

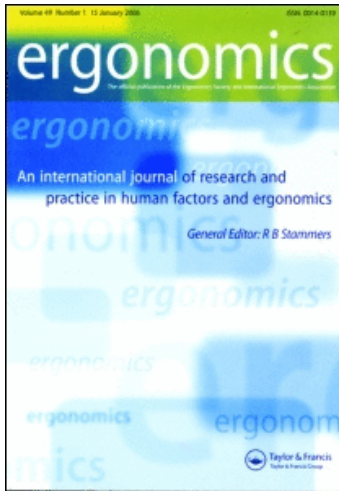
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From accident report to design problems— a study of accidents on board ship

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A study of shipboard accident reports was carried out as part of a Government sponsored project on ships boarding and access. The data was re-processed to arrive at location of accident on specific ships, which were then subject to survey and ergonomics appraisal. Locations inspected included gangways and accommodation ladders, stairways, lifts and hoists, engine rooms, ladders, masts and platforms, lifeboats, holds and tanks and staging. Recommendations based on applicable regulations and best ergonomics practise were prepared and proposed as a Code of Practise for the industry.

1. Introduction

This study was concerned with getting on and off ships and was sponsored by the National Maritime Institute and paid for by the Ship and Marine Technology Requirements Board of the DoI.

What is reported here are the slipping and falling accidents which formed a small but significant part of that study. In an attempt to get an overview of the problem interviews were conducted with a wide range of users of ships boarding and access systems. These included ships pilots; crew; shore workers; Port Health and Customs Officers—all of whom may be said to be regular users—and occasional users such as police and emergency services. The discussions revealed a much greater scope and range to the problem than was originally anticipated and three important categories were identified:

- (1) Pilots boarding at sea.
- (2) Boarding at docks, quays, from other ships and from the air.
- (3) Access and movement within the ship.

Internal access on the ship could include accommodation, holds and tanks, masts and platforms, engine rooms, stores and machinery spaces and lifeboats and rafts. Small vessels such as fishing boats could also have been included, but they had been deliberately excluded from our original proposals.

The concensus view seems to be that boarding both by pilots and crew is one of the most critical areas for investigation, and it was decided to conduct a search of the available objective data for evidence which might support this contention and thus focus the field for investigation.

Accident reports have always been an attractive source of information to ergonomists and we accordingly turned to the body responsible for collating accidents to seamen, which is the General Council of British Shipping, who report in turn to the Department of Trade.

The GCBS maintains a data bank made up of some 7000 non-fatal accidents to seamen annually (1975–78), reported from affiliated shipowners. These do not include, with one or two possible exceptions, owners of fishing vessels, neither do they include a number of ships not affiliated to the GCBS.

Fatal accidents, it should be noted, are not included in the GCBS data bank, being subject to direct reporting to the Registrar of Shipping and Seamen; we did, however, examine what records were available for this class of accident. Some 41 deaths were reported in a 15 month period 1975–76, fatalities being classified as 'lost overboard or missing', 'illness' and 'deaths ashore'.

2. Procedure

Each accident is received by the GCBS from the ship via the owner on an accident report form known as an E2. The report form is similar to those found ashore and simply includes details of the accident and injury as well as the usual identification of the seafarer and ship. It also includes such questions as 'was the seafarer sober?' and asks whether the accident was caused through 'negligence, default or misconduct'.

These original reports are available for a limited period in the Claims Department of the GCBS. Each accident is numbered. The main details are classified according to type of accident and injury and transferred to edge-punched cards of the Cope-Chat type. The classification follows established practice and includes categories well known ashore such as 'slips, trips and falls', 'falling objects', 'moving objects', 'fires, explosions', etc. Amongst causes of accident are listed 'slippery surface', 'obstructions', 'movement of ship' and 'improper use of gear or equipment'.

Thus, it is possible to locate specific types of accident, extract the original report form and thus identify the ship and some of the circumstances under which the accident took place. Although mainly interested in accidents involving gangways and accommodation ladders, these are no longer specifically identified in the GCBS classification, so that it was decided to check through several more general categories over as long a period as possible of available records.

GCBS furnished us with monthly summaries of accidents reported in 1977, and because edge-punched cards were immediately available for the months of August and September 1977 these were examined first. Although the exercise was very time consuming it was decided on the basis of that sample to perform a complete search for the full 10 months available for 1977.

The procedure involved selecting a category and extracting all cards in that category from the total for the month. Successive sorts allowed a numerical order of E2s to be produced, following which each corresponding accident report form was systematically scrutinized for details of the accident and reclassified for location on board.

