Focus on seafarer performance
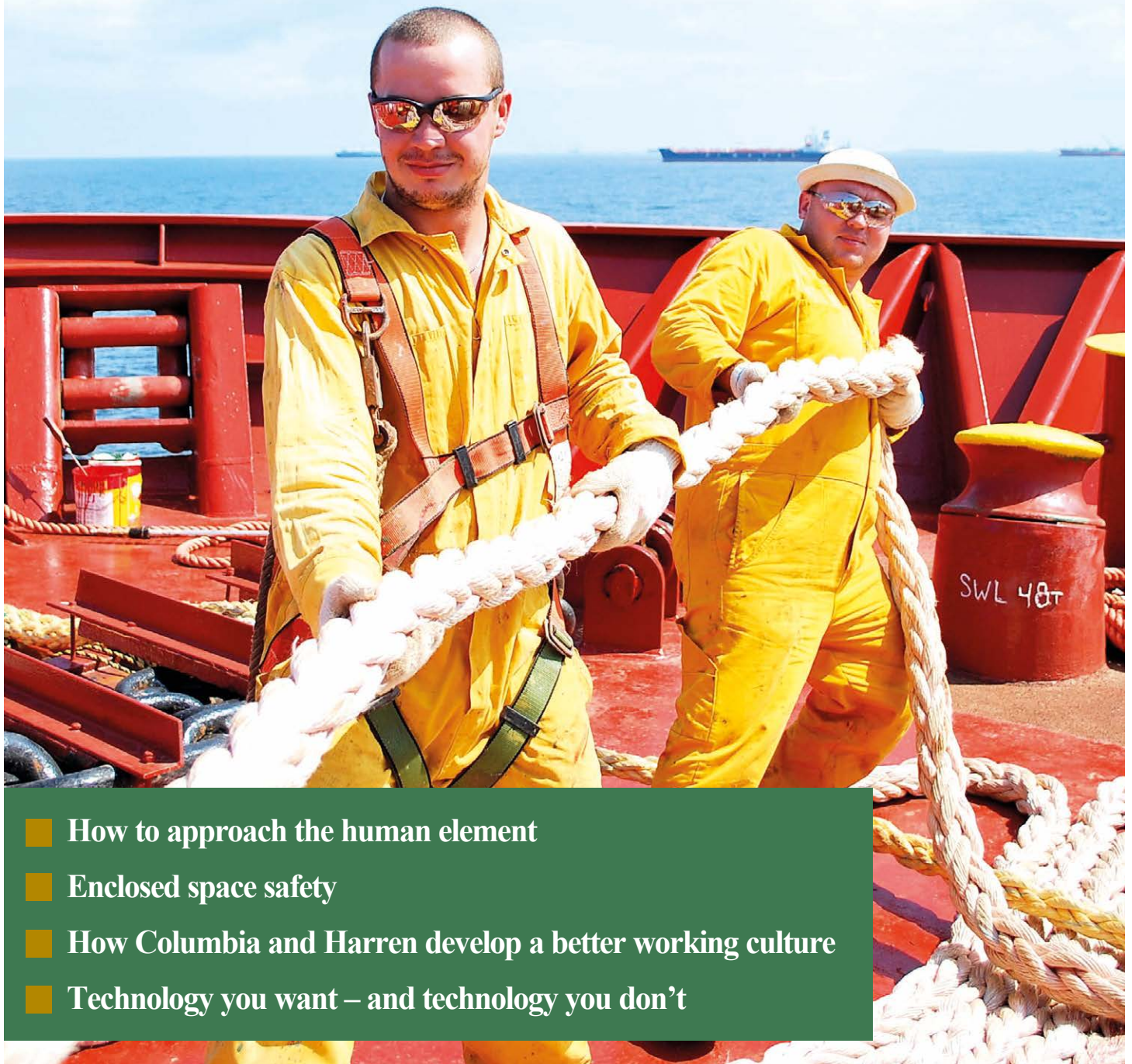
- **How to approach the human element**
- **Enclosed space safety**
- **How Columbia and Harren develop a better working culture**
- **Technology you want – and technology you don't**

Contents

Human element - the next frontier in improving safety?

This special edition of Tanker Operator magazine focusses on the 'human element'.

The tanker industry has made big steps to improving its safety record over past decades, through efforts to improve the vessels themselves, the machinery, crew competence, procedures, management systems and regulation. The safety record, measured in terms of casualties and pollution, shows a steady decline over the past decades. But over recent years, the decline has not continued, and there are still too many accidents.

So industry leaders, with the Oil Companies International Marine Forum (OCIMF) in the middle, are looking for new 'levers' to improve industry safety, and have picked the human element as the area to focus on.

Working out the right approach to the human element can be tricky for those of us with a background in engineering and other technical subjects, as many maritime people do. Experts say that it starts with respect for people, which makes complete sense, but is not something to easily put into a management system. But then, revising a management system to better incorporate 'human element' is probably not the best place to start.

Tanker Operator magazine held a forum in Hamburg last October on the human element, which we report on in depth in this issue, with speakers from OCIMF, InterManager, Columbia, Harren, MOAMS, Ulysses and Scoutbase, giving their perspective on the issue and how they break it down into ways which an organisation can tackle in an organised way.

One indication of an organisation which is poor at the human element could be how readily it accepts "human error" as a reason for something going wrong. People do indeed make mistakes, but they don't usually intend to make them. There are nearly always elements in the environment which surrounds them which contribute to the risk.

Companies which are good at the human element will focus on areas such as getting the right working culture, effective procedures, effectiveness of rules, stress / fatigue, and well-designed equipment and controls.

The working environment they aim to create will be modelled against reality. The procedures and rules will fit work as it is actually done, not how someone in an office imagines it is done. Stress, fatigue and level of being rushed will be manageable. The software and systems will give people what they need.

People will be able to feel part of a bigger organisation, not just delivering their piece of work and going home. There will be much better ways for seafarers and office staff to keep in close contact, inform each other what is happening, what may be going wrong, and maintain closer relationships.

There will be levels of trust between ship and shore sufficient that seafarers feel comfortable saying when they feel they have been asked to do something unsafe.

Customers and regulators will play their part. OCIMF, as an organisation of customers, will develop ways to reward shipping company which makes a good job of the human element, and regulators will avoid burdening people.

Ship designers will create ships which are easy to maintain, including good management of the dangerous 'enclosed spaces' and 'void spaces'. Technology companies will make tools which give seafarers the information they need, and not bombard them with information they don't need.

All of this is plausible and can be done right now, and the articles in this issue show how some of the industry experts are moving forward. Although the industry's slow drift towards the "gig economy" is not helping.

Also in this issue on the subject of seafarers: Perspectives on improving enclosed space safety, based on a seafarer survey by InterManager; Harren and Partner on how we can define "effective communication"; How Columbia Shipmanagement is finding better approaches to training; How to find digital technology which will actually help you, not what companies want to sell you; how to get a better understanding of your seafarers' actual working environment.

Frank Coles, managing director of Wallem Shipmanagement, on a story on very poor treatment of crew by the Korean Coastguard - and how to make this an industry where we are proud to send people out to sea. Better ways to gather and manage data from sensors which are worn by crew; and what SpaceX's "Starlink" satellite communications might mean for shipping

Note: slides and videos from some of the talks at our Hamburg conference are available online at www.bit.ly/TOHam19

Karl Jeffery, editor

Martin Shaw – what "human element" means

Tanker companies which embrace the "human element" are companies which appreciate people's role as successful goalkeepers (rather than someone to blame), acknowledge the limits of procedures, manage onboard complexity, and are careful about how we introduce automation, said tanker technical expert Martin Shaw

"Seafarers need help, not controlling and punishing," said Martin Shaw, managing director of consultancy Marine Operations and Assurance Management Solutions (MOAMS).

There is still too much misuse of the term "human error". It is used after nearly any incident, and there are many debates about the percentage of incidents that are due to human error, Mr Shaw said.

In fact, virtually all incidents are born of "human error", but an error made at some point in the regulation, design, build, operate, maintain cycle, he said. But the culture of shipping only considers errors by seafarers.

This focus on the seafarer means the main "tool in the toolbox" to improve safety is changing procedures to prevent the incident from re-occurring, he said.

But it might be better if energies were spent looking at what is behind this seafarer error, and finding better ways to ensure the seafarer feels supported by everyone around, he said.

