MARINE ACCIDENTS: PRESENT TRENDS AND A PERSPECTIVE OF THE HUMAN ELEMENT

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Introduction

This paper briefly reviews shipping casualty trends within the world trading fleet, with an emphasis on tanker casualties, and shipping accidents within the Great Barrier Reef (GBR). It then discusses a view of the human element in industrial accidents, that is gaining currency in high hazard/low risk industries, such as aviation and the nuclear power industry.

Many hazardous cargoes are transported by sea. Despite incidents such as the collision between the *Olau Britannia* and the *Mont Louis*, about twelve miles off the Belgium coast in August 1984, when the *Mont Louis* sank with 450 tonnes of uranium hexaflouride, casualties to oil tankers are the most visible and their cargo, if spilt, the most obvious. Yet it can be argued that oil spills, while having very serious consequences in the short term, are often not the catastrophe that first impressions and reactions would have us believe. Public perception seems to equate oil tankers with risk and this paper will tend to be orientated toward tanker accidents.

Accidents, including marine accidents, are random events, which can not be predicted in time or space. Yet, accidents seem to come in series (or form groupings) within the human consciousness, thereby creating a greater impact.

The tanker *Haven* exploded off Genoa on 11 April 1991, killing two crew members, and on the same day, just 90 miles away, off another North Italian port, Leghorn, the ferry *Moby Prince* collided with the anchored tanker *Agip Abruzzo*, loaded with 80,000 tonnes of naphtha, resulting in 142 deaths and pollution.

The *Aegean Sea* (Corruna, Spain, December 1992), the *Braer* (Shetlands, January 1993), and the *Freja Sea* (Teesport, UK, February 1993) occurred within weeks of one another.

Five incidents, the *Exxon Valdez* (March 1989); the *Khark V* and the *Aragon* off Morocco and the Canary Islands respectively (December 1989); the *American Trader* off Huntington Beach, California (February 1990); and the *Mega Borg* in the Gulf of Mexico (June 1990); occurred over a span of 14 months, yet appear to have formed a "cluster" of pollution incidents.

These groupings give rise to the fear that pollution incidents are common and that the risk to the environment is high. These fears are not entirely baseless, nor are they altogether rational.

In seeking a reason for these and other major casualties, and disasters (*Herald of Free Enterprise*, 193 dead, March 1987 - *Dona Paz*, 4,400 dead, December 1987 - *Moby Prince*, 142 dead, April 1991 - *Neptune*, up to 1800 dead, February 1993) current wisdom is that the acts or omissions of the master or crew of these ships are the dominant cause of the accident.

The World Casualty Rate

There is a general perception that the shipping industry is going through something of a safety crisis. However, I would argue that the weight of evidence does not support this perception.

In the 1991 Lloyd's Register Casualty Returns, the world fleet of trading and fishing vessels of over 100 gross tonnage was put at 80,030. Of that fleet, 258 vessels were declared as total losses during the year, the worst absolute figure since 1986, when the world fleet was 65,266 ships and 265 ships were totally lost (Figure 1).

Although 1991 was judged a "bad year" for shipping casualties, the loss rate was about the same as in 1988, at 0.32 per cent of the total fleet. Although a rise in absolute numbers over the preceding years, the actual number of ships lost was lower than all the years between 1965 (when 277 ships were lost from a fleet of 41,865) and 1987 when 219 ships were lost from a fleet of 75,240 ships. The loss of ships on a percentage of the total registered fleet had exceeded the 1991 figure in all the years between 1939 and 1987. Early indications are that the losses sustained in 1992 will be significantly lower than in 1991.

Vessels that are at greatest risk and make up the bulk of the losses are fishing vessels and cargo ships of under 1,000 gross tonnage. The statistics show that 1991 was no different, with small trading ships and fishing vessels accounting for 48.5 per cent of all losses.

The tanker fleet of 5962 ships represents 7.4 per cent of the world's registered ships. Thirteen tankers were reported as lost in 1991, giving a loss rate of 0.22 per cent of all tankers. The world tanker fleet contains a substantial number of small tankers, with 45 per cent of vessels being less than 1000 tonnes deadweight. Of greatest concern to us are the 1970 tankers over 30,000 tonnes deadweight, which make up 2.5 per cent of the world fleet (33 per cent of the tanker fleet). Eight of these large tankers were declared lost in the year, two through war damage. Six larger tankers or 0.3 per cent of the tanker fleet were therefore lost through "normal" causes.