We selected for further study all accidents involving gangways or boarding of any kind. In addition it became clear that other types of access accident were appearing in reports with some regularity, especially slips and falls from stairways and ladders in engine rooms and crew accommodation. Selected samples of these were also extracted for further study, together with some further special categories of location. Altogether some 3000 accidents were contained in our categories.

Our interest in the data was concerned primarily with the *location of accident* and so re-classification of the selected E2s was carried out to provide the required view of the data as a whole.

The locations chosen for re-classification were as follows:

- (1) Gangways and accommodation ladders.
- (2) Stairways internal to ship.
- (3) Lifts and hoists.
- (4) Engine rooms.
- (5) Ladders, fixed and portable.
- (6) Masts and radar platforms.
- (7) Lifeboats.
- (8) Holds and Tanks.
- (9) Staging, etc.

3. Results

3.1. Non-fatal accidents

Taking all *causes* of accident (GCBS classification) for only four *types* of accident whilst on duty and all off-duty accidents led to the totals given in table 1. Off-duty accidents were thought to be specially relevant because much boarding and disembarking from the ships is done by crew in this state.

Table 1. Categories searched by month—totals access accidents (1977 data).

	Cat.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Total
On duty												
Slips, trips, falls	1	162	160	127	128	160	98	99	147	88	119	1288
Falling objects	6	15	14	15	7	13	2	4	12	8	8	98
Moving objects	7	44	16	36	37	24	18	19	29	18	22	263
Manual handling	8	55	50	69	51	22	54	31	43	25	22	422
Off duty												
Accidents on board	12	53	54	70	59	56	50	42	54	27	40	505
Accidents ashore	13	35	33	39	17	34	33	41	29	22	34	317
Unclassified	14	—	4	21	12	17	6	2	2	9	5	78
Total		364	331	377	311	326	261	238	316	197	250	2971
No. in locations		73	71	64	63	72	36	33	63	28	60	563
Per cent		20.1	21.5	17.0	20.3	22.1	13.6	13.9	19.9	14.2	24.0	18.9

Registrar General data
(fatals=32)

2%

A total of 2971 accidents were selected for further examination and re-classification by categories. Table 2 shows the result of further selection and the re-classification by location of accident.

The successive selection procedures thus yielded a total of 562 accident reports in the first 10 months of 1977 involving some form of access. This represents approximately 10% of all reported accidents. Accidents taking place on, or in the

Table 2. Accident locations by month—access accidents (excluding fatalities) (1977 data).

Location	Cat.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Total
Ganways and access ladders	*S	4	8	1	—	6	4	1	4	2	6	136
	M	19	17	11	11	11	1	7	10	6	7	136
Stairs int. to ship	S	3	2	1	1	3	6	2	3	1	2	177
	M	11	16	28	12	25	9	11	19	8	16	177
Lifts and hoists	S	—	—	—	—	—	—	—	—	—	—	4
	M	2	—	—	—	—	—	1	—	1	—	4
Engine room	S	1	—	1	—	1	—	1	2	—	1	74
	M	9	5	6	13	9	4	3	10	3	6	74
Ladders	S	6	4	2	4	1	3	2	2	1	2	123
	M	10	15	10	14	9	6	8	9	5	12	123
Masts, radar, platforms	S	—	—	1	—	—	—	—	—	—	—	6
	M	—	—	—	3	2	—	—	—	—	—	6
Holds and tanks	S	1	2	—	—	—	—	—	3	—	—	5
	M	1	—	—	1	—	—	3	3	—	5	5
Lifeboats	S	2	1	—	—	1	—	1	—	—	—	14
	M	3	—	3	—	2	—	—	—	1	—	14
Staging, etc.	S	1	—	2	—	1	1	1	1	—	—	15
	M	—	1	—	2	1	2	—	—	—	2	15
Total		73	71	64	63	71	36	33	63	28	60	562
Total all accidents		534	532	626	595	662	538	532	563	399	553	5649
Per cent		13.7	13.3	10.2	10.6	12.6	6.5	6.2	9.6	7.0	10.8	9.95

*S, severe; M, minor.

vicinity of, or as a result of using, gangways, etc., amounted to 136 or 24% with a further 23% taking place on ladders and 31% on stairways. In addition to re-classifying accidents by location on board we also noted the ships type and tonnage, geographical location and the severity of the accident, where it could be reasonably deduced, as minor (including bruises, sprains, cuts, etc.) or severe (fractures, major surgery, hospitalization, etc.).