Martin Shaw's background is in tanker operations, originally working as an engineer at sea, and then running a ship vetting organization for an oil company, and then managing an oil company fleet. He has been consulting for the past 8-10 years and becoming "more and more interested in the human element".
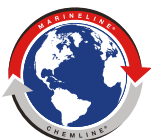
Types of human error

One of the world experts on human error, James Reason, has said that human errors can be categorized as "skill-based errors,

Martin Shaw, managing director, MOAMS

mistakes and violations."

A violation is defined as someone deliberately doing something wrong. But seafarers' mistakes might be viewed too often as "violations". Normally people don't deliberately set out to make mistakes, Mr Shaw said. This view links to the increased criminalization of seafarers. Normally someone would need to have deliberately done something wrong for it to be considered a crime. After a major incident, often "the first thing that happens is that seafarers are locked up."

It would be better if there was more willingness to accept that seafarers might make unintended mistakes – and look at whether the environment they work in can be changed to make them less likely.

In a 1991 book "Human Error", James Reason differentiated two different drivers for unsafe acts – local workplace factors (including technical factors), and organizational factors.

Mr Shaw presented this quote from the book. "Rather than being the main instigators of an accident, operators tend to be the inheritors of system defects created by poor design, incorrect installation and bad management decisions. Their part is usually that of adding the final garnish to a lethal brew whose ingredients have been long in the cooking."

But in the shipping industry, the attitude too often is still, "it's the seafarer's fault, how did he make that stupid mistake."

The seafarers should be supported by their shore-based management, regulators, and other recognized organisations. Other relevant parties are the equipment designers, system designers, programmers, port operators, terminal operators, charterers, vetting organisations, industry bodies.

As a seafarer, Mr Shaw recalls making some mistakes at sea which caused shipboard electricity supply to trip. As a fleet manager, "I made some quite huge mistakes".

"We're all prone to human error. We get ourselves hung up that the only person who makes errors in the shipping business is the seafarer, because we view the seafarer as a hazard."

"We make the assumption that all ships are correctly designed, all the procedures around that are fine, the only thing that's wrong is those damn fool seafarers who keep making mistakes. We make the assumption that if you focus on those mistakes you prevent accidents – monitor them more and pushing them more. That's what's called

'work as imagined,'" Mr Shaw said.

But in the real world, management systems are not perfect, things go wrong all the time.

"The only reason things don't go wrong is that seafarers make them operate. They are the glue that make things keep running."

"What would happen if you focus on the other 99 per cent of the operation and the things that went right?"

Seafarers as goalkeepers

Mr Shaw sees seafarers like goalkeepers, the people who prevent problems from becoming big problems.

"If you are manager of a [football] team, the team loses five nil, do you sack the goalkeeper? Maybe you should. But what if he saved 50 goals? That means 55 times the ball is kicked to the net. What about the other 10 people – what were they doing? How do you stop the ball getting close to the net? You need to do a lot more work on that one. At present the seafarer may feel alone on the pitch with an angry opposition bearing down on them."

In 2008 James Reason wrote 'the Human Contribution, where instead of focusing on human error, he wanted to focus on the human contribution, the good things people have done.

So if you tell the story of the Titanic, you could focus on the Carpathia, the ship which rescued the survivors, including preparing for them to come onboard, recording their names, and informing their relatives.

The limits of procedures?

Efforts to improve safety have been through a number of waves. The first stage was improving the hardware, the machinery itself. The second stage was to focus heavily on competence.

The third stage, starting about 1990, was to focus on improving procedures and management systems. In the tanker business the owner and flag took responsibility for compliance with these. Vetting organisations provided a further layer which could be described as 'enforcement' as well as generating best practice.

Shipowners developed continuous improvement systems, identifying what they thought they could improve, and then doing it. "They improved things dramatically." They basically removed all the systemic problems from the system.

This focus was successful at improving the safety record. Data of tanker industry casualties shows a steady decline in

accidents, measured by casualties and pollution incidents. The introduction of double hull tankers during the same period also helps.

But in the past decade, the accident trend goes up slightly, partly due to the increased number of tankers following the Chinese boom, and partly because of some things going wrong, including more groundings which may have been caused by problems introducing ECDIS, Mr Shaw said.

So it may be fair to argue that a limit was reached of what could be achieved with procedures and what can be achieved with simpler accident investigation models which stop at what happened aboard ship

Ultimately, if people are given more to do with more complex systems the potential for error rises, he said.

Procedures are an important part of how you run ships – you can't not have them. But they need to be useful, not a stick to beat people with.

"In many cases the last people who read procedures are the lawyers, to see if there's any liability in there, not to see how easy they are to follow," he said.

Complexity onboard

Today's seafarers have security and environmental requirements in addition to safety requirements. There can be 5 or 6 things they need to assimilate in their heads and connect to make decisions, and sometimes people need to decide what gets priority.

"You reach this horrible phase called complexity," he said.

To understand where the complexity comes from, we can break down what work is like on a ship.

The core of the work is "relatively straightforward" tasks, like navigating, loading and discharging cargo. You have engineering systems to support you. Behind that, you have a lot of processes to assist, including procedures, checklists and forms.

Then there is a large amount of communications which need to be done during port calls. "Someone comes onboard asking for the captain's time. They've got statutory powers behind them. 'We are here, and you'll do what we tell you to do.'"

This is where it starts to get complex. "The captain gets tied up. The terminal is desperate to get you in and out as quickly as possible. You may well have port state inspections, charterers inspections, maintenance."

There are people who can help you with

maintenance, such as "riding squads" (crews which stay on the vessel for a short time for a certain task). But operations generally rely only on those onboard.

Behind that, are a number of maintenance processes and planned maintenance systems, class requirements, and stores and spares to manage.

You have a shipowner making sure everything works correctly, and a regulator making sure the shipowner is making sure.

Regulators 'not in touch'

The problems arise because these people making regulations are not in touch with how people currently work onboard ships. They believe that ships work the way they did when they were seafarers themselves, 30 years earlier, he said.

The way the industry is meant to work is with a ship interacting with ports, a shipowner interacting with the ship, the shipowner being in charge of how ships are designed, operated and maintained, and national regulatory bodies – and the IMO – making regulations.

But there are now about 170 different flag state regulatory bodies, over 30 classification societies, and thousands of owners and ships, all working in different ways.

In the 1990s, there were a number of tanker incidents leading to oil on people's shorelines, leading to a call for a new sort of locally controlled regulatory body, known as port state control. "Coastal states wanted to have some sort of leverage on the ships coming in and out of ports."

The port states influence flag states and class by creating black lists of bad flags, so vessels with these flags were subject to more port state inspection. "Nobody wanted to have a flag that meant they would be targeted by port states, and so the black listed flags had to improve and quickly.

Then you have the vetting organisations, working on behalf of oil companies – the charterers – whose big concern was that they would be the 'deep pockets' for a major pollution incident.

So there are multiple organisations with slightly different goals and requirements. "There are all sorts of systems that people have got to understand, all sorts of communications that people are having to deal with. They are all sitting on top of the poor chap in the middle as he tries to make sense of it."

Increasing automation

We also have increasing use of automation,

but no opportunity to practice running without it, he said.

"In my days [at sea] automation was nice to have – but when automation went wrong, you knew roughly what to do.

"If the main interface is the computer systems, then you need to understand the logic of the control system as well as that of the system it is controlling."

Today, we hear stories about systems affecting each other which should not have any connection, such as an alarm system which would somehow cause the ship to turn to starboard when it was tested, he said.

Enclosed space deaths

Investigation into accidents such as enclosed space deaths, the second largest killer on ships, often ends up saying that the individual did not follow procedures. "It doesn't look at what is behind that"

For example, time pressure might be an indirect cause. Time pressure can be explicit – if you are asked to do something quickly. But can also be implicit, when someone does something because they feel under pressure.

If someone senior believes they are under time pressure, that is pushed onto everyone beneath them.

There can be systemic pressures – where a system is designed to function quickly, for example a system designed for fast loading of car carriers.

In the tanker sector, a terminal operator may need to make a choice between building a new jetty, so there is ample space, or just trying to increase the throughput to get more tankers in and out more quickly.

You have charterers who expect "utmost dispatch" and owners who want to maximise their earnings.

Usually, there will be enough people in the management structure who are aware of the dangers of putting crew under time pressure. But there are also situations where commercial management is handled by brokers, manning is handled by manning managers, ship management is handled by technical managers, and the captain sits in the middle.

Time pressure is not something which can be removed completely, the question is making sure people are able to say when it is too much. "That to me is the difficult bit. You've got to create armour for the captain. The shipowner has got to make it explicitly clear, If the captain feels under pressure, he has a right to say no."

