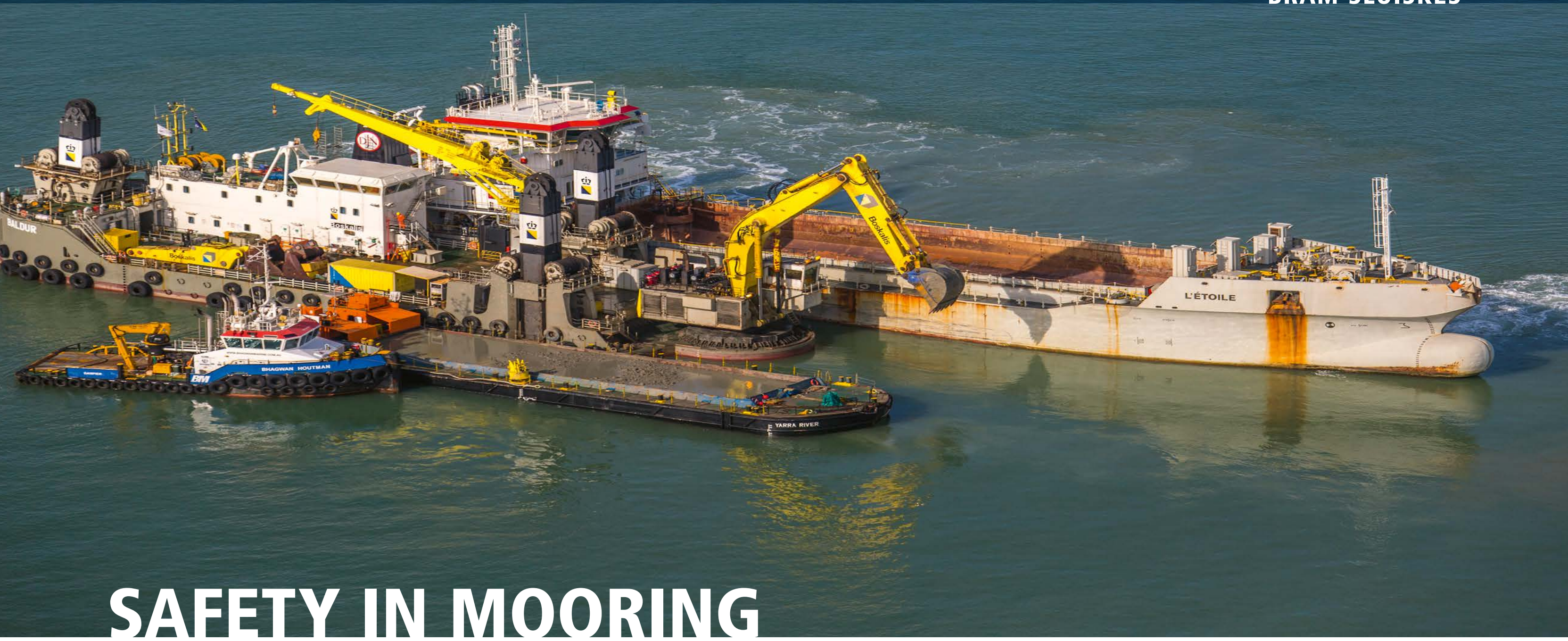
BRAM SLUISKES



SAFETY IN MOORING

ABSTRACT

According to the International Maritime Organization (IMO), "shipping is perhaps the most international of all the world's great industries and one of the most dangerous." Ships enter and leave ports regularly. Tying up a ship when alongside a berth or another vessel is potentially a very hazardous operation, unless everyone engaged in mooring operations is trained, has the right mindset and the correct equipment to perform the work.

The risks of mooring within dredging operations are even more important, since vessel to vessel mooring happens very often in the dredging business. For example, hopper barges are regularly moored alongside grab dredgers during loading.

In terms of hardware, mooring equipment is sufficiently controlled by international, national and class regulations with regard to their design and maintenance. However, the best of systems will fail if the human factor and more precisely the mindset for doing the work is not right.

In this article, the risks associated with mooring operations; mooring equipment; training and competence; the human factor in mooring operations and future developments in the field will be discussed.