From this data recorded from our selected 562 reports a simple frequency count was carried out and a number of ships identified as reporting on a fairly regular basis. The results of this analysis are shown in table 3, where ships reporting more than four accidents are identified.

Table 3. Ships reporting four or more accidents (Jan.-Oct. 1977).

No. of reported accidents	Name	Constructed	Ship type
12	Passenger liner	1969	P
10	Passenger liner	1961	P
8	Passenger liner	1960	P
7	Passenger liner	1954	P
6	Channel ferry	1962	F
5	Channel ferry	1968	F
	Channel ferry	1975	F
	Gas carrier	1972	G
	Passenger liner	1965	P
4	Tanker	1968	T
	Cargo-passenger	1961	C.P.
	Bulk carrier	1968	B
	Bulk carrier	1971	B

3.2. Fatal accidents

Fatal accidents are not categorized under the same system, nor are they punched on to cards by the GCBS, but available records were scrutinized for a period of about 2 years. These records are incomplete for two reasons; firstly, claims may be outstanding against some and the records are therefore located elsewhere, and

Table 4. Fatal accidents—summary of available data.

1975-76		A. Reported to GCBS (E2s)
Oct.-Mar.	11	Includes lost overboard or missing, illness, deaths ashore
Apr.-July	8	
Aug.-Dec.	22	
Total (15 months)	41	
1976		B. Returns of Registrar General of Shipping
Jan.-June	28	Includes GCBS data
July-Dec.	40	
Total	68	
1977		
Jan.-June	32	

secondly there is a statutory requirement that deaths have to be reported direct to the Registrar General of Shipping and Seamen, but no such mandate exists for a report to the GCBS. Table 4 summarizes such data as was available.

From all available information about fatal accidents, if we assume the same ratio for fatal and non-fatal accidents, i.e. 10:1 then from four to six fatalities per year may take place in connection with the boarding/access activity.

A request to the Registrar General of Shipping and Seamen did not produce any more detailed breakdown than already published in the DoTs *Casualties to Vessels and Accidents to Men* for 1975, the relevant table from which is reproduced here (table 5). Insufficient manpower was available to us to examine the Registrar's records filed alphabetically by ship's name in order to categorize deaths on the basis of location of accidents as required by our analysis.

4. Discussion

An inspection of the summary table for all non-fatal accidents in January of the year studied (table 2) shows that about 14% take place in one of the nine chosen ship locations. Furthermore some 30% of these are in the 'boarding' category. A similar pattern is observed throughout the rest of the year. It was felt that this evidence supported the view that boarding whether by gangway, accommodation ladder or whatever is indeed a critical area and should be further investigated. The analysis of remaining accident locations shows an equally high proportion on stairways and on ladders with a fairly large number of ladder accidents taking place in the engine room.

Very little can be deduced from the report of the accident on the E2 that can further explain the cause, and in no cases is the manufacturer or type of equipment in use described so that design failures cannot be readily assessed. Thus it was considered that a representative sample of ships on which the accidents took place should be selected for detailed scrutiny.

A possible way of selecting these ships would be by using the frequency of report analysis shown in table 3. Whilst it is true that frequency of report does not necessarily mean an especially dangerous ship or equipment (it could mean also that the owners or ship's officers were especially zealous in reporting accidents) it does allow selection on rather more than an arbitrary basis for a number of case-studies. It must be emphasized that no special significance was or should be placed on such selection other than the frequency of reporting, on the whole, minor injuries.

The data in table 3 suggest one or two conclusions and some less explicable:

- (a) Passenger ships and ferries, with large numbers of crew and passengers and many decks and stairways, could be expected to produce a large number of accidents at these locations and they do. However, hardly any accidents are to passengers.
- (b) Many of the accidents state the seamen involved as carrying something, occasionally large and heavy objects (the same is true of some of the engine-room accidents where tools or parts are involved).
- (c) Five ships stand out in the analysis in addition to passenger ships and ferries. Two are bulk carriers, one is a passenger cargo vessel, one a tanker and one a gas carrier.

Table 5. Deaths among crews other than from disease (reproduced from *Casualties to Vessels and Accidents to Man* (HMSO, 1976)).

