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HUMAN FACTORS IN MARINE CASUALTIES

ABSTRACT

Human factors play an important role in the origin of accidents, and it is commonly claimed that between seventy and ninety-five percent of industrial and transport accidents involve human factors, see Figure 1.

Some authorities, however, claim that ultimately, all accidents involve human factors.

KEY WORDS

marine accident, human factor, organisational factor, attention, memory

1. INTRODUCTION

Before we can start to understand why accidents happen, we need first to understand a little about human limitations. An area of human factors, which has received a great deal of interest, is human cognitive abilities and limitations. This includes constructs such as attention, memory, decision-making, action, skilled performance, and stress. Greater understanding of this area enables us to reduce errors and accidents caused by technology. It also helps investigators understand how accidents happen and assists in determining suitable recommendations.

2. ATTENTION

Attention is such a fundamental fact of life that we may not even be aware of how our attention works and what the limits to attention are. For example, what is occurring when, whilst conducting your own conversation you become aware of another conversation on the other side of the room, once you hear your name mentioned? How is it that people who live near a railway line may no longer hear the trains go by? What happens when a taxi driver must simultaneously drive in heavy traffic, enter information into the base computer, and deal with complaining passengers? And why is it that sometimes when we are concentrating on a television program, we do not hear other people talking to us?

A "booming buzzing confusion" of sensations is available to our senses. You are probably not aware of the feel of your feet in your shoes, or the sounds happening outside. Obviously, we must be able to focus in on what is important to us at the moment and screen out the irrelevant information. It is as though we have a flashlight beam, which we can shine on only one area at a time. The problem is that there will be times when there is too much important information coming in for us to cope with all at once, or we will miss information which is outside our attentional "beam of light". Or perhaps our attention will stray onto distracting information like financial concerns or physical discomfort.

Psychologists have come up with diagrams to explain how our attention works, and although there are some differences between different approaches, there are also some points of agreement. It is agreed that there is a finite limit to the amount of information that can be processed at any time, and that we have a bottleneck in our information processing system, allowing only a limited amount of information to squeeze through to consciousness at a time. In this sense, our information processing system is sequential rather than parallel. When we feel that we are consciously attending to several things at a time, such as monitoring a radio and holding a conversation, we may in fact be rapidly switching our attention from one to the other.

Obviously, the limits of attention do not prevent us from doing more than one thing at once; we can drive

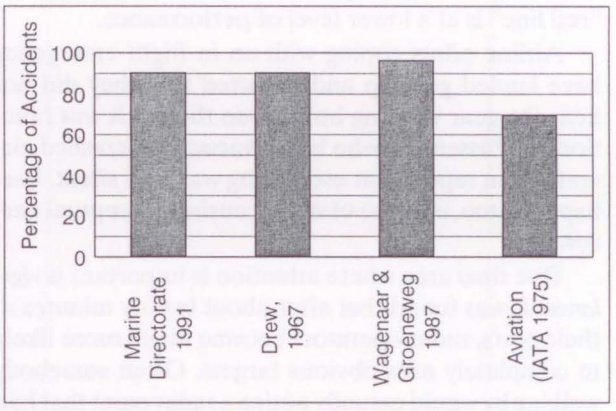

Figure 1 - Contribution of Human Factor in Accidents

a car and talk at the same time. But this is because well-learned skills like driving become increasingly automatic and hence demand less and less of our attention. One of the consequences of the limits on our attention is that individuals have a "red line" on their ability to process information.

For example the Three Mile Island accident occurred when operators failed to diagnose the reason for loss of coolant from the reactor. This may be because more than 100 control panel alarms were activated with no means of suppressing the unimportant ones.

Faced with an overload of information, a person can respond in a number of ways:

Load shedding is when a person ignores some of the information and concentrates on one or two aspects of the situation.

An extreme form of load shedding is ***channelled*** attention, in which the individual gives all of his or her attention to only one aspect of the situation.

Another coping mechanism for overload is ***Regression***. Regression is the effect where an overloaded individual goes back to a previously well learned pattern of behaviour. Under stress and information overload, individuals may revert to familiar, automated behaviour.