The loss rate for larger tankers equates with the loss rate of the world's registered ships in general. It is possible to conclude that, on a pro rata basis, tankers are no more likely to be involved in a shipping casualty than any other type of ship. However, any resultant pollution is highly visible and the damage caused by oil, whether transient or not, raises public emotion, and the news media's circulation or rating.

It should be pointed out, that not all accidents result in a vessel being declared a total loss. *Exxon Valdez* was repaired and did not figure in the 1989 statistics. The bulk carrier *Atlas Pride*, lost much of its bow in August 1991 about a month after the *Kirki* incident, but was repaired; the *Kirki* was declared a constructive total loss and appears in the 1991 losses. However, total loss figures are a reasonable index of shipping casualties in general, against which accident trends may be measured.

Shipping Incidents Within the GBR 1983 to 1993

For the purposes of this paper the GBR is taken to include the Torres Strait and the system of Reefs and cays south to Sandy Cape.

While not "busy" on a world scale, some 2132 ships used the inner route in 1992, on passage between South East Asia (and the mineral ports of Weipa and Groote Eyland) and the east coast ports of Australia. This works out at between 5 and 6 ships per day. However, the pro rata rate of shipping accidents within the Great Barrier Reef Area has been relatively higher than other sea areas around the Australian Coast.

Some statistical figures suggest that the rate of collisions within the Great Barrier Reef is higher than that in the Dover Strait by a factor of 25 and that of grounding by a factor of

17.1[66] This is difficult to accept as a meaningful measure, given the significant density in traffic, the fact that the Dover Strait experience in four days the volume of traffic that the GBR may experience in one year. Other factors such as the depth, length and width of the passage together with the number of course alterations should also be taken into account.

The most significant grounding to occur in the area of the Great Barrier Reef was the *Oceanic Grandeur*, on 3 March 1970, when the loaded tanker grounded on an uncharted rock south of Alert Patches. This paper draws on incidents since January 1983(Table 1). None of the accidents within the GBR have resulted in the total loss of a trading ship, though some fishing vessels have been lost.

Since 1983, there have been twenty reported incidents in the GBR area involving trading ships. Of these twenty incidents, the Department has investigated fourteen. The six not investigated were on passage out of the area and the incident was referred to the flag state.

Two of the trading ships were tankers. The most significant of these was the unpiloted, loaded, Liberian tanker, *Mobil Endeavour*, which sustained bottom damage on Alert Patches while on passage from Singapore to the west Pacific in July 1986. It was of double hull construction and, although spaces below the cargo tanks were breached, no pollution resulted. The Liberian Authorities investigated the incident, suspended the master's certificate, recommended strongly that all Liberian flag ships should comply with the IMO resolution on recommended pilotage, and circulated the report and its recommendations at the IMO Maritime Safety Committee.

Of the 2132 ships passing through the inner route in 1992, 12.75 per cent were Australian flag vessels. The most common type of ship using the route are bulk carriers, with tankers making up 6.4 per cent of the traffic.

Leaving aside the qualifications of the pilot, seven of the twenty trading ships involved in reported incidents since 1983 were manned by navigating officers holding Australian certificates of competency. Given the proportion of Australian shipping using the inner route, Australian qualified personnel feature in a disproportionately large number of accidents.

Of the twenty incidents, there have been 13 incidents of grounding and seven incidents of collision with fishing vessels or yachts.

Accidents in the GBR predominantly take place during the hours of darkness, only four incidents have occurred in daylight, of the 16 that have occurred in darkness, 11 occurred between midnight and six o'clock in the morning.

Any marine accident in the GBR will almost certainly be a grounding or collision, which will take place in the hours of darkness. Collisions seem more likely to involve larger ships over 100m in length, perhaps suggesting that the manoeuvrability of the ship's themselves, and limitation on the depth of water, are factors. Otherwise it is difficult to find any common threat which might suggest a pattern that would help in predicting a typical GBR accident.