INTRODUCTION

Mooring a ship is as old as sailing itself, but there are few activities on board which appear so frequently in accident reports. As a captain once quipped: "I don't envy the Flying Dutchman as I know it can never make port and is doomed to sail the oceans forever. But that also means they don't have to moor."

There are many examples when the activity of mooring went terribly wrong, often with severe consequences for those engaged in mooring operations and even for innocent bystanders. A recent publication, "Risk Focus Consolidated 2016: Identifying major areas of risk" by UK P&I Club, a UK-based organisation providing protection and indemnity insurance across the globe, provides an insight into the types of injuries (with claims over US$100,000) occurring during mooring operations from 1987 to 2013.

The top four injuries that insurance was claimed for were: leg (19%), followed by multiple injuries (14%), death (13%) and back (13%). (See Figure 1 on next page). This leads us to an important question: what makes a mooring operation such a high risk activity? Is it the equipment? Is it because of human factor risks? Is it because it is a team operation during which team members who often do know each other well (vessel crew working and shore-based personnel) have to work together?

What can be done to reduce the risks associated with mooring operations? In the article, the following will be discussed in more detail: the risks associated with mooring operations; mooring equipment; training and competence; the human factor in mooring operations and future developments in the field.

Above: Hopper barges are moored alongside grab dredgers during loading

THE MOST COMMON RISKS IN MOORING

The Danish Maritime Authority and the Danish Shipowners' Association published in their guide "Mooring – Do it Safely", an overview of common risks and how to prevent accidents during mooring operations. The following are the most common risks:

Equipment
- Use of old, damaged wire
- Poor equipment

- Poorly designed mooring system
- No overview of mooring area
- Hazard/tripping risk sites not highlighted

Work processes

- Lack of communication and planning
- Poor wire/line handling

Crew qualifications

- Lack of knowledge about the hazards of the job
- Unclear instructions
- Lack of information
- Lack of supervision (supervisor involved elsewhere)
- Small, untrained deck crew
- Ineffective on-board mooring training that does not identify and provide an understanding of the dangers associated with snap-back zones

Crew concentration

- Stress and fatigue

Ship's safety culture

- Procedures not followed
- Shortcuts taken
- Standing in the wrong places (in the snap back zone)
- Standing/walking on a bight
- Walking over a wire
- Quick mooring versus safe mooring
- No risk assessment process prior to mooring operations
- Cluttered mooring area
- Cluttered deck

Weather

- Icy, slippery deck

MOORING EQUIPMENT

Mooring equipment comprises all the equipment required to moor and cast off a vessel effectively and safely. As with all vessel equipment, they must be maintained and operated correctly to ensure safe and effective use. The main parts of a mooring system and the steps to take in order for safe use are as follows:

Mooring winches

These can either be hydraulically or electrically powered. Winch brakes should be regularly inspected and adjusted to ensure that they render below the breaking strain of the mooring line. The Oil Companies International Marine Forum (OCIMF) provides good guidance on the testing and setting of mooring winch brakes.

Remote control stations

They are fitted to some systems. The control can be from the bridge and/or from a fixed control station on the winch deck or via a potable remote control. In all cases, the operator should have had appropriate training with the operation of the winch remote control system. During the operation, the operator should have a clear view of the mooring operation whilst maintaining good communication links with the rest of the mooring team.

Remote camera systems

It is common for modern mooring systems to be fitted with closed circuit TV (CCTV) monitoring which can be monitored from the bridge. These systems are not meant as a replacement for the mooring deck local safety monitoring but only as another pair of eyes.

Ropes and wires (mooring lines)

Mooring lines that are to be used in a mooring operation should be in good condition. Also, ropes should be inspected frequently for both external wear and tear between the strands. Wires should be treated regularly with suitable lubricants and inspected for deterioration internally and for broken strands externally. The safe working load (SWL) of the mooring line should be on the mooring line certificate and this should not be exceeded.