Another way to reduce enclosed deaths could be to try to reduce the problem. While we can't prevent seafarers from having to enter enclosed spaces at all, we can try to reduce the number of times they have to do it. There can be better arrangements for ventilation. A current method is to use a thick pipe to pump air into the space, which also blocks the same hole which is needed for someone to exit.

The industry takes a bias towards trying to solve problems with administrative methods, and "that's where we get into problems".

It shouldn't be necessary for someone to enter a tank with breathing apparatus, except in an extreme emergency to rescue someone else.

InterManager – reducing enclosed space deaths

One of the biggest causes of death onboard vessels today is enclosed spaces - people collapse due to the atmosphere or other reasons, and cannot be rescued. Captain Kuba Szymanski, secretary general of InterManager, suggested some better ways we can try to reduce the risk

One of the biggest causes of death onboard vessels is now enclosed spaces, where people collapse due to a non-breathable atmosphere or other reasons, and cannot be rescued, said Captain Kuba Szymanski, secretary general of InterManager.

The normal techniques shipping companies use to minimise the risk, procedures, training and posters, are not solving the problem. So we need to look at new ways to reduce the risk, he explained.

Examples of enclosed spaces are tanks for cargo, ballast or fuel, or a 'void space' between the vessel hull and a tank.

About three quarters of the deaths are seafarers, a quarter is people visiting a ship while it is in port.

It is possible that one day, the family of any deceased seafarer could sue the shipowner, for not having "provided sufficient environment for the seafarer to work."

"A very good American lawyer will go after the owner."

Didn't follow procedures

When people have accidents, the investigations will often report that it was due to the person not following procedures. In other words, blaming the person who died.

People don't realise that in a typical marine situation, the procedures are hard to follow, and seafarers are under pressure to not to follow them to the letter in order to save time, he said.

InterManager's Captain Kuba Syzmanski

"A typical attitude from shipping company management and regulators is to say, we have given seafarers a lot of training into enclosed spaces, we have put up posters about the risks, so if they have accidents, it must be their fault."

Chapter 15 of the UK Maritime and Coastguard Agency "Code of Safe Working Practices for Merchant Seafarers", 545 pages in total, available free online, has comprehensive instructions for working in enclosed spaces. Shipping company managers often keep it in their office.

But they do not often refer to it, Mr. Szymanski said. It is written in a language where people who do not have English as a first language would struggle to understand, he said.

And it would be a lot to memorise. Many seafarers are not confident enough in their relationships with their employers to say, they need to stop work while they go back to check it, he said.

More usually, seafarers are afraid to admit they don't have a comprehensive understanding of it. "He doesn't know it is OK to not know. That is the environment we have created," he said.

The P+I Clubs can be held indirectly responsible for some of the problems – by selling shipping companies insurance against deliberate acts of seafarer negligence. This gives shipping companies an incentive to say that any problem is due to deliberate seafarer negligence if they can.

No safety report repository

Not all shipping companies are aware that the risks of enclosed spaces are so great. There is no central repository of safety incident reports in the maritime industry.

Data is collected by bodies such as the International Bulk Terminal Association and the UK's Marine Accident Investigation Board (MAIB), and these are well known, but not global.

The IMO has developed a central database of safety data called Global Integrated Shipping Information System (GISIS). But not all states submit data to it, including Denmark and Germany, he said. "So it is empty. There are no statistics."

No independent investigation

The inclination to "blame the seafarer" can be stronger when the investigation is not independent. It is not independent if (for example) the regulations, created by a body also doing the investigation, may be part of the cause.

In the US, the US Coastguard was the body responsible for investigating the El Faro container ship accident where 29 people died. "Did they find the US Coastguard made a mistake? Of course not. They said, 'it must be the old man, he was told so many times not to sail'".

Similarly, the Costa Concordia accident was investigated by Italian authorities. "Are they going to say anything about themselves? Of course not."

InterManager survey

InterManager decided to try a different approach – to start by surveying seafarers to ask about the reasons they were taking risks. The survey only had a single question, "why are you killing yourselves in enclosed space", and collected nearly 5,000 responses.

One of the biggest causes, cited by 30 per cent of respondents, was procedures and conflict within them.

For example, OCIMF's ISGOTT (International Safety Guide for Oil Tankers and Terminals) says that seafarers "should not enter enclosed space in breathing apparatus unless it is an emergency".

But typically Wall Wash Tests have to be carried out and many operators requires seafarers to wear breathing apparatus sets for

this "operational activity," he said.

Ship design

Not many seafarers saw it as their role to question how the ship has been designed, but they probably should do, he said.

There is usually just a single small cover which is removed to access the space, big enough for one person to squeeze through. "What if we've got someone having a heart attack, how are you going to get them out of there?"

Also the vents in the tank could be better designed to provide a breathable atmosphere.

"None of the people who designed enclosed space ever thought about humans working there," he said.

There is a lot of industry discussion about unmanned ships. An unmanned ship would need to be designed with ballast tanks which never need inspections to be done on them – just as they would be designed to never need paper work to be done on them. But rather than wait for fully unmanned ships before we do these things, we could do it now.

Short term hire

Another issue is the employment relationship seafarers have, which strongly discourages them from complaining too much. 90 per cent of seafarers are hired for a specific vessel, so when they finish one contract, they frequently don't have the next one lined up, and cannot be sure there will be an assignment. The other 10 per cent of seafarers have a contract saying they have a certain amount of notice. This is usually just the master and chief engineer.

"You were working until Friday, and you may work on Monday, you don't know," he said. "How do you relax on the weekend? Your wife says, what are you doing on Monday. You say, I don't know, they will call me. What if they don't call you?"

In such a working environment, "are you going to rock the boat, when you may not work again?"

30 years ago, 90 per cent of seafarers were employed by owners. Fourth engineers could see their steady progression up the ranks within the same company. But today, when people are asked where they think they will be in ten years, they typically say, they don't know, they just hope to be still working at sea.

Any new master would be very reluctant to pick up the phone and say, "I've got a problem".

Lack of trust

When people are working with people they don't know, there is no trust. "People are very concerned that they don't know who they are getting. They it takes months [to gain trust]."

If people feel comfortable with their fellow crew members, they don't see the need to check what they are doing. But the opposite is true. "He will be saying, why are you checking, I am an experienced chief officer. I say, well I don't know you Henrik. I am just covering myself."

Training

Seafarers are not formally trained how to inspect the structures of tankers. "We don't know how to take a hammer and learn where to knock it. We learn on the job, provided we have a good mentor."

Class societies teach their surveyors a special structure for writing reports. Seafarers are also expected to write reports about tanks, but without this knowledge.

"There's no point in sending a chief engineer to the bunker tank, he has never been there with a surveyor's hat," he said.

Stakeholders

In the second phase of the InterManager project, it identified the different stakeholders for the enclosed space issue, including class, shipyard and company senior management.

"A lot of [these people] do not see themselves as part of the problem," he said. They believe that preventing enclosed space accidents is the responsibility of seafarers themselves.

"But design of the tank is approved by class. Why is class not asking themselves the question what if, how?

And people ashore can be "oblivious to what happens on a ship".

Never been used

When Mr. Szymanski takes a ferry, he will often present his business card to the administrative office and ask if he can visit the bridge. He asks the second officer if they issue enclosed space certificates, and if they have oxygen meters onboard.

The answer is nearly always "now we have one, until last year we had zero," he said.

It seems that 99 per cent of ships in the world which are not tankers have just one, which is the minimum.

And the oxygen meter "is in the chief officer's cabin with a blanket, saying 'do not touch, it is for inspections.'"

Carrying an oxygen meter is an essential safety precaution, because the concentration of oxygen can vary in different parts of a tank.

Rescues

Then there is the question of how someone is rescued if they collapse in an enclosed space. The hatch to enter tanks can be a little wider than one person – so impossible for one person to carry another out. They would also need to take in rescue equipment, such as a rope, torch and resuscitator.

It is possible to buy an oxygen resuscitator, a device using positive pressure to inflate the lungs of an unconscious person who is not breathing, in order to keep them oxygenated and alive. "Even the best companies are not investing in that equipment," he said.

Sometimes people enter enclosed spaces without realizing they are enclosed spaces. For example, a cargo hold which was previously full of wood chips. "They don't know there's no oxygen down there. Within minutes they are dead.