Of the 20 trading ships involved in accidents, seven carried pilots, but in only two of the incidents was the pilot in charge of the navigation at the time. Both accidents involving the pilots occurred during daylight hours, between 1700 and 1800, on Australian flag ships.

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66 Evanson,J.P. & Potts, A.E. 1990, Risk of ship collision in the Barrier Reef Inner Route shipping lane, Paper presented to Conference on Engineering in Coral Reef Region, GBRMPA and Institute of Engineers Australia, Townsville, November 1990.

In none of the accidents have the navigation aids within the reef area been shown to be deficient.

We are therefore thrown back to human error as the causal factor.

Some Considerations of the Human Factor

With a growing awareness of environmental issues and consumer rights, public tolerance of accidents in any field has decreased. This reduction in tolerance has been as marked in shipping as in any other area of commercial or government service to the public.

Nevertheless, there is a general trend to fewer accidents, although there is an argument that there has been an increase in "maritime disasters", what ever they may be. I prefer to refer to disasters when loss of life is involved, and then a substantial number of lives.

Better regulation, training and equipment all have played a part in improving marine accident figures. However when they do occur, the errors committed and the actions or omissions often seem so glaring that people are outraged that those in charge of ships are not in some way more accountable.

Current wisdom is that human error, attributable to the master and/or crew of a ship, has been responsible for over 80 per cent of all accidents. The Tavistock Institute of Human Behaviour, after analysing data from UK shipping incident reports, came to the conclusion that the human element was found to be present in over 90 per cent of all collisions and groundings and in 75 percent of all incidents involving contacts, fires and/or explosions. The report noted the response to such incidents was towards regulation and enforcement and went on to comment:

"These developments suggest that the sheer volume of safety related measures in the field of legislation and other rules and standards might be defeating the objective, and that an entirely new approach might in consequence be called for".

It does seem to those of us involved in investigating marine casualties, that at some stage there is a level at which accidents will level out, the "normal accident level". The Tavistock Institute seems to be suggesting that we may well be close to that level now. If this is true, and we are to continue to make shipping safer, we may need to look at human factors in a different light and borrow from a different transport mode.

"A report to the Flight Safety Foundation in 1986 claimed that mechanical failure preceded by faulty maintenance was the principal cause of air accidents (Foreman, 1990). In 1987, the chairman of the U.S. Transportation Safety Board (NTSB) told the press that bad weather near airports caused 64 per cent of major crashes in the preceding five years. The Lufthansa World Accident Survey (1989) found that cockpit crew errors were the prime contributor, accounting for 76 per cent of all causal factors.

Whom should we believe? In my view none of them."[67]

Professor James Reason, of the Department of Psychology, University of Manchester, went on to argue that failures in performance are not uncommon but only rarely do they cause accidents, although they are necessary elements.

Shipping is in general a (relatively) high hazard low risk operation.

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67 Reason, Latent Causes in Aircraft Accidents, p.2

"About 1.4 million tons of oil is moved annually by over 3,000 tankers over an average distance of 4,700 nautical miles. Only a very minute amount of oil is spilt, as 99.9995 per cent of all oil cargoes is delivered safely."[68]

The best managed and operated shipping company can not control all factors that make up an accident,
"In other words, "safe" organisations can still have bad accidents, while "unsafe" ones can escape them for long periods".[69]

Accidents are caused by a chance combination of elements coming together at a moment of vulnerability. These may be represented as the result of a number of causal chains simultaneously failing, or coming together to a single link, which is overloaded and breaks. The causal chains can also be seen to consist of both latent and active failures, which may be seen as separate but related elements in a production sequence. It has to be recognised that safety is an element of production, just as the output of goods or cargo tonne/miles. While the outputs can be measured directly in terms of monies earned or lost, safety has a measurable cost but its benefits are not easy to demonstrate directly and hard to quantify in any sort of cost benefit analysis when competing for finite resources.