Bitts and static fairleads (chocks)

These should be inspected for signs of deformation, corrosion, abrasive wear and pitting. If there is an indication that any of these are excessive, they should not be used. If they are badly corroded or worn they will cause mooring line damage and/or personal injury due to sharp edges. The safe working load (SWL) should be permanently marked on

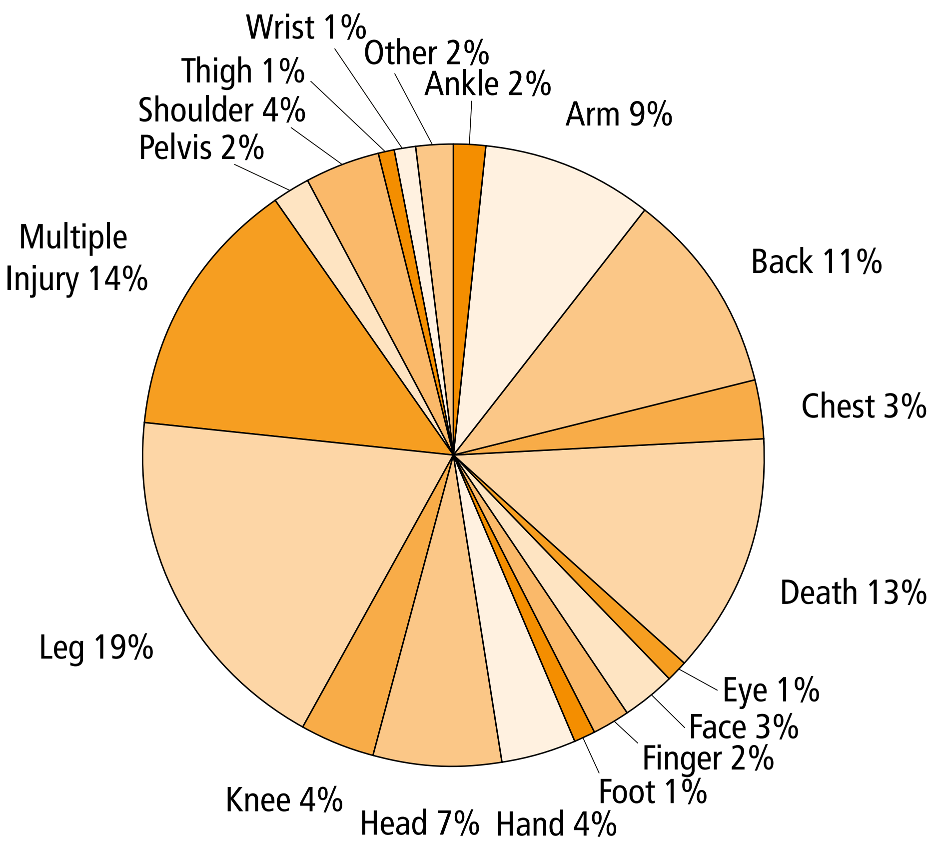


Figure 1. Insurance claims for types of injuries from mooring accidents (data from UK P&I Club)

or adjacent to these equipment by welded bead.

Roller fairleads

These are to be inspected in the same manner as static fairleads, but additional attention should be paid to the rollers. Ensure that they are free to turn and that no excessive axial or radial movement is detected that may indicate a worn bearing. The rollers on button type fairleads are not meant to take axial force. If subjected to axial force due to incorrect mooring line positioning, the fairlead roller may become detached with severe consequences.

In addition to the risks associated with operating mooring equipment there are also risks associated with modifying mooring equipment. Care must be taken that no modifications are made to the layout of mooring arrangements and associated equipment without completing a risk assessment and obtaining the necessary approvals.

THE HUMAN FACTOR IN MOORING OPERATIONS

The previous section looked at the actual mooring equipment or the "hardware", but a safe mooring operation depends on the human factor.

Human factor is a broad concept and can be considered as the "software" both literally and figuratively. Here it refers to personnel engaged in mooring operations and who can be easily injured when something goes wrong during the work, sometimes with fatal consequences. In mooring operations the "hardware" and "software" are interdependent and neither can be utilised on its own.