The limits of attention do not apply just when someone is severely overloaded. Even a moderate mental workload can reduce an individual's capacity to deal with new information. NASA studies have shown that if pilots attempt to perform a listening/identification task at the same time as a visual tracking task, their eye movements can be reduced by up to sixty percent. A listening task will also cause an individual's peripheral vision to be less effective, almost as though they were wearing blinkers. Visual field narrowing, as this effect is known, has obvious implications for traffic scanning.

Stress, as well as information overload can also cause some cues to be filtered out. A person under stress has less capacity to deal with information; the "red line" is at a lower level of performance.

Airline pilots coping with an in-flight emergency have landed gear up and reported that they did not hear the gear warning horn, even though it was functioning. Passengers who have evacuated a crashed aircraft often report that everything was very silent. Perhaps this too, is a case of stress causing perceptual narrowing.

One final area where attention is important is ***vigilance.*** It was found that after about twenty minutes at their posts, radar operators became much more likely to completely miss obvious targets. Often somebody walking by would casually notice a radar paint that had been missed by the operator, even though he or she was intently concentrating on the screen. This problem, known as the *vigilance decrement,* applies to many monitoring tasks where *"hits"* are relatively rare.

Aircraft inspection, the checking of medical X-rays and quality control inspection in factories are all areas where vigilance decrements may occur. Vigilance can be improved by increasing the conspicuousness of the signal and increasing the number of rest breaks or the variety of work. Vigilance is also often better in a more social atmosphere, perhaps because it keeps people more alert.

To summarise the main points concerning attention: Individual's limited capabilities of information processing can be easily overloaded and can result in *load shedding, channelled* attention or *regression* to ingrained but inappropriate skills.

The capacity to process information can be further reduced by stress, fatigue and lack of currency. Any conscious task can occupy attention and block out other information. This includes thinking, daydreaming and worrying.

Novel or difficult mental tasks can cause narrowing of the visual field. However, well-learned skill routines take up less mental capacity than routines that are less polished. Tasks requiring intense vigilance will suffer after approximately 20 minutes.

3. MEMORY

We often talk about memory as though there is only one sort of memory whereas in fact we have a number of memory systems, each adapted to a different purpose. We remember new telephone numbers just long enough to dial them. Other information must be remembered for years.

If memory worked perfectly all the time we could ignore it. Our interest in memory stems from the problem of forgetting. Just as there are different types of memory, so there are different types of memory lapses. Such as:

- forgetting a name but recognising it as soon as it is mentioned;
- filling the gaps in our memories with logical expectations;
- assuming that the information retrieved is correct when in fact it is the wrong information;
- blending memories together to come up with an answer that is half right; or even forgetting something entirely!

3.1 Sensory store

The first stage of information processing is the short-term sensory store. This store enables us to hold information momentarily before it is processed further. The two most important sensory stores are

echoic memory and iconic memory. Echoic for sounds, and iconic for images.

3.2 Iconic memory

The sensory store retains a brief trace of the stimulus after the stimulus has disappeared. For example, children commonly write in the air with sparklers, making use of the momentary image left after the sparkler has moved on. You can time how long the iconic trace lasts by placing a light on a wheel at night and rotating the wheel. If you measure the speed of revolution of the wheel at the point where a continuous circle of light begins to break up, you have measured the duration of iconic memory. Information in iconic memory lasts for between 0.5 and one second. Iconic memory enables you to glance at an instrument and mentally scan it after your eyes have moved on.

3.3 Echoic memory

Echoic memory lasts a little longer than iconic memory, in some cases up to eight seconds. It enables us to hear a message and briefly put off listening to it until we have finished dealing with other information. For example, half of a radio message may have passed before you hear your name and realise that it relates to you. Echoic memory enables you to mentally "replay" the message and go back over the initial bit that you were not attending to.

3.4 Interference in Echoic memory

Like all forms of memory however, echoic memory can let us down. Each sound in a string of sounds can interfere with the preceding sounds. For this reason, the final word in a string of words has a better chance of being recalled than a word from the middle of the message. Unnecessary radio transmissions at the end of a message (such as "over") can potentially mask out part of the echoic trace of the preceding message.