Safe manning levels is another issue. A tanker might have only three crew members on deck, which need to periodically visit 35 tanks. If two people go into the tank, there is only one further person available to rescue them if something goes wrong. "How is this going to work?"

Harren – defining effective communication

German vessel operator Harren & Partner is making a big effort to improve communications between crew and the office. Fleet manager Ömer Faruk Bayar explained

German vessel operator Harren & Partner is making a big effort to improve the communications it undertakes between the office and crew.

Ömer Faruk Bayar, marine fleet manager, and master mariner, explained what is happening, with a talk at the Tanker Operator Hamburg conference in October.

The company was founded in 1989 by Peter Harren, and today operates a fleet of 76 units including tankers, heavy lifters, bulk carriers, offshore construction vessels, tugs and container feeders. The company's seafarer retention rate is an impressive 98 per cent.

Captain Bayar was working at sea since 1994, joined Harren in 2004 and joined the office in 2018 having worked on tankers for 14 years.

The project started following a realization that seafarer training, procedures and checklists are not enough to stop every problem happening onboard. And if communication with crew is not effective, then much of the efforts to improve safety and operations can be a wasted effort.

There is no need for a formal definition of effective communication – you can define it by whether or not it is successful, he said. From a seafarer's perspective, "effective communication is communication which is effective."

A straightforward answer can be to say that the best way to achieve effective communication is to have a lot of respect and understanding for the people you are communicating with.

You also need to make sure that people are able to receive your message, including crew who are ashore or on leave, he said. "When your captain or your chief engineer stays at home 2 months, 3 months, and you change something in your system, they are not aware of it."

Workshops

Harren started running company sponsored seminars and workshops, on topics such as "resilience training".

"The most important part to me is that we are really trying to push our top management, our managing directors, to participate in all these events. Not as lecturer or speaker, but as participants," he said. "It is really very good to have directors there, with crew."

Some of the most useful conversations happen during the coffee breaks, not during the formal presentations, when a crew member wants to tell a manager something honestly. "You have nowhere to escape."

The company's managing director is not a former seafarer, but "he's happy when he's gathering together with all these people."

The crew can learn that the company is serious about safety and doesn't just care about money – including hearing the message from the company senior management.

Harren also runs small sized workshops, with a maximum 5 people, which are closely structured.

Encouraging reporting

Harren found that in many cases, only the people in the top four roles on the vessel saw it as part of their job role to report anything they see which might be a safety concern, or otherwise of interest to company management.

One solution developed was to give every crew member a small notebook to carry at all times, to report negative and positive observations. The notes are dropped into a box, which are then sent back to the company.

Attitude

People talk about competence as a combination of skills, experience, knowledge and attitude. But perhaps it makes more sense to say that the attitude is the multiplier rather than an additional factor, he said. "We strongly believe – and we strongly state – that attitude is the key factor for change."

In the resilience training event, the company has people appointed as "resilience champions", who moderate the discussion, and encourage crew members to talk, so you don't just hear from the captain or chief engineer. "We really have a lot of good feedbacks," he said.

Reducing questions to ships

The company has made effort to try to reduce the number of questions which get asked of shipboard staff.

It creates organizational maps which make it more obvious who is responsible for the vessel within the company, including the head of chartering, the operations manager, assistant,

Harren & Partner's Ömer Faruk Bayar

crew manager, purchaser, safety manager, and technical superintendent. The idea is that (for example) If the purchasing manager has a technical question about the ship, he can ask the technical superintendent in the office, rather than the crew.

The same software which is used to track data about the vessel, can be used to track who is responsible for different aspects in the office.

Getting to know each other

Another project is to improve personal relationships between shipboard and office staff.

When people never meet each other personally, the wrong beliefs can take hold, for example shipboard staff might believe that people in the office don't do anything but send e-mails.

Harren assigns a "project crew" to come and work in the office for a number of months. People can get to know each other as individuals, not just the "captain". This can also help develop better understanding between ship and office, which can lead to better communications methods.

Crew can meet their technical superintendents, who otherwise they would only contact via by e-mail.

In comments, Martin Shaw of MOAMS said from his experience with seafarer visits to office, it is important that you make it mandatory. If you let people volunteer to come to the office, you just end up with the people who would rather work on the office than on ship, which is not necessarily the people you need.

Mr. Shaw also noted that when seafarers are considering what senior managers think, they may form their opinion based on aside comments such as "you need to do some work on your budgets", rather than anything presented as part of a formal presentation. When the senior manager is gone, they say "he may say he is interested in safety , but its money he's really interested in". TO

Columbia – finding better approaches to training

Columbia Shipmanagement is improving the ways it encourages seafarers to think about safety, develops a safety culture, and trains the crew. Capt. Faouzi Fradi, group training director, Columbia Shipmanagement explained

Columbia Shipmanagement, one of the world's largest Shipmanagement companies with 15,000 employees, is exploring better ways to encourage crew to look at safety, build a safety culture, and improve training. Capt. Faouzi Fradi, group training director, Columbia Shipmanagement explained more.

Captain Fradi formerly worked as a master on oil tankers, gas carriers and chemical tankers, and has worked as a pilot, marine superintendent and crewing manager.

Columbia is keen to accentuate the positive side of safety – rather than tell people what not to do, it wants to tell them to "live another day", he said. "Safety culture for us is not only about procedures."

"Human element is what we do when no-one is watching. This is how we feel the safety culture, this is how we take it onboard, and this is how we look at each other. When we see people doing the right thing and no-one is watching, we feel that safety culture is really implemented into the company."

Projects include making safety culture part of everyday life, emphasising the company's core values, trying to motivate more critical thinking, improving training, encouraging open-reporting, and focussing on welfare.

The company embarked on one project to ask staff from one of the manning agencies to ask their children – so mainly children of seafarers - how they feel about the environment, ships and safety. "The message was very impressive," he said.

"I CARE"

One project focussed on the words "I care", telling seafarers "that we care about them, they care about us, the office, the ships."

Columbia Shipmanagement's Capt. Faouzi Fradi

I CARE "became our philosophy – which is sitting on top of our values".

The company developed I CARE into an acronym, standing for "Commitment, Appreciation, Responsibility, Evidence."

Open-reporting

One Policy was to encourage people to report elements of concern they see, any non-compliance or misbehaviour, not only those related the environment. "We try to tell people, by reporting things, you are not snitching," he said. "If we do the right thing – but we tolerate someone else doing the wrong thing, we are getting nowhere, and we are not achieving our goals."

"By reporting, by saying, by telling us things, we have saved a lot of situations."

"It is amazing the number of reports we have received, when you implement such a Policy of Open Reporting."

"Some people may try to use Open Reporting for different purposes, not what you expect," he said. "But that doesn't matter. What matters is you get to know exactly what is happening on the ships, and you come up with solutions to fix them."

Critical thinking

Critical thinking is a very important factor when we talk about the human element, he said. "If seafarers and office employees do not have critical thinking, then nobody is going to question the procedures," he said. "We need to look at things with a critical mind."

To encourage this, Columbia launched a campaign called "think".

Meeting clients

Columbia invites its seafarers to attend meetings in Cyprus – and also invites its shipowner clients to come and meet them.

"Working with industry is very important," he said. "We always have speakers from different areas of industry. We get oil majors, insurance people. We want the industry to speak to seafarers, we want seafarers to hear from the industry."

The training can also include role-play and teambuilding exercises. "You see the engagement and how much fun they have," he said.

It can be very interesting to simulate ship operations onshore, where people are usually more relaxed than when working.

"We talk about all the possible risks which come with such operations," he said. "You see there's a lot of learning."

Learning management System

Colombia has implemented a learning management system, which allows people (both seafarers and shore staff) to access many different training modules, including via their mobile devices. "We want to make training accessible anywhere and anytime," he said.

There is a learning management system, which records the courses everybody has completed. Managers can monitor the progress of their teams.

Many courses were developed in-house, so they are specific to the company's requirements, and the equipment it has onboard specific vessels, such as scrubbers and ballast water treatment systems.

10,000 people are currently using the system.

The system is also used to manage classroom training (it does not replace classroom training).

Course certificates are digital, and can be accessed via mobile devices.

There can be friendly competition between Columbia staff about how far they have got with the training. "I saw two of our directors competing with each other, with one saying, 'I got a Guru badge and you are still behind.'"

The system can be used to send messages and share videos.

Examples of course topics include management system, cyber security, GDPR, risk assessment, enclosed space entry, and using planned maintenance software.

Seafarers are asked to provide feedback on all the training they receive. Their superiors also get notified about how their performance has improved.