	Casualties to vessels				Accidents to men												Total								
	1975 Officers and ratings* Seamen on Asiatic agreements Total	1974 Officers and ratings* Seamen on Asiatic agreements Total	1975 Officers and ratings* Seamen on Asiatic agreements Total	1974 Officers and ratings* Seamen on Asiatic agreements Total	Foundering	Strandings	Collisions	Missing vessels	Explosions and fires	Other casualties	Accidents, etc., in engine-room and stokehold	Falls from aloft	Killed on deck of vessel	Fell down hatchways, etc.	Fell overboard from deck of vessel	Washed overboard		Killed or drowned coming aboard from ashore	Drowned in dock, etc., ashore	Killed or missing ashore	Drowned bathing	Homicide	Suicide or supposed suicide	Missing at sea	Other causes
1975 Officers and ratings* Seamen on Asiatic agreements Total	20 4 24	7 — 7	1 — 1	— — —	4 3 7	— 1 1	5 1 6	5 2 7	1 1 2	11 2 13	4 1 5	— — —	12 1 13	7 — 7	4 1 5	2 — 2	3 1 4	17 5 22	5 1 6	5 — 5	17 5 22	12 5 17	11 — 11	8 — 8	106 24 130
1974 Officers and ratings* Seamen on Asiatic agreements Total	7 — 7	— — —	— — —	— — —	5 1 6	7 — 7	1 1 2	3 2 5	5 1 6	11 2 13	4 1 5	— — —	14 1 15	10 — 10	3 — 3	2 — 2	4 3 7	12 5 17	11 — 11	8 — 8	17 5 22	11 — 11	11 — 11	8 — 8	94 18 112

* Excluding seamen on Asiatic agreements.

From accident report to design problems

It was therefore proposed that, in addition to the five ships identified above, a representative passenger vessel and one or two ferries should be included in the next stage of the study. Each ship would be subject to close examination and a detailed ergonomics evaluation of the locations and equipment involved in the accident reports, from which general conclusions and recommendations would be prepared.

The problems of pilots boarding at sea and under way is not apparently reflected at all in the GCBS data neither were any pertinent data readily available.

5. Conclusions

This paper has described how it is possible to arrive at apparently dangerous locations of slipping and falling accidents on board ship from rather unpromising original accident reports. The second part of the study concentrated on the nine locations identified on the actual ships selected and a number of interesting factors emerged, one of which is worth mentioning here.

It was apparent that a significant difference existed between ladders and stairways on board ship and their shoreside and domestic counterparts. The range of angle of inclination of ships stairways (known to the seamen as 'ladders') was 35–70° as against the domestic/industrial norm of 30–35°. Related to this was a tendency to employ more than one angle of stairway on a single ship—an extreme being ten different angles found on a car ferry, a possible contributory cause to the high number of reported accidents on that particular ship.

These and other aspects of design were commented on in the light of ergonomics considerations and prevailing regulations where applicable. Detailed recommendations were derived and the final report on the subject proposed publication in a Code of Practise for the industry.

Une étude concernant les accidents survenant à bord des navires a été entreprise. Elle constituait une partie d'une étude plus vaste effectuée sous les auspices gouvernementales, relative aux structures d'accès et d'accueil sur les bateaux. Les données ont été retraitées pour parvenir à une localisation des accidents sur certains bateaux qui ont alors fait l'objet d'une étude plus approfondie ainsi que d'une évaluation ergonomique. Ces localisations se rapportaient aux coursives, aux échelles de coupée, aux escaliers, aux monte-charges et appareils de levage, aux salles des machines, aux échelles, mats et plate-formes, aux canots de sauvetage, aux cales, aux réservoirs et aux débarcadères. Des recommandations ergonomiques ont été élaborées et proposées aux constructeurs.

Eine Untersuchung über Unfallberichte auf Schiffen wurde als Teil eines regierungsgeförderten Projektes über Schiffsauf- und -zugänge durchgeführt. Die Daten wurden überarbeitet, um die Unfallstellen auf bestimmten Schiffen zu ermitteln, die anschließend genauer untersucht und ergonomisch bewertet wurden. Die überprüften Stellen beinhalteten Gangways und Kabinenzugänge, Treppen, Fahrstühle und Aufzüge, Maschinenräume, Leitern, Masten und Bühnen, Rettungsboote, Halterungen, Behälter und Gerüste. Empfehlungen wurden auf der Basis praktikabler Vorschriften und bester ergonomischer Praxis erstellt und als Anwendungsvorschrift vorgeschlagen.

船上での事故報告に関する研究が、Ships Boarding and Accessという政府プロジェクトの一部として行なわれた。特定の船における事故の所在場所がデータから明らかにされ、それらは実地に検分され、人間工学的に評価された。検査された場所は舷門、タラップ、階段、リフト、起重機、エンジンルーム、梯子、マストとデッキ、救命ボート、船倉とタンクと足場などである。適用規則や人間工学的に最適な実践に基づいた勧告が準備され、産業界への施行法として提案された。