3.5 Short-term memory (STM)

Sensory memory lasts for a few seconds and decays very rapidly. But there is another form of temporary memory that is more durable and enables us to keep several bits of information in mind at once. This is the working memory or short-term memory. When you look up a phone number and keep it in mind until you dial it, you are depending on short-term memory. Mental arithmetic is another situation where we have to keep several items stored in memory until we have found the answer.

Short-term memory is not necessarily limited by the time that items are stored, because by saying them over and over (rehearsing them) we can store something for a long time. Short-term memory is limited by the number of items that can be held. Common way of checking the capacity of short-term memory is *the digit span test.*

The digit span test was first conducted by Jacobs (1887). A sequence of numbers is read aloud in no particular order. After the sequence has been completed, the listeners are asked to write down as many as they can remember. In general, people can store between five and nine unrelated items in short-term memory. The average is around seven, and the capacity of short-term memory is sometimes called **"seven plus or minus two".** This limitation is tremendously important, particularly when receiving important information which is transitory (such as auditory information) which must be momentarily kept in memory before they are acted upon.

However, it is possible to increase the capacity of short-term memory by chunking information together. Such as encoding a string of numbers as dates instead of single digits e.g. 1914 2000 1988. Or for example, the Russian chunk telephone numbers into three large numbers rather than six digits e.g. ninety six, twenty seven, thirteen for 962713.

Short-term memory seems to depend on verbal rehearsal, so if you are told to call on 123.9 just as you are about to do something else, you may repeat 123.9 to yourself under your breath. Without this sort of verbal repetition, short-term memory decays rapidly. But verbal repetition has some important implications for short-term recall.

First, similar sounding items are likely to get confused with each other. For example the letters t, p, v, and d, all sound similar and therefore may interact with each other and influence the way any of them are rehearsed and consequently remembered.

Furthermore, items of information containing common or redundant elements are also likely to be confused, for example, A123, A734, A391 are harder to remember than just 123, 734 and 391. Having to talk or pay attention elsewhere will disrupt the short-term store. In addition, if items must be retained in short-term memory, it is better if the information is distributed over time rather than received all at once.

Finally, we should not forget that the capacity of short-term memory decreases with age.

3.6 Long-term memory

A small proportion of the information that passes through our short-term memory finds its way into long-term memory. Unlike short-term memory, there is no limit to the amount of information we can store in long-term memory. There are two types of long-term memory. Episodic and semantic.

3.7 Episodic

Episodic memory is the recall of specific events or episodes such as a particular voyage or a day's events. A limitation of episodic memory is that it is easily distorted after the event. For example accident investigators often find that the way they ask questions of a witness can easily change the witness' recall of events. In an interview, terms like **breeze,** may tend to encourage recall of the weather as milder than was experienced. Whereas the word **wind** may elicit recall of stronger weather conditions. Episodic memory for events in time is also notoriously unreliable. For example, witnesses sometimes recall an event that lasted thirty seconds as lasting for much longer or even reverse the order of events.

3.8 Semantic

Semantic memory is where we store our abstract knowledge of meanings, relations and the mental frameworks we use to understand the world. Semantic memory appears to be a permanent record.

Once you have learned about meteorology or how turbine engines function, that knowledge is there for good. This is not to say that information is always easy to retrieve!

Semantic memory relies heavily on associations between memories, or memory cues for retrieval. This is why when we lose our car keys, it helps to go back to where we last had them. The sights, smell and sounds of the place will help us get access to the information in our memory. This principle has wider applications than just looking for keys. In general, the more associations a memory has, the easier it will be to recall. Another result of this is that it will be easiest to recall information in the same environment in which it was learned.

Information learned in a classroom will be recalled most easily onshore and things learned on a ship will be best recalled in that environment.

Bad memory is often a sign of poor organisation and failure to link the information to the existing knowledge.

It is a general principle that the more mental work we do at the time of encoding in memory, the better our memory will be. For example, you will remember more of any lecture if you have actively thought how the principles apply to your own company than if you have simply listened attentively.

What we are talking about here is essentially learning. It is sometimes assumed that people learn better under stress. Although everyone is different, in general, stress hampers learning.