There are "social learning" tools where people can exchange ideas online with other staff members.

Columbia is open to works closely with its competitor ship management companies in developing training courses. As to avoid accidents, people on other ships need to be well trained too, he said.

Virtual reality training

Columbia is working with a UK based virtual reality company to do training.

It has software tools where people go through a checklist – inside the VR – of what conditions need to be true before enclosed space work can begin. It has also developed training tools for scrubbers.

The idea here is that people might learn better by going through a virtual simulation of what they have to do on a ship (in accordance with the procedures), rather than just telling them what the procedures are, which sounds very theoretical. "The idea is to put people through real situations."

Training centres

The company is gradually transforming all of its training centres.

"During our training – all our seafarers have free access to mobile phones and laptops. They are asked to question what the trainer is saying and be very critical to what they hear."

"Sometimes we forget seafarers are adults," he said. "They should have the choice of what they do."

The company also provides training for its own instructors, including teaching them about decision making and different leadership styles.

Mental health

Columbia is developing a "mental health first aid guide" for ship masters. It is being developed in collaboration with a number of psychologists, based in Greece, Ireland, Scotland and Australia.

"It is not our goal for masters to become psychologists, but to have a basic understanding of mental health issues," he said.

All seafarers and employees of the Company have access to a free of charge mental health support via a 24-hour hotline.

The company also gathers perspectives from seafarers related to mental health and welfare via a number of surveys.

TO

How to find the maritime digital technology you want - Dimitris Lyras

Not all digital technology offered to the maritime industry will help us - and the technology which would help us is often not on offer. Dimitris Lyras, director of Lyras Shipping, and maritime software company Ulysses Systems, shared some ideas on how to technology which will actually help you and your seafarers

Many software companies are approaching shipping companies with products which were originally developed to solve someone else's problem, said Dimitris Lyras, director of Lyras Shipping, and maritime software company Ulysses Systems.

The software could be defined as a bag of tricks. "Does the bag of tricks work for you? It generally doesn't," he said.

It means that shipping companies need to "filter the noise" - work out what is relevant for them out of the products they are offered.

A software company won't usually put themselves in your position, as a shipping company manager. If you just experiment to try to find out whether it is helpful, "you can spend a couple of million bucks in the process."

Software companies typically promise their products will "help mariners perform better".

But the best way their products could do that is by providing better access to the right information. This means the right information when you need it, and not having to spend time with information which you don't need.

If the information isn't specifically tailored to what you need, then this is what will happen.

"This is how you do digital transformation," he said.

"If you do it by someone coming and telling you what they have to sell you, who is going to tie it all together? Who is going to finally deliver a working solution?"

And any solution is unlikely to come from just one vendor - so it will need the products of a number of different vendors to integrate together.

AI

Many companies are talking about AI in shipping.

Artificial intelligence is a misleading term, since one of the most advanced examples you read about, a computer recognizing a dog in an image, is hardly considered "an intelligent thing for a human."

"Recognizing a dog is really hard for a computer," he said. But in human terms, "you can tell them it's stupid - just doing something some other dog could have done."

AI companies are spending enormous amounts of money training computers

to do tasks like this, and they want a return. There are many excellent uses for this. But they have spent money solving a problem they had - and it doesn't mean it is going to solve any specific maritime problem.

Shipboard networks

Meanwhile, there are useful digital technologies for shipping. One example,

Lyras Shipping Director, Dimitris Lyras

which Mr Lyras had recently seen at a conference, was wireless communications networks which work on a ship.

It is often not possible to use normal wi-fi or cellular communications inside a ship because the radio communication cannot penetrate the steel walls. But this company (Scanreach) had developed a protocol which can work on board a ship.

Knowing mariners' location on the ship is the most important safety and co-ordination issue of all.

Better networks make it possible in the future to have for example data communications in an enclosed space, communicating data about whether it has a dangerous atmosphere without spot checks that a mariner cannot continuously be doing while working in the tank. Or to keep track of where the mariner is in the tank You could presumably communicate data about the heartbeat of people while they are in the tank.

"You can have sensors that tell you what people are doing in there, if they are alright. It's going to be a game changer," he said. "It is knowing what is going on, on the ship."

"Networks onboard are important. We don't talk about it."

Co-ordinating work

"Co-ordination onboard ship is extremely important.

A lot of co-ordination is required on repairs and maintenance work, including with safety, if one person runs into difficulties, another can provide assistance.

"The co-ordination isn't quite there because technology isn't there. It's not because people didn't try, it's because technology didn't exist. Soon enough it will."

Some software companies are promoting tools to help co-ordinate work, but not the sort of work co-ordination which is useful for shipping people. For example, one ERP vendor was advertising that its products enabled staff to approve a purchase order while at the gym. This is because it's easy to show a purchase order. Less easy to show what is going on at any one time on a ship.

What would be better is if the smart device knew what the ship and its crew are doing. For example some of the crew are undertaking a piping repair, there are people entering closed space, or cleaning tanks, pressing up a pipe or a tank for a test. Attention is dispersed in a certain way. It tells you what everybody else is doing."

We all know how useful handheld devices can be, from our experience with smart phones. "But remember handheld devices

were made by companies that invest billions in generic features," he said.

Ships don't only use generic co-ordination features. "There's no company that's going to come out of Silicon Valley which will work out if you are doing tank cleaning, what is sensitive in the operation, what defects a component has, what safety issues are prevalent, what knock on effects you might encounter if you stop the tank cleaning momentarily."

A shipping expert would be aware that "mooring processes can cause injuries and other hazards" he said. Or that "handling windlasses can cause overloading of windlass motors".

How well are junior mariners informed of these issues?

It would be useful to know what machines are doing when you are not standing next to them.

Seafarers don't spend their time just watching one machine, they move around the ship. It could be useful to have situation awareness tools, different from those of a factory. "Nobody is going to help us with it."

Knowledge management

Mobile devices could also deliver useful knowledge to seafarers. For example, they could provide updated information about hazards, safety issues, current information, history of machinery. "Knowledge management is one of the things you don't hear about," he said.

Previous efforts to build knowledge management systems, carried out over the past 2 decades, failed largely because companies were unable to connect the knowledge to the current situation of the practitioner.

Knowledge not linked to the current situation "is just a file store", he said. "Just because you can put information in there doesn't mean it is knowledge."

"Today, because of power of handheld computing, you can actually solve some of these problems."

If people don't have the best possible information, they might start doing work on machinery which would be better left untouched. "They adjust things that don't need adjusting, because they don't have information at the time of need."

"Information at the time of need is possible. We have a computer very close to us these days.

That computer can be told what's going on. Nobody is doing it because Silicon Valley doesn't make any money figuring out what you are doing."

A person going to a ship does not have a way of sharing knowledge from the person who previously did that role on the ship, just some files or personal notes.

"If you're going to involve mariners, you have to have a system where the mariners' knowledge and corporate knowledge somehow mesh together," he said.

And machinery manuals are usually "not written for the guy who's about to read it."

Perhaps computer systems could even assist with interpersonal skills. "It's quite obvious when things go sour on a ship - people have an interpersonal skills problem," he said.

The pathway to improved software systems onboard is to find ways to involve mariners in configuring certain aspects of the software, so it brings them exactly what they need. "You can say, do I want my mariner making changes to the software? Yes you do. But how is he going to get involved - and which part is he going to make changes to?"

Advanced technology

One audience member asked how virtual reality should fit into the maritime industry - since it potentially offers completely new ways of doing things, not just a replacement for the usual methods. It would make sense for the shipping industry to embrace new technologies as soon as possible, since it will come along eventually whether the industry wants them or not.

Mr Lyras replied, perhaps the first step is careful consideration, because VR training is not something which can be introduced "with the snap of a finger," and vendors are unlikely to do all the work of creating effective products themselves.

"We want to enable mariners to do good work - not let machines do good work. It is a thinking process It is a domain experts process."

Companies can often go too far in thinking advanced technology solves all problems. Mr Lyras cited one example he knows of a shipping company person who ran into financial problems and was arranged a meeting with the bank. Rather than talk about the company finances, the bank's representative suggested that a data lake might be the answer.

"Do you think a data lake is something we're ever going to hear about again? It was a fad at some point," he said.

Scoutbase – prevent human error with real-time data

Danish start-up Scoutbase is developing better ways for shipping companies to find out where their seafarers experience challenges in everyday work - before they turn into accidents.