The concept of human factor in relation to the shipping industry is extensively discussed in the paper, "Safety in shipping: The human element" (Hetherington, Flin & Mearns, 2006). The authors discuss the causal factors within accidents in shipping and identify the relative contributions of individual and organisational factors in shipping accidents. They also emphasise that monitoring and modifying human factors issues could contribute to maritime safety performance and shipping practitioners can focus on interventions in these areas.

The paper also provides a framework for human factors which contribute to organisational accidents in shipping. The framework shows the underlying causes (organisational and management issues) and immediate causes (personnel issues and design issues) that lead to organisational accidents. Within organisational and management issues, three causes – safety culture, safety climate and safety training – are listed. Under personnel issues, stress, shiftwork, situation awareness, fatigue, health and wellbeing, decision-making, communication and training are listed as underlying causes for accidents. Within design issues, automation is listed as an underlying cause.

However, there are two elements in the framework, which according to the authors are especially applicable for mooring operations – automation and situation awareness.

Automation

Vessel operations have been made safer by various methods of automation and there is little doubt that mooring operations can be also more automated.
Automation of mooring activities is currently aimed at repetitive mooring – mooring of vessels such as ferries, roll-on/roll-off (ro-ros) and container feeders with a standard hull shape or engaged in fixed routes and vessels mooring along the same quay all the time.

Automatic mooring of vessels that do not have fixed routes, have non-standard hull shapes and those that encounter different mooring lay-outs every time they moor is a much more difficult process. These operations require a more sophisticated type of automation.

Currently, there are two types of automatic mooring being utilised – magnetic and vacuum mooring. These two methods have their advantages and disadvantages.
The advantages are:
- there is no need for mooring ropes
- limited amount of personnel are required for mooring operations and they will be mostly engaged in observing the mooring operation
- a quick mooring operation

Figure 2. A V-shaped mooring bollard

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After graduating in 1991 from Dutch Polytechnic Noorderhaaks in Den Helder, he worked two years on drill rigs as a casing-running engineer. Afterwards, he sailed for five years around the world as a safety officer on semi-submersible crane vessels. Wishing to work onshore again, he worked as a consultant for an engineering firm before he worked for 10 years as a HSE engineer with a large Dutch dredging company. In 2010, he joined Dockwise as a lead HSE engineer. After the merger with Boskalis, he now works as a lead HSE engineer in the Boskalis Offshore Energy Division.

The disadvantages are:
- electrical failure could lead to the loss of mooring capacity
- magnetic field causes the ship to become an induced magnet (magnetic mooring)
- the high purchase costs of the systems
- automatic mooring systems require more maintenance

Another approach is mechanising existing mooring equipment – utilising existing vessel mooring components but optimising one or more subcomponents. An example of this is the V-shaped mooring bollard (Figure 2). The traditional mooring wire is still present but it is connected to a ball. This ball-and-wire combination is part of the mooring actuator, which has been designed for mooring and unmooring workboats by Royal Boskalis Westminster. The mooring actuator consists of an arm and two constant tension (CT) winches and can be controlled with a remote control. A hook is attached to the end of the arm, which can pick up the cable. The arm, with the cable, then moves towards the workboat, to place it over the bollard. This working method is considerably safer and ultimately makes mooring faster.

Situation awareness

Situation awareness is the ability of individuals to build and maintain a mental model of what is going on at any one time and to make projections as to how the situation will develop taking into account their own actions and the actions of those around them.
Thus, situation awareness is especially important in work domains where the information flow can be quite high and poor decisions may lead to serious consequences. For an example, a typical mooring operation would mean that the whole mooring team (personnel on the vessel and onshore) has the same mindset with regards to their work. However, often, mooring operations are done on a tight schedule and getting to the same work mindset via lengthy discussions is often impossible.

The best a mooring team leader can do is than use the principle of “chronic unease”. Chronic unease is the opposite of complacency. It is a healthy skepticism about what a person can see and do. It is about understanding the risks and exposures and not just assuming that because systems are in place everything will be fine. It is not just believing in what a person sees or hears or what the statistics state. It is about resetting one’s tolerance to risk and responding accordingly and continually questioning whether what one does is enough.

The thought process of a leader of a mooring operation therefore changes from: "It is going well” to "Is there anything we are overlooking and what else do we need to do?"