4. DECISION-MAKING

The history of accidents and disaster is frequently the history of wrong decisions. The charge of the Light Brigade, the sinking of the Titanic, Amoco Cadiz, the Challenger space shuttle accident and any number of groundings and collisions are all examples of disasters which resulted in part from poor decisions. More often than not the people who made these decisions were properly trained and had all the necessary information available to them, but for some reason persisted in making a poor decision.

Poor decision-making also accounts for a large proportion of accidents at sea, as indicated in Table 1.

So apparently, any attempt to cover human factors must consider decision-making, and try to answer why properly trained and usually extremely experienced individuals, sometimes make poor decisions.

Unfortunately, the idea that people make rational decisions by carefully weighing up the information and considering all the possibilities has been shaken in recent years. We have learned that when people make decisions, they frequently allow emotional factors to influence their decisions, they do not consider all the alternatives or they take labour-saving mental shortcuts to arrive at solutions.

Table 1 - Human Errors in 100 Accidents at Sea

Category of Error	No of Accidents
False Hypothesis	51
Habits	46
Decisions	35
Training	35
Personality	35
Ergonomics	34
Social Pressure	17
Stress	17

Source: Wagenaar and Groeneweg 1987

People do not passively observe the world around them in the way that a camera forms an image.

When we perceive an object or experience a situation we do so within unconscious mental frameworks, which influence our understanding of what is going on. For example, if I said *"the notes were sour because the bag burst"* you would probably have no idea what I was talking about, although you might try a few mental ideas to attempt to explain what the sentence is about.

But if you knew that the sentence was about bagpipes you would have a context which would allow the sentence to make sense. People have a very strong tendency when they experience something new to try and slot it into a familiar context. It is as though we hate being put off guard by something unfamiliar and only

relax when we have recognised it as something which we have encountered before. Inappropriate mental models can distort decisions just as surely as they can distort perceptions.

4.1 False hypothesis

Psychologists sometimes talk of the "strength of an idea", meaning the way in which an idea, once formed, can become very resistant to challenge, even when information is available that would contradict the idea. In a very short time, an idea can become firmly entrenched. For example: On 14 December 1982 the seven hold bulk carrier *Farmsum* was engaged in hold cleaning. Four men were in number six hold. No. 4 hold was ballasted, No. 5 hold was meant to be empty with men working in No. 6 hold, which had some residual water in it. However, no suction could be obtained. Water was being lost from No. 4 hold. The mate found that the ballast valve on No. 4 was stuck open. The mate assumed that this accounted for the loss of water from No. 4 and the inability to get suction in No. 6. In fact No. 4 was leaking into No. 5. The water being pumped into No. 4 in fact also filled No. 5 until the bulkhead, which was not designed to withstand the pressure of ballast, failed. Three of the four men were drowned.

False hypothesis is very common with radio work, particularly when we expect to hear a particular phrase. For example, the world's worst air disaster occurred when the Captain of a KLM747 at Tenerife apparently believed that he had received a take-off clearance when in fact none had been issued. Despite rather mild challenges from his crew, the captain held on to this idea and attempted to take off while a Pan Am 747 was still on the fog-covered runway.

To sum up this issue of the false hypothesis, in ambiguous situations, we tend to be uncomfortable with uncertainty- and have a strong tendency to latch on to an explanation or an idea. Common scenarios or ideas have a strong tendency to become default assumptions. This is particularly the case when: expectancy is high, at times of diverted attention, when the assumption is a comforting thought, or after a period of high concentration.

Many sources of information are quite unreliable, for example, a message heard through static, or an instrument reading that is notoriously unstable. Other information sources are very reliable and unambiguous. But when weighing up the available information, people often treat all the information as if it were equally reliable.

Once we have a theory of what is wrong, we tend to search for information which will confirm what we suspect. People however, rarely attempt to disconfirm their suspicions and in fact, often disregard information which would contradict their ideas. An example of this is the expectations created by stereotypes. One final, interesting bias in thinking is the tendency when choosing between losses to often prefer a possible loss to a certain loss, regardless of the seriousness of the losses. In other words, to take a punt on the possibility of a large loss in preference to a certain minor loss. For example, a master may press on into bad weather although he knows his hatch covers are suspect and risking the complete loss of the ship, or turning back or avoiding the weather and facing the certain, but relatively minor, lengthening of the voyage. The master under these circumstances prefers possible disaster to certain inconvenience.