Scoutbase of Svendborg, Denmark, is developing better ways for shipowners to continuously get anonymous feedback from their crew - thanks to their proprietary feedback tool which allows them to send questions directly to the mobile phones of seafarers.

Seafarers don't need to install any app, the system comes up automatically when they connect to a shipboard crew wi-fi. So, for example, before they can get to Facebook, they are asked a question, they answer and then go on to Facebook.

One example question on the company website is, "What makes you rush at work" with options "unplanned extra work, interruptions, change in plans, something else". Another example is "are you sleeping well onboard".

The system is designed to make it as easy as possible for seafarers to anonymously inform their employer if they are stressed or fatigued, or what they find difficult.

This gives shipping companies an entirely new data set on what they need to target in their next budgets, priorities safety intervention and campaigns.

The response rate so far has been 85 per cent, providing around 400 data points per vessel per month. This is much more data than a safety manager would get from waiting for near miss reports.

A pilot project was running with shipping operator DFDS from January to December 2019, which will now be scaled up to their whole fleet.

The same software can also be used for communications to crew, including to share announcements or ask them to watch a safety

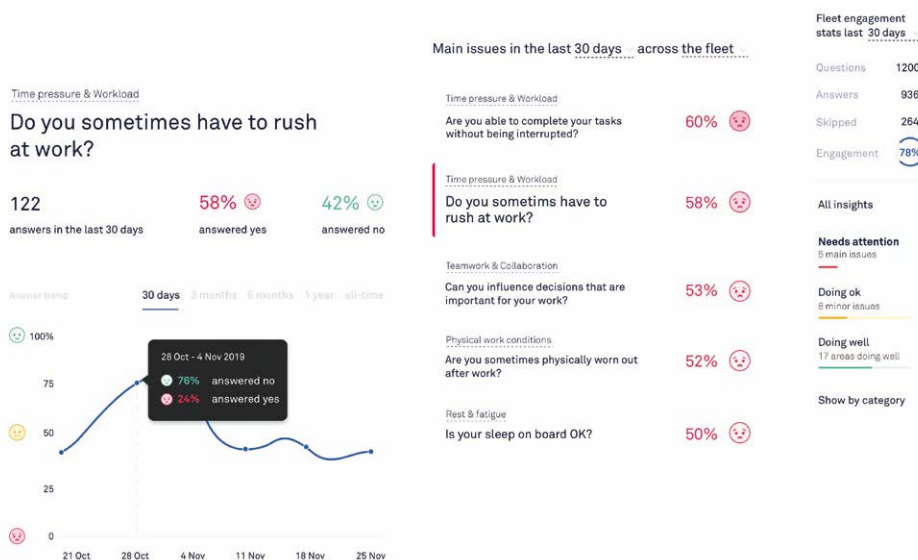

Sebastian Nause-Blüml, Co-Founder, Scoutbase.

video.

It only requires a very small amount of data bandwidth to send the actual response data – the software works offline and can send the seafarers' responses whenever there is a faster data connection.

Better situation awareness

The purpose of the tool could be described as making it easier for safety managers to maintain situation awareness of what is happening on ships, so they can make better decisions.

Safety managers often have useful and actionable little data to try and prevent human error at sea. Near miss reporting for example typically gives around 4 data points per vessel per month, often with questionable quality and usefulness. Scoutbase on the other hand

provides vastly more and highly actionable data – in real time.

An analogous situation could be trying to drive a car without a speedometer, says Sebastian Nause-Blüml, Co-Founder, Scoutbase. "That's how a lot of companies that we have spoken to describe the situation that they are in with the crew – they don't have the data to know what's really going on"

And it is common for seafarers to encounter problems in work or have ideas about how it could be done better, but not tell anyone. "All of this precious insight on what could and should be better stays in their heads," he said.

With Scoutbase in use, the company safety department and other staff can see data coming in and use that to make decisions – including on priorities, campaigns and training.

The most useful information for managers is what is difficult in people's everyday work.

Maintaining anonymity

The responses are anonymized, so shipping company staff cannot link any response to any individual crew member.

Since the responses are taken through an app rather than by e-mail, it is easier for seafarers to trust that the data is kept anonymous.

Some shipowners have asked Scoutbase which individuals onboard made a certain response. But Scoutbase needs to decline these requests, because it is quite important for the system functioning that crew can trust that their data will be treated anonymously. "If we lose the trust of seafarers then we've lost," he said.

TO

Are KPIs useful?

The panel discussion explored the increasing use of "key performance indicators" – and whether they actually remove a lot of useful information.

Dimitris Lyras of Lyras Shipping said that with experience, there are factors a shipping expert knows are likely to increase the risk of accidents, such as having a "riding crew" onboard for a short period preparing a vessel for dry dock, who are less familiar with the vessel. This sort of insight can be more useful than a KPI.

Martin Shaw said that many companies are very keen on "zero accident cultures". Having reduced their injury rates to a very low level, such as 2 days of lost time injury per year for their fleet, still want 5 per cent improvement every year, because that is what the KPI system demands.

One of the drivers for KPIs is to make it easier to compare companies. "The various accountants are talking about benchmarking themselves against other organisations. Whether that makes sense Is another thing," he said.

Another reason people like KPIs is that it saves them from having to understand what is really going on. They can just say they are having a "5 per cent improvement".

One audience member noted that seafarers find it frustrating when they spend time providing data for calculating KPIs – but then see no action gets taken about the results.

Making this industry proud to send people on ships

By Frank Coles, Chief Executive Officer at Wallem Group

We have way too many seafarers dying in unsafe conditions, way too many seafarers committing suicide and far too many seafarers being detained in an indiscriminate manner for crimes they didn't commit.

We have seafarers trapped in unpaid situations and unable to make it home.

So before we get high and mighty about our training programs, and before we talk about diversity, lets make it an industry where we are proud to send people out to sea.

Let's protect those at sea, lets create a fair society and lets recognise the need to create a fair platform, while we take care of our own business. It is up to the strong to make it better for the weak and disadvantaged in our industry.

Here is another example we are dealing with as well. Fabricated evidence and ignorant government employees hell bent on a scapegoat without evidence.

Drugs found on board ships is never an easy matter to deal with. The question of whether the ship's crew is involved or not is always one of the main points. Alongside this is also the question of whether the proper precautions were taken in the load port in South America?

With this in mind when you have a ship found with drugs on board it is important to be open and cautious as the authorities investigate. Provided they are fair and honest.

However, when you start to see what can only be described as excessive abuse of process, bullying and mental torture, you have to question whether the actions of the authorities is appropriate.

Let me set the scene. The ship arrives in South Korea from Colombia and 100kg of drugs are found in the anchor chain locker. This is as a result of a tip off from USCG.

The ship had called in Singapore for bunkers. For 6 months prior to this voyage the ship had been trading Colombia to Mexico. The crew of the ship knew of the change of orders for one week before the ship left Colombia. The crew are all from the Philippines where drug penalties are severe.

From this one might-deduce, the crew would not be involved because they would know about the change of route and warn the supplier.

You might think that the crew would know an anchor chain locker would not be the place to hide the drugs, they would get damaged, get trapped under the chain when it is hauled in. You might wonder why the USCG did not tip the Singapore authorities? Which long time sailor is going to take this risk, knowing the penalties at home? There is no evidence at this point.

The crew have from the start denied any involvement. As managers we have had a member of staff with the crew throughout.

At no time have they shown anything but open demeanor. They have cooperated at every step. The ship has left with a new crew, the old crew are being kept in a hotel in Korea.

The treatment, well judge for yourself?

At first things were relatively simple, Korean Coastguard (KCG) begun a series of questions and interviews. They gathered data from the VDR, they took photographs and they decided they were going to use a lie detector to ask questions.

But, there were three problems, the KCG had never handled a case of this size, and there was obviously a pressure to find someone whether guilty or not.

Second, the KCG lacked the knowledge or experience to understand world trade, chartering orders, ships operations and generally were ignorant of large ships and operations.

The third problem was the language barrier. The KCG knowledge of English was poor, and knowledge of Tagalog was nonexistent. The interpreters were weak and the crew were not allowed their own representation.

Then the problems began, interviews for 10-15 hours, going on until 3am, shouting and insisting someone was guilty. Telling crew if they gave someone up they could all go home.

The KCG used every dirty tactic they could and blocked any sort of representation they could.

Here we are now, 2 months on, nobody has been arrested, no evidence is available. Endless continuous long interviews, amateur questions of ship operations and a lack of human rights and judicial process. 5 crew members have gone home, and it is probable that more will leave tomorrow. Yet they continue to want to make up evidence.