So how should we be looking at accidents and what lessons should be learnt to improve safety?
"In considering the human contribution to systems disasters, it is important to distinguish two kinds of error: active errors, *whose effects are felt almost immediately, and* latent errors *whose adverse effects may lie dormant within the system for a long time,...."*[70]

Active errors can be seen to be the actions of the ship's crew leading up to and at the time of the incident. Latent errors may have their origins many years before, at the building of a ship or in some high level management decision, or at some lower level line management decision.

"Rather than being the main instigator of an accident, operators tend to be the inheritors of systems defects created by poor design, incorrect installation, faulty maintenance and bad management decisions. Their part is usually that of adding the final garnish to a lethal brew whose ingredients have already been long in cooking."[71]

Conclusion

Despite all that has been written in newspapers and stated at various conferences and in learned papers, the evidence is that the accident trends world wide are improving. By the very nature of accidents in general a zero level will never be reached and it is probable that we are approaching a level at which accident rates will form a plateau, possibly at about 0.2 per cent of the world's fleet.

However, with the possibility of serious and wide spread pollution from oil tankers and ships' bunkers, and the far more serious and long term risks in the transport of certain chemicals and radio active materials, society's tolerance of shipping accidents will continue to be severely tested. There will be demands for ever safer shipping, which in turn may involve special efforts in specific areas of maritime transport, as has been the case with tankers and gas carriers.

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68 Reason, Latent Causes in Aircraft Accidents, p.2
69 Reason, Latent Causes in Aircraft Accidents, p.2
70 Reason, J. Human Error, p.173, Cambridge University Press. 1990.
71 Reason, Human Error, p.173.

It may be possible to protect the GBR by local initiatives aimed at regulating and controlling shipping within the reef. That will not make the overall problem disappear.

It will be necessary for investigators to identify a variety of factors within the human element, as well as any mechanical factors that may be present. Regulators and operators will need to squarely face the issues of latent failures that contain the seeds of an accident, particularly in the field of ship management and human psychology.

In reviewing accidents in the GBR we know that the human element has been a dominant factor. On the evidence of Australian investigations, it is not possible to simplify the issue as one of sub-standard crew or ships, or to single out foreign certificates of competency as significant; Australian crew qualifications have been present in 35 per cent of the incidents since 1983.

Yet while people may have acted incompetently, it is difficult to point to an incompetent person - the most competent person is not competent all the time. Again in a number of cases it is possible to follow a path of latent failures that, combined with the psychological precursors and the actions or omissions of the individual, have come together to result in an accident.

One reaction to this approach is that it is a means of excusing the actions of those involved. This reaction may, in itself, be a means of avoiding the real issues. If society is to face up to the problems of any activity involving humans and significant risk, then we should be concerned with human risk analysis techniques. We do not have to excuse people their actions, but we do need to understand them fully, anticipate them and build defences to guard against them, to protect the oceans and seas of the world in general and the GBR in particular.