Two handy size bulk carriers grounded on the same reef within 18 months of each other. In both cases they were chartered to load grain at a major port in South Australia. However, both were diverted to a smaller port. Neither ship had charts of the port approaches. Nevertheless, both masters pressed on, instead of diverting to a nearby port to pick up the required charts. Both ships grounded on Tippara Reef in the Spencer Gulf.

5. AUTOMATED SYSTEMS

With simple systems, it is relatively easy to develop a mental conception to explain how it works and predict what the effect of your actions will be. But with increasing levels of technology, the human operator's understanding may lag well behind the capabilities of the system and in fact the individual may have a mental concept of how the system works which is adequate only when the system is operating normally.

There are other potential problems with automation. For example, there is the fear that people may lose their skills or may become complacent about the reliability of automated systems. Humans are notoriously bad monitors. And yet, automation is increasingly putting the individuals into a monitoring role for which they are poorly suited.

6. ACTION AND SKILLED PERFORMANCE

The activities of an individual can basically be divided up into three types of actions.

Knowledge-based actions, rule-based actions and skilled behaviour.

6.1 Knowledge-based behaviour

Knowledge-based behaviour is required when there is no pre-packaged solution to a situation. The individual must think out a response using his experi-

ence or knowledge. Knowledge-based behaviour tends to be slow and very demanding of mental resources.

In effect, knowledge-based behaviour is about thinking or decision-making, often in unfamiliar situations.

6.2 Rule-based behaviour

We use rules constantly in everyday life, without necessarily being aware of them. These rules are often procedures we have learned through trial and error and then applied to situations in an "if-then" manner. For example, if the dipstick in you car indicated that the engine oil is low, then you would top up the oil.

Although it is a conscious process, it does not require you to go back to first principles in the way that knowledge-based behaviour does. People constantly apply rules, many of them formally laid down procedures.

6.3 Skill-based behaviour

Skill-based behaviour is different to knowledge--based and rule-based actions because it is unconscious, it is rapid, it is seemingly effortless and most importantly it is automatic. Proficient drivers control their vehicle without having to consciously dwell on every movement of the steering wheel. Drivers can change gear, steer and work the accelerator without giving it a moments thought because these skilled actions have become automatic. Every person has an astounding repertoire of skill routines which they can consciously initiate and then leave to run their course.

The automatic nature of skill frees us to think about other things, but the cost of this automaticity is that we monitor what we are doing less.

Another problem is that skilled operators are generally unaware of the automatic procedures they are following and may be unable to explain how the skill is performed.

6.4 Skill acquisition

The knowledge, rule, skill distinction is also helpful in explaining how we acquire skills. Typically we begin in the knowledge stage, by knowing what we must achieve but having no pre-packaged routines to help us. Driving a car for the first time takes an enormous amount of mental effort as we consciously think about moving the steering wheel and applying the brakes, etc. As we become more familiar, rules begin to take over, such as "if the speedometer goes over sixty, take your foot off the accelerator, if the car doesn't slow down, apply brakes". But with time, all the control processes become mentally automated and we have spare capacity to talk with our passengers and listen to the radio.

7. ERRORS

One of the most useful aspects of the Skill-Rule--Knowledge distinction is that it helps to explain why errors occur and to predict the types of errors that will occur under various circumstances.

Some errors (slips) are typical of skilled performance, other mistakes occur with rule-based performance and other errors are typical of knowledge--based behaviour.

One of the most common skill errors is sometimes called "environmental capture" or habit intrusion. This occurs when you are performing a well learned action in familiar surroundings, but your routine action is no longer appropriate because the environment has changed. If you then fail to make an appropriate attentional check, you may find that you have executed the well learned action without modifying it to the new or unusual circumstances. A common example is filling in a form in January and, when dating it, writing in the previous year.

This sort of error is seen in the marine field when a pilot or master slavishly follow set pilotage directions, even when the ship is out of position. (Sea Empress)

Another common skill error is the "Omission following an Interruption". If a well-oiled routine is interrupted, it may never be completed, or may be picked up again at the wrong stage.