Using a poor VDR recording every word in

Tagalog that sounds like cocaine is twisted, or every English word that is a mixture of languages is supposed to be talking about the drugs. Every attempt is made to put words into the crews mouths.

They ask ridiculous questions like, define a boat, a ship and a vessel? Who gives the vessel's voyage orders? One must ask, who are these clowns?

Wallem Group's CEO, Frank Coles

As I said at the start, every attempt has been made to be open, to be cooperative. Yet we are two months in, with no evidence and a desperate bullying Korean Coastguard.

At what point is this attempt at finding a scapegoat going to end?

I know Koreans, I have good friends who are Koreans, and I know their justice is based on a proper rule of law, so why is the Coastguard allowed to behave in this manner?

They even took the Chief Officer to court but the judge refused to enter an arrest warrant, as there was no evidence. How can there be any difference now? How many times can they interview and try and make up evidence?

Not only was he taken to court on flimsy creative evidence, but while waiting for the judge's decision, he was held in handcuffs and tied with rope. Note he was not under arrest.

We have to ask what country are we in? Once again the criminalization of the seafarer, and different rules apply.

Legal representation is only allowed in certain cases and KCG block every attempt at proper protection.

If someone was guilty, if they had evidence, if this was being done fairly and with proper judicial process fair enough. This is not. Korea should be ashamed of the behavior of the coastguard. Our local agents who are Koreans, are ashamed.

How long is it fair and correct to just hold people in a hotel and pull them out to interview them at leisure for hours on end?

Two months is not fair, but then this is a ship's crew and they are from the Philippines, so almost nobody cares. It's a disgrace. **TO**

Real-time People Data from "wearables" – an integrated safety system

Wearables Technologies has developed a software platform called Eleksen to make it easier to handle "wearables" data in an integrated way – such gas, noise and proximity sensors worn by offshore workers

Wearable Technologies Ltd (WTL) of Leicester, UK, has developed a software platform called Eleksen to make it easier for oil and gas companies to handle "wearables" data from their global workforce in an integrated way – such as data from noise, gas and proximity sensors, and people's location.

It is common for offshore workers to carry safety sensors, such as gas detectors, as they work. But until now, this data has only been used in a limited way, to inform the worker themselves, but not the control room.

CEO Mark Bernstein had the idea for the technology after a visit to an oil refinery, where he saw staff carrying portable gas sensors, which could alert the worker to gas, but did not alert co-workers, and didn't alert the control room.

Meanwhile staff in the control room were monitoring equipment but weren't monitoring people. If there was any safety incident, they would not know exactly where people were or their status.

Mr Bernstein's idea was that data about individuals, their location, and the gases they are exposed to, would be managed in an integrated way.

This is similar to the systems which have already been developed to track physical objects in an integrated way.

Coming from a technology background, Mr Bernstein thought it should be a cloud-based wearables "platform", which could gather together data from the various wearable sensors, rather than a specific product.

The technology development was co-funded by BP and is being sold into oil and gas, construction and utilities industries.

There is a question of whether staff will be comfortable being continually monitored and tracked in this way. They should do, so long as they see that it provides a benefit to them, not just the company, Mr Bernstein says. A similar example is the introduction of tachographs in trucks, keeping a record of speed and over time, which were disliked by drivers when first introduced. But now, "tachographs have become the drivers' friend. They prevent unscrupulous employers forcing them to do longer hours. So, this technology can be a force for good," he says.

One common people data platform for North Sea

The company has had a trial running in Aberdeen supported by the Oil and Gas Technology Centre (OGTC), following a May 2018 workshop about "how to make the connected worker a reality" in oil and gas.

The workshop concluded that there "needed to be a common data platform across the industry – that all the oil and gas majors could use, their supply chain, their subcontractors on rigs," he said.

OGTC has funded WTL to upgrade its existing data platform, "So that it could be the standard data platform used across oil and gas in the North Sea."

Partners involved include BP, Wood Group, Stork, device manufacturer Draeger, and communications supplier Tampnet.

The OGTC funding will cover the cost of developing ATEX certified hardware (which does not give off any spark which could ignite gas). It will also improve the software platform to make it sufficiently scaleable, reliable and secure that it can be easily integrated into large IT systems.

The technology is being pilot tested on a number of oil and gas sites, both onshore and offshore. The data platform is built upon open standards, enabling any other company to integrate their products into it.

How it works

To explain how it works in more detail - offshore workers typically carry a number of devices, monitoring their location (GPS), their exposure to noise and gas and, in some cases, their proximity to moving equipment such as cranes, forklifts and vehicles. They also carry radio communications.

By integrating this data in an automated way and communicating it back to a control centre, supervisors and the control room could be immediately notified if the person is at risk. A
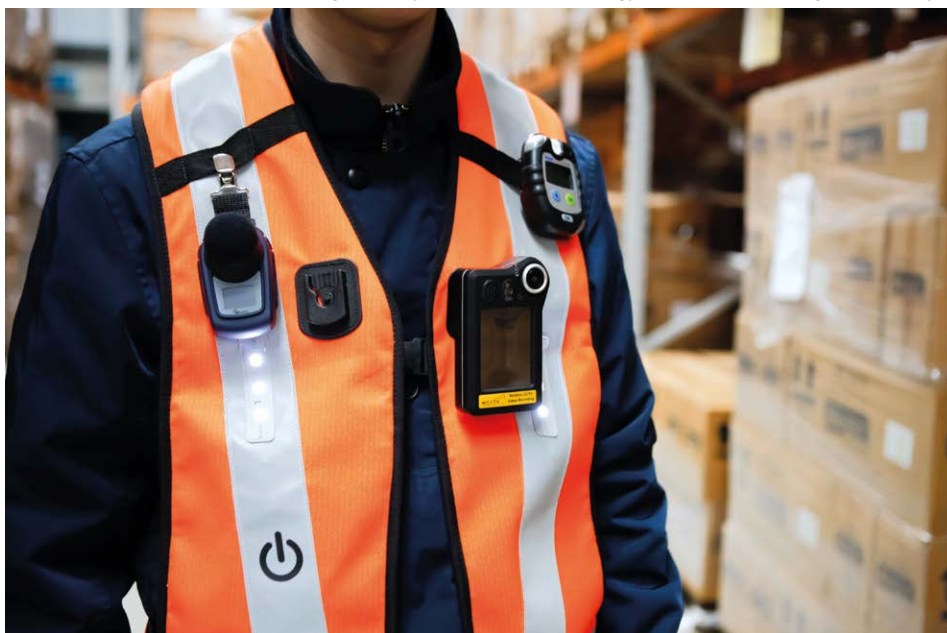
real-time holistic picture is also created showing the short term and long term risks each worker has been exposed to, during a shift or even during a whole year.

The WTL technology involves a wearable hub device attached to the worker's clothing which receives, analyses and integrates the data wirelessly from multiple sensing devices carried by the worker. This data is transmitted, including the person's identification where relevant, by the hub device to a company server or cloud system via cellular communication. Workers are identified to the hub using a unique card or ID number, eliminating the risk of data being associated with the wrong person.

The wearable hub also provides power to devices, such as lights embedded in smart PPE garments, where necessary.

If workers are indoors and out of the range of GPS, companies can install Bluetooth beacons on the ground, which enable the system to track when a worker comes in close proximity to them.

The system can also be used to monitor who is on site and where they are.

Mark Bernstein, CEO, has a technology start-up background, with a list of past projects including in virtual reality, a big social network sold to Yahoo, a computer games business which was floated in the UK, and a mobile payments business. He has also been involved in hardware and smart garments projects.

The system is device agnostic – designed to make it possible for customers to add other sensors as and when they choose to, including sensors they already have. This avoids the need for multiple dashboards for each different type of sensor - data from any number of different sensors can be integrated and displayed on a single dashboard.

Having all the data in one place, integrated together in a standard 'data set', makes it easier to do further analytics to get more insights into the overall level of risk different workers have been subjected to, or compare working environments.

Mr Bernstein sees the "connected worker" as a step following the "connected home" and "connected factory", with multiple devices bringing information together.

The company believes it may be serving a $10bn market in the connected worker space, with very few companies in it.

Further uses

The system can be expanded to include many other devices, such as sensors to monitor heartbeat, respiration and heat stress, or even posture, since "back pain is the biggest cause of days off."

The system can send emergency alerts, both to the worker and to the supervisor, if anyone is exposed to gas or noise levels which are dangerously high. "We can monitor the actual noise environment for each worker for months, build up a good long-term occupational health picture.