Table 1 TRADING SHIP GROUNDING AND COLLISION INCIDENTS GBR INNER ROUTE 1985 - 1992

VESSEL	FLAG	TYPE	DATE	PLACE	LENGTH	CARGO	POLLU -TION	PILOT ON BOARD
TNT Alltrans *	Aus	Grounding	Mar 85	Lady Musgrave Island	189	Bulk Carrier - Alumina	None	No
River Boyne / F.V. Babirusa *	Aus Aus	Collision	Jun 85	off Barrow Island	255 40	Bulk Carrier - Bauxite	None	Yes
Iron Cumberland / F.V. Saltfjord *	Aus Aus	Collision	Jun 85	Princess Charlotte Bay	190 30	Bulk Carrier -Ballast	None	Yes
Maritime Gardenia *	Lib	Grounding	Aug 85	Alert Patches - Prince of Wales Channel	128	Bulk Carrier - Wheat	Minor Oil Poll	No
Mobil Endeavour	Lib	Grounding	Jul 86	East Bouy - Prince of Wales Channel	171	Petroleum Products	None	No
Alam Indah *	Lib	Grounding	Sep 86	Chapman Is Reef	142	General Cargo	None	No
Ruca Challenge *	Cyp	Grounding	Apr 87	Piper Reef	80	Bulk Carrier - Potassium Nitrate	None	No
River Embley *	Aus	Grounding	May 87	Alert Patches - Prince of Wales Channel	255	Bulk Carrier - Bauxite	None	Yes
Leichhardt *	Aus	Grounding	Dec 87	Endeavour Strait	64	Ro/Ro	None	No
Pacific Ace	Pan	Grounding	Aug 88	Waterwitch Reef	154	Bulk Carrier	None	No
Spartan II / F.V. Unknown	Pan Aus	Collision	Jan 89	off Eel Reef	300 53	Supply Vessel	Nil	No
Adele	Dan	Grounding	Jun 89	Heath Reef	89	Livestock Carrier		No
Caraka Jaya Niaga 3	Ida	Grounding	Apr 90	South Warden Reef	98	General Cargo - Ballast	None	No
Pioneer Tween / F.V. Elizabeth *	Lib Aus	Collision	Aug 90	off Unison Reef	145	General Cargo		No
Jin Shan Hai / Kikenni *	CPR Aus	Collision	Jun 91	off Port Douglas	176 15	Bulk Carrier - Alumina	None	Yes
Jovian Loop *	Pan	Grounding	Sep 91	Unison Reef	107	Product Tanker - Tallow	None	Yes
Khudozhik Iganson / Zodiac *	Usr Aus	Collision	Sep 91	off Cairns	169 14	Container	None	No
TNT Carpentaria *	Aus	Grounding	Oct 91	Prince of Wales Channel	225	Bulk Carrier - Bauxite	None	Yes
Fareast / Ronda Lene *	Bah Aus	Collision	Dec 92	Middle Reef	144 17	Bulk Carrier - Coal	None	Yes
Gulf Tide	Aus	Grounding	Jan 91	Endeavour Strait	56	Diesel Oil	Limited	No

* Unit investigation report published.

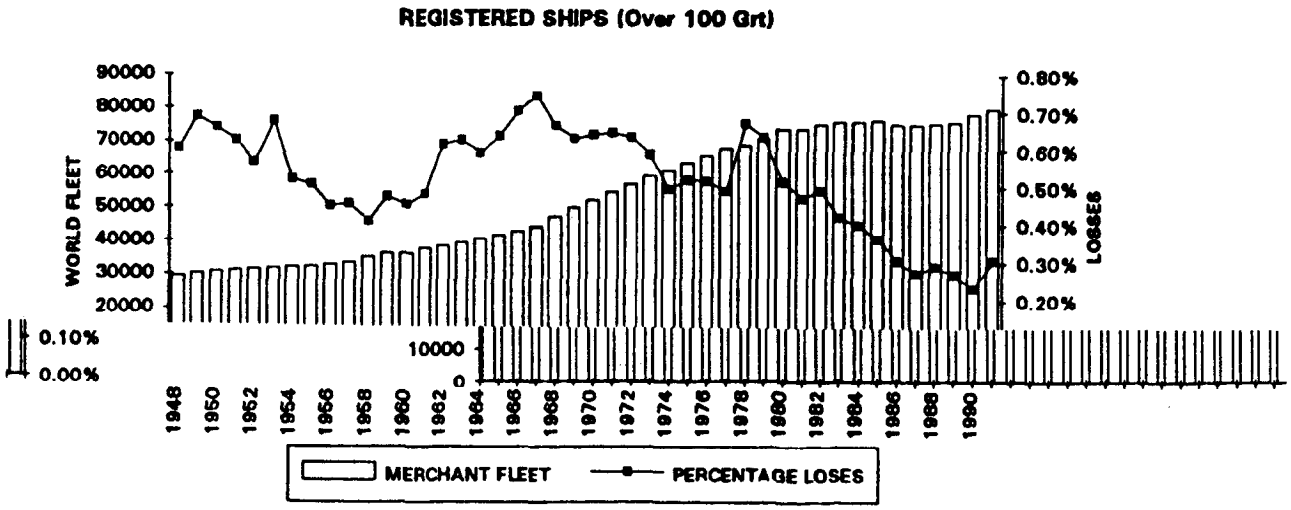
Table 2

SHIPPING USING THE INNER ROUTE OF THE GREAT BARRIER REEF

Month 1992-	Total Number of ships	Australian Flag	Tankers *(oil and Chemical)
January	180	24	12
February	175	23	16
March	162	22	5
April	170	24	8
May	169	23	8
June	157	17	18
July	183	23	12
August	187	24	11
September	178	26	14
October	176	23	16
November	203	24	12
December	192	19	4
TOTAL	2132	272	136
Average	177.7	22.7	11.3
Percentage of total fleet		12.76	6.38

* Gas carriers have been excluded as the cargo is judged as not posing a risk to the environment. It should be noted that a number of chemical tankers carry tallow loaded at a series of Australian ports.