One of the most dangerous manifestations of this in the marine field is the interrupted position fix.

One of the final aspects of skill to mention is the speed accuracy trade off, in which errors become more likely when time pressure exists.

8. STIMULUS-RESPONSE COMPATIBILITY

Stimulus-response compatibility refers to the effect where the speed and accuracy of a response are related to the physical arrangement of the display and the control. For example, an arrangement where the display for the left engine is on the left and that for the right is on the right is more compatible than one where the arrangement is reversed.

9. RISK

Weighing up risks is an important part of decision-making. Although risk will always be a part of life, people sometimes underestimate risks.

We are particularly likely to underestimate risks when we have had a long stretch without an incident or accident, when someone else has succeeded despite the risk (the 'follow the leader' syndrome or "we know its wrong but we've always done it/got away with it) and when we are excessively focused on the goal. One final warning is that we tend to take more risks when we are under emotional stress brought on by life events such as marriage problems or financial worries. For example it has been found that people who are facing high levels of life stress are less likely to bother wearing seat belts in cars.

10. STRESS

The term "stress" encompasses a number of quite different human factors issues. While there is no universally accepted definition of what stress is, a reasonable working definition is that "stress is the body's response to stressors". It is important to distinguish the stress response from the stimulus or "stressor" which triggers it.

There are environmental stressors such as noise and heat, task stressors such as demanding, time pressured tasks, and there are life event stressors such as financial uncertainty and domestic worries. Different stressors can lead to different stress problems.

Life event stress resulting from significant life events such as divorce, financial worries and the like, can reduce general wellbeing and increase the susceptibility to some illnesses (Table 2).

People who are experiencing such events may be distracted by intrusive thoughts, particularly when workload is low. In addition, people who are experiencing life stress may take more risks than they otherwise would. US research has found evidence that Navy pilots who had accidents were likely to have had a higher level of "life events" in the months preceding the accident than pilots who had not had accidents.

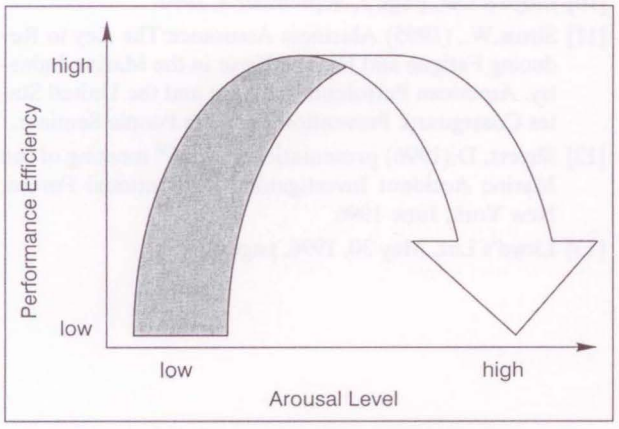

Figure 2 - Inverted U Curve: Performance versus Arousal

Table 2: Social Adjustment Rating Scale

Life Event	Life-change value
Death of spouse	100
Divorce	73
Marital separation	65
Jail term	63
Death - close family member	63
Personal injury or illness	53
Marriage	50
Sacked	47
Marital reconciliation	45
Retirement	45
Health change - family member	44
Pregnancy	40
Sex difficulties	39
Gain of new family member	39
Business readjustment	39
Change in financial state	38
Death of a close friend	37
Change in line of work	36
Foreclosure of mortgage	30
Change in work responsibility	29
Son or daughter leaving home	29
Trouble with in-laws	29
O/s personal achievement	28
Wife begins or stops work	26
Begin or end school	26
Changed living conditions	25
Revision of personal habits	24
Trouble with boss	23
Change in residence	20
Change in school	20
Change in recreation	19
Change in church activities	19
Change in social activities	18
Change in sleeping habits	16
Change in eating habits	15
Vacation	13
Christmas	12
Minor legal violations	11

Source: Holmes and Rahe (1997)

Task stress, or acute stress arises when the demands of the task approach or exceed the capabilities of the person. An individual coping with an emergency may be affected by task stress. An important idea related to task stress is the "inverted U curve", as illustrated in Figure 2. According to this idea, performance is best when the person is moderately challenged by the task. Too little challenge, (resulting in boredom) and too much challenge, (resulting in panic) both result in poor performance. So, a moderate level of task stress can be quite helpful.