When leaders use chronic unease in their work, it enables them to:
- think flexibly
- not jump to conclusions ("think slow")
- encourage employees to speak up
- listen to others
- be receptive to bad news
- show safety commitment

As discussed before, the concept of “chronic unease” is a state of mind, not a tool. However, this needs to be augmented with standard Health, Safety and Environment (HSE) management tools such as generic risk assessments, toolbox talks and Last Minute Risks Assessments (LMRA).
Particularly, the LMRA can be useful to remind a mooring crew that they have a personal responsibility to be aware of risks and to take action when necessary.

TRAINING AND COMPETENCE IN MOORING OPERATIONS

To execute a mooring operation safely and efficiently, all involved personnel have to be trained and competent. While the competence of the mooring crew onshore cannot always be assessed or controlled, every effort must be taken that the vessel crew participating in mooring operations are trained and competent.

Training and competence are two sides of the same coin, they are very closely related although there are marked differences:

- Training is the structured approach to increase someone’s knowledge that often involves the undertaking of specific taught courses or on-the-job training where a person is given the knowledge needed to apply theory into practice.

- Competency consists of a number of aspects, of which training is only one. Others include skills, knowledge, experience, appreciation and understanding of the task at hand, the surrounding environment, and a range of human factors.

Training and/or qualifications alone will not necessarily mean that a person is competent. There are many situations where a person’s theoretical knowledge will not be sufficient to execute a task safely. Particularly, during mooring operations, it is experience that teaches one what works and what does not.

Nevertheless, training is an important part to ensure that personnel engaged in mooring operations are competent. After all, everybody involved in a mooring operation should know (Figure 3):
- how to stop a rope by using stoppers (and don’t forget that you have to take them off after use)
- a person does not just belay a rope by using figures-of-eight: instead, he or she should first hitch it twice around the lower side of the bollard

Although sometimes considered outdated, the “learning pyramid” provides a simple framework which presents the most effective ways of learning (Figure 4).

The top part of the pyramid is considered to be “traditional” and “passive” learning. The learner is a passive consumer of information.

Figure 3. A mooring operation being undertaken by crew in a safe and efficient manner

The bottom part of the pyramid is considered to be "active" or "participative" learning. In addition to absorbing information, the learner is also a sharer of information.

The concepts of situational awareness and chronic unease, as described in the previous section, can be explained and taught in the upper part of the pyramid. However, it probably it will not make a lasting impact unless information is interchanged between tutor and learner.

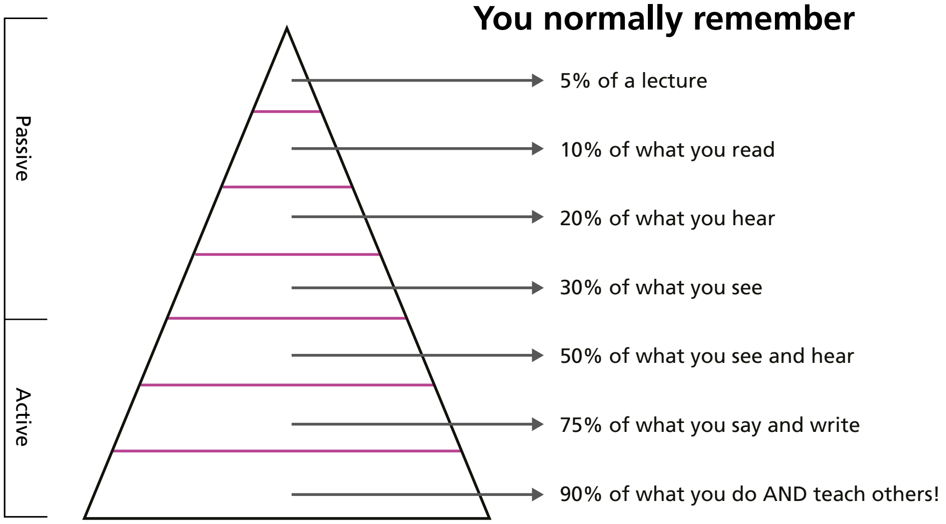

Figure 4. The "learning pyramid

FUTURE DEVELOPMENTS

The future of shipping has changed considerably over the last decades and will continue to change. One of the major changes will be further automation of vessel operations. But where is the unmanned ship? Unmanned airplanes (drones) are a reality and unmanned cars may just around the corner.