Figure 1



QUESTIONS AND ANSWERS*

Kit Filor's presentation

Question
With respect to the statistics about ship losses and trends; is there any correlation between the obvious stable trend and the use of port state controls, particulary in Europe, to detect unseaworthy ships before they go to sea and get lost?
Second, your optimistic outlook that they are not getting any worse. Can you explain why the oil companies and the major export bulk commodity groups are spending big money vetting ships before they come to Australia, and other ports overseas?

Answer
It is that lowering of tolerance, and I'm not saying it's a wrong thing to do. The point I'm trying to make is, when I was a lad at sea, and you were too, and these things (unseaworthy ships) were still going around. The public tolerance has changed and things like *Exxon Valdez* have raised the liability levels of oil companies and the like to huge heights now, so what they're really doing in my view is underlying what's been there all along, but they are now much more accountable.

Question
How about the correlation between port state control and reduction in ship losses?

Answer
Well I think that may have been a factor in Europe in bringing that down, but also too, are better radars and various other navigational aids.

Comment from the floor
I am just concerned that you are raising expections that at the coal face things are getting better. I would say that at the coal face most people here that work on the ships, say that standards are getting worse over time.

Comment from the floor
The standards of watch keeping officers at sea do vary vastly but we're getting vastly more crews from third world countries and their standards are considerably less. I've noticed in the years I've been in the pilot service, about the last 5 or 6 years, they've definitely gone down. Now how that fits in with the statisics you show there about accidents decreasing, it's a little hard to understand.

Answer
Well I think there's two aspects there if I may. One is perception: "I was a lot better at sea than anyone else." We become immune in time, with great respect to everyone here. I've suffered it myself and you have to offset some of these perceptions against that sort of view. I can only speak as I find, and I go on board these ships when they have accidents and we talk to people. We've been on as many Australian ships as others, and we're finding the same sort of thing, and they are momentary lapses, they are things that they will never do again in a hundred years. It's the human condition.

Question
You put some graphs up, and you said accidents are going down, The graph shows that accidents have gone down since the eighties, but to the same level it was in the seventies. There was a "lump" in the eighties.

Answer
What you have to do, is compare it against the increase in the total fleet, The fleet has doubled since the late sixties and early seventies. Twice as many ships are at risk.

Comment
I commend you for what you're trying to do. You're trying to show figures to address the media-hype that sometimes goes on. But regarding the total fleet, it's a bit of scary figure to put up because there's so many different vessels involved. I think some work needs to be done there. The 1983 figures are interesting for the total number of deaths is very low relative to all the other figures you've got up there, yet that was one of the worst pollution years that we had.

Question
Today, we undoubtedly face a situation where there are more and more people ashore legislating for less and less people at sea. There is an enormous amount of time and effort put into keeping abreast of legislation by sea staff. In port state surveillance the emphasis is still on looking at equipment. I would suggest that a lot can be learnt from observing the practices of the officers and crew while the ship is in port to determine their competence, because the IMO legislation makes provisions within the port states administration of control to intervene if in their opinions the officers and crew of the vessel demonstrate that they do not have a sound working of the vessel. I really feel that, if we are to come out and make statements about the incompetence of people then we need to address that, and we need to start gathering statistics and taking action because otherwise we're just going to keep going around in circles.

Answer from the floor
We're trying to develop objective criteria to judge crew competence. It is a difficult area because there are some Australian ships that are not good. So it's a world-wide problem. It is an area where the IMO is working and we hope to have some guidelines in three or four months time.

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* Note: This text is not a verbatim record of the questions and answers. To assist with comprehension, the Editor has deleted some text and made modifications to highlight key points. Speakers are not identified.