11. CONCLUSION

Approximately 80% of marine casualties have root causes in human and organisational elements. The vast majority of these accidents occur during system operations.

Ignorance and pride combined to doom the Titanic and 517 of her passengers in 1912. These two human failures are still central to the now officially recognised role of the human element in marine casualties. In fact, they continue to dog the maritime world as control systems become more complex, rules and regulations more complicated and management / organisational practise more Byzantine.

If substantial improvements are to be made in marine safety, challenges concerning human and organisational elements in design, construction and operation of the system must be addressed, at least so well as one has learned to treat technical aspects.

POVZETEK

ČLOVEŠKI DEJAVNIK V POMORSKIH NEZGODAH

Za predstavitev problema identifikacije in analize varnosti pomorskega prometa in s tem varnosti okolja, vključojoč povezovanje človeških in organizacijskih faktorjev, je potrebno analizirati pomankljivosti verjetnostnih podpornih varnostnih analiz in same metodologije analize pomorskih izpostavljenj nevarnostim, ki jih običajno uporabljamo za identifikacijo nevarnosti.

V primerih, kjer se nezgodnji scenariji gradijo preko majhnih napak in odpovedi, tako na tehničnih kot na človeških sistemih, se je prejšnje prepričanje izkazalo za napačno. Prišlo je do spoznanja, da je potrebno kompleksne sisteme obravnavati kot sociotehnološki sistem in opazovati kako tehnološki in človeški in organizacijski sistem sodelujeta oziroma se povezujeta.

Izpostavitve nevarnostim so v povezavi s človeškim in organizacijskimi faktorji izpostavljene občasnim napakam, ki tako ali drugače vplivajo na okolico. Večina takšnih napak se konča brez večjih posledic, nekatere pa imajo lahko večje posledice za ljudi in okolje. Napakam se ne moremo povsem izogniti, vendar pa lahko preprečimo ali zmanjšamo njihove posledice za ljudi in okolico.

LITERATURE

[1] The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended in 1995, Chapter VIII. Section A-VIII/1

[2] NUMAST (1997). Give Us a Break. A report on the results of a survey of the hours of work undertaken by members of NUMAST 1997

[3] STCW Convention. Regulation VIII/1

[4] Incidents At Sea No. 63 (1994). Departmental Investigation into the structural damage sustained by the tanker *Osco Star* at the port of Kwinana, W.A on 19 January 1994, MIIU.

[5] Incidents At Sea No. 66 (1994). Departmental Investigation into the sinking of the off-shore supply vessel *Boa Foirce* on Saladin No. 3 wellhead off Thevenard Island, Western Australia on 24 February 1994, MIIU.

[6] Incidents At Sea No. 79 (1995). Departmental Investigation into the grounding of the German flag container ship *Carola* on South Ledge Reef on 30 March 1998. MIIU.

[7] Incidents At Sea No. 82 (1995). Departmental Investigation into the grounding of the Danish flag ship *Svendborg Guardian* south of Murdering Point, Quee0nsland on 24 June 1998, MIIU.

[8] Incidents At Sea No. 95 (1997). Departmental Investigation into the grounding of the Panamanian flag refrigerated cargo vessel *Peacock* on Piper Reef, in the Great Barrier Reef, on 18 July 1996. MIIU.

[9] Incidents At Sea No. 116 (1998). Departmental Investigation into the collision between the fishing vessel *Exterminator* and the Liberian tanker *Unisina* off the south coast of NSW on 25 April 1997, MIIU.

[10] Lloyd's List, page 3, September 4, 1997

[11] Sirois,W., (1995) Alertness Assurance:The Key to Reducing Fatigue and Human Error in the Marine Industry. American Petroleum Institute and the United States Coastguard. Prevention Through People Seminar.

[12] Sheetz, D.(1996) presentation at the 6th meeting of the Marine Accident Investigators' International Forum, New York, June 1996.

[13] Lloyd's List. May 30, 1996, page 8.