This is where Maritime Autonomous Systems (MAS) come in. As MAS become more reliable and accepted, it is natural that people will start thinking about using the concept for larger commercial shipping operations. Some high profile projects in this field include the European Commission funded Maritime Unmanned Navigation through Intelligence in Networks (MUNIN) project. MUNIN aims to develop and verify a concept for an autonomous ship – a vessel primarily guided by automated on-board decision systems but controlled by a remote operator in a shore side control station.

If vessel operations can be automated, so can mooring operations. The magnetic and suction systems are already in use. Using these systems eliminates the use of mooring ropes and hence the risk of injury to shore and ship personnel by these ropes.

New and more intelligent automatic mooring systems should be able to recognise different hulls and ship shapes and compare them with the information from a database in order to position the vessels in the most optimum location to moor.

As for training and competence (management), the trend is to move away from the scholastic / classroom approach of learning where the student is merely a passive learner and move towards interactive schemes (Figure 5).

- Using the latest technology to present an up-to-date training programme. Some examples include:
  - o E-learning: suitable to deliver a tailor-made training aimed at the current knowledge / training requirements of the trainee
  - o Virtual reality: Meant to be Seen (MTBS) virtual reality devices are most likely be the next step in presenting a realistic mooring environment. An environment which can be adapted to include vessel characteristics and take in account variables such as wind, current, passing vessels and other relevant information. In the virtual reality environment, realistic mooring emergencies can also be simulated without danger to the trainee.
- Using story-telling as a powerful means for sharing and interpreting experiences. Stories are universal in that they can bridge cultural, linguistic and age-related divide. Storytelling can be used as a bridge for knowledge and understanding allowing the values of "me" and "team" to connect and be learned as a whole.
- Story-telling can be done the traditional oral way without any support. But it is more efficient to use the latest technology which will increase the impact of the story. Story-telling is also the most suitable vehicle to get the mindset of “chronic unease” across to other mooring team members.

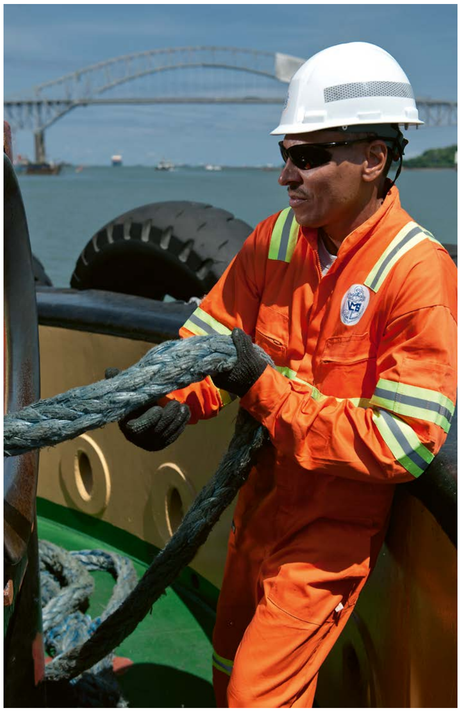

Figure 5. A crew member utilising a mooring rope.

CONCLUSIONS

Regardless of various automation systems or the “hardware”, mooring a vessel with people will always be a necessity. And it looks that for the foreseeable future, personnel (both on the vessel and onshore) will be needed to conduct a mooring operation.
Furthermore, in mooring operations, we need to manage the current risks, predict those of the future, and absolutely focus on the human element and carefully consider each individual’s tasks , the competencies needed to carry out tasks and how these will be developed and maintained. The best way of doing that is using the ancient old ritual of storytelling combined with the latest technological developments.
Automation of mooring operations will also continue to developed. The future of these automated mooring systems is positive but at the moment they cannot (yet) handle all hull shapes. Furthermore, whether automated vessels are a possibility is yet to be seen.

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