The data can be used in any legal cases, for example if there is a claim that an employee has damaged hearing due to sustained exposure to high levels of noise. "It is quite difficult to defend if you don't have actual data from that actual employee," he says.

It may be possible to use data analytics, to identify which workers are being placed under the highest levels of risk and from what, which could be useful to insurance companies.

"A customer can decide what they want to monitor," he says. "If a sensor exists, we can integrate it.

Our solution is really an integration and communications platform that sits on top of all those devices."

TO

SpaceX's Starlink - what does it mean for shipping communications?

Elon Musk's company SpaceX is in the process of launching 12,000 to 42,000 communications satellites. What might this mean for shipping communications?

Elon Musk's spaceship company SpaceX is launching tens of thousands of small communications satellites to form a constellation called Starlink. You might be wondering what it means for shipping.

This article is an attempt to bring together some of the commentary and facts to put together a picture. But please note that very little information has been released about the company's market intentions, so there is a lot of conjecture in this article.

SpaceX was founded in 2002 by Elon Musk, with a goal to make it possible to colonise Mars. The satellite constellation

is something it thought it could launch additionally, at a cost of just $10bn (2018 estimate).

By owning its own rockets, SpaceX can launch a satellite constellation much more cheaply than other satellite companies, who have to make a contract with a separate rocket launching company.

SpaceX's plan is to launch 60 satellites every 2 weeks from early 2020, starting on Jan 7 and Jan 24, 2020. It follows 2 x 60 satellite test launches in May and November 2019, and 2 test satellites launched in February 2018. 60 satellites can be launched at once from the company's "Falcon 9 Block 5" rocket.

At this rate of launching, it will have enough satellites in the sky to start offering a service in mid-2020, and for global coverage by the end of 2020 (after 24 launches), and 12,000 satellites to be deployed by mid 2020s, providing more and more capacity.

The company said it was developing a new rocket called "Starship" which could launch 400 satellites at a time.

Other than that, there isn't a lot of public information about Starlink. We know about the launches, we know

about the filings made with the various regulatory bodies, and there is the odd tweet from Elon Musk.

But then, there's an enormous amount of commentary on the internet about what it might be, what it might offer, and if it might work financially. Some of this commentary comes from highly knowledgeable and well-placed sources, including the former president of the Mobile Satellite Users Association; a NASA engineer who formerly worked on Hyperloop One; and a University College London Professor of

How the SpaceX "Starship" prototype Mk1 rocket might look

Networked Systems. Some links to expert blogs and videos are at the bottom of this article.

For shipping

A first point to consider - from shipping's point of view - is that data to and from satellites goes in straight lines.

This is fine for geostationary satellites, such as those operated by Inmarsat, which are 35,786 km from mean sea level. The data can go from the ship to the satellite and back to the ground station, and reach a ship in the middle of the Pacific.

But for low earth orbiting satellites like SpaceX (or Iridium), the satellites are too close to the earth's surface for the communications to go from ground station to satellite to ship in one hop, if the vessel is far out at sea.

Iridium solved this problem with a complex system for sending data from satellite to satellite. But Iridium does not operate at gigabyte bandwidths. Its maximum speed is 704kbps.

SpaceX has announced plans to build a system for communications from

one satellite to another by laser. Laser based communication is already used on spacecraft.

In an October 2019 interview, CEO Gwynne Shotwell said, "By late next year, we'll be flying satellite with lasers that allow them to talk to each other in space and share data, which ensures customers will never lose service".

But this laser-based system does not exist on the satellites being launched during 2020. Whether this will set-back the systems' applicability for shipping for a year, or longer, will depend on how successful SpaceX is at developing it.

It does sound quite tricky technically to have a laser on one moving satellite pointed with complete accuracy to another moving satellite, but it may be feasible.

Without intra-satellite communications, the service can only work within a certain distance to a base station. We can calculate this distance using trigonometry and the angle of elevation.

In a March 2017 FCC filing, SpaceX said that its constellation was designed to provide service at "minimum operational

elevation angles of 35 degrees", in order to minimize the effect on terrestrial systems.

If the satellite is 340 miles above the earth, and the minimum elevation angle from the ship to the satellite and back to another base station is 35 degrees, we can calculate there must be another ground station within 970 miles for it to work.

An alternative is that SpaceX builds its own base stations in the ocean. If a customer satellite terminal can also act as a base station, taking data from one satellite and transmitting it to another, these base stations could be the satellite terminals fitted on ships of other SpaceX customers.

Or SpaceX could position its own ships across the ocean as base stations, which sounds ambitious until you remember this is a company which built its own rockets.

The same issues would apply if providing services to aviation over the sea.

Another issue to consider is how maritime satellite communications services today involve much more than airtime. Supplementary services offered by maritime satcom providers include separate accounts for crew members, e-mail, cyber security

services, technical support and software.

Also Inmarsat and Iridium communications services come backed with a safety guarantee (in order to be accepted as GMDSS equipment), and reliability of data transmission can be more important than the price.

So it may require more than much lower cost airtime and faster speeds to encourage shipping companies to switch away from traditional providers.

Main markets

But also bear in mind that SpaceX has never shown any interest in the maritime market.

It has not said anything much in public, but comments from the CEO last October hinted that the market they have in mind initially is US customers in remote places, who often still pay $80 a month for fairly poor quality broadband delivered through cables.

Another anticipated market is "backhaul" internet traffic, replacing fibre optic cables.

Providing satellite communications services to this market does sound plausible, if SpaceX can install a base station across the terrestrial US every 970 miles. The base stations do not need connection with fibre optic cables, they just need to have power to receive signal from one satellite and send it up to another.

Ground stations

Another question is the cost of the user terminals, the device which customers install to send and receives data to and from the satellites. Elon Musk tweeted in Jan 2020 that it looks like a "UFO on a stick" – which users would just need to plug in and point at the sky, with no training required.

Experts have said it is probably a phased array antenna, a device which monitors the location of satellites and sends data communications directly to them, as they move.

SpaceX has said it believes the device can be made for $200. News agency CNN interviewed Bill Milroy, chief technology officer of US antenna maker ThinKom, which makes computer controlled phase array antennas. He said that if he was asked to make user terminals as cheaply as possible but at large volumes, it might be possible to get the cost down to $1000 each.

Mark Handley from University College London, has speculated that the user terminals could be ground stations themselves, handling data from other customers, not just their own. The data

Aerial view of the SPACEX headquarters and rocket manufacturing building in Hawthorne, California, USA.

would be sent from a satellite to a user terminal, and then up to another satellite.

The initial terminals are being made by SpaceX itself.

Direct-to-customer

The communications services are likely to be sold directly to customers, similarly to how Elon Musk's Tesla cars are sold to customers directly. Although in some countries, regulations will require that the service is offered through local telecom companies.

The company will be hiring a whole workforce for sales, technical support and product engineering, looking in particular at user terminals.

It may initially target US customers who are paying high fees for poor quality broadband. CEO Gwynne Shotwell mentioned "millions of people in the U.S. pay $80 per month to get "crappy service."

Any customer with access to reasonably fast broadband is probably not going to be interested in this - whether cabled or via fast cellular. So it will probably not be of interest to customers who have good broadband or cellular coverage.

Other issues

Other issues commentators have raised is the challenges with the "very low earth orbit" altitude, because there is atmospheric drag, which would normally result in a short lifetime for the satellite. The information about SpaceX's technology for this has not been made public.

To handle the "space debris," the

company announced in late 2017 that satellites nearing the end of useful lives (5-7 years) would move into a 'disposal orbit', and re-enter the earth's atmosphere.

SpaceX has a contract for $28m with the US Air Force Research Laboratory, to test way that the services can be used for military.

The company is also in a race with other companies planning similar constellations, including OneWeb.

Online material

Mark Handley
https://youtu.be/m05abdGSOxY
Mark Handley, Professor of Networked Systems in the Department of Computer Science of University College London, shares ideas on how the ground communication might work.

Tim Farrar
A past president of Mobile Satellite Users Association shares ideas on how the finances might work and how many customers might be needed for viability
http://tmfassociates.com/blog/2019/12/12/reality-and-hype-in-satellite-constellations/

Casey Handmer
A software systems architect with NASA Jet Propulsion Laboratory and former engineer with Hyperloop gives his ideas on the cost and financial viability
https://caseyhandmer.wordpress.com/2019/11/02/starlink-is-a-very-big-deal/

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