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Research Note

Determining Awkward Spaces in Ships Using Posture Study

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In this paper, crew work posture, as one of critical human factor considerations, will be reviewed in different ship spaces. Whether crew members are standing or seated at a workbench or machine, their working posture is extremely important. If the available hardware forces crew members to remain in an awkward position for a long period of time, they will obviously become fatigued and, thus, more apt to make mistakes or incur some type of physical disability. In such spaces, different work postures are one of the most important parameters in affecting crew efficiency and must be studied for each space. In this work, each working space, in some real ships, regarding different work postures has been studied and the profile of each workplace has been determined. In this work, by allocating a grade for each workplace, awkward spaces in ships may be determined.

INTRODUCTION

The reasoning behind all workplace analysis is the use of ergonomic methods for the improvement of work.

Designing workplaces is a complicated matter. In practice, it is only during the phase of detailed engineering that attention starts to be paid to ergonomic aspects, such as the layout of a workplace and installation factors. An ergonomic contribution in earlier design phases is not yet common practice. However, during these earlier design phases, operator jobs and workload, which are of major importance to the quality of working life, are then defined.

If there is no ergonomic input in the earlier design phases, often, the installation and instrumentation are designed by technical engineers without consideration of the contents of operator jobs. Ergonomists have strived for the integration of technical and organizational design since the publication of Singleton's Ergonomics in System Design (1967) [1]. It is stated by Lenior and Rijnsdorp (1990) [1] that the lack and the importance of ergonomic contribution in earlier design phases was substantiated during the workshop entitled "integrating technical and organization design" which took place during conference on Marketing Ergonomics.

In this literature study, micro studies for work posture [1] have been encountered, which has mostly been done by the International Maritime Organization (IMO) [2,3], but not a macro study of the workplace with different work postures.

Even the International Shipping Registers, such as L.R., have few issues, as technical notes for internal circulation only, without any detail. The International Labor Organization (ILO), is the only major organization in the world having general obligatory rules for workplaces/living places, but, again, not in any detail. That is why some shipbuilding countries have their own codes.

Human effort analysis consists of using a complex system of muscles. There are some mathematical methods for evaluating and comparing different work postures, which are not exact but very close to reality [4,5].

The workplace environment depends on different work postures. Regarding this matter, this paper presents a new idea, which could be considered as a starting point.

METHODOLOGY

If one wants to realize ergonomics in system design, the approach should be integrated in existing system procedures. There are different tasks done onboard a ship using different body postures. Crew members either complain or agree, usually depending on the place where they work. Therefore, an ergonomic study

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of crew work postures is needed. In nearly all cases, the number of crew per each group of tasks is fixed. This is because the various groups require different training, knowledge and experience.

In this methodology, the crew work posture study was carried out by means of observation, interview and by using a prepared questionnaire, with the support of the IRISL (Iranian Shipping Line).

Evidently, experienced operators can offer valuable contributions, as they have wide and detailed knowledge about their jobs. The main problem is finding ways for involving them in the study.

In the authors' approach, questionnaires were filled up through observing and interviewing different ranks of the ship crew: Captains, chief engineers, chief officers, cadets, cooks, etc. In some cases, incorrect information was deleted and incomplete data were modified. The different work postures are given in Table 1 and the different workplaces are: Bridge and radio room, deck, control room, E.R. and maintenance works, work shop, galley, mess, cargo hold, store and others (dispensary, office, etc.).

After having all probable work postures for each place, the score is determined by a simple averaging method and, then, a grade will be specified. Of course, for further research work, instead of taking a simple average over all posture points, it is possible to determine a weight factor for different postures based on a mathematical method [4,5] and, also, considering their different applied duration in the same place.

CASE STUDY

As mentioned in Methodology, by using some questionnaires and by interviewing different ranks of ship crew and applying some corrections on the results, the ship's different spaces were classified with their different work postures, using the "Renault Method" [1]. Then, by using the "DAF Method" [1], the points were expressed as scores (Table 2).

For this case study, the ships belonging to the Iranian Shipping Line were chosen. The principal particulars of those ships and some general notes can be found in the Appendix.

If needed, in some cases, the scores were corrected, according to the movement and/or existence of stairs in each workplace (Table 3). The frequency per hour of the work was not considered, because work activity on a ship is not like a production line, e.g. car manufacturing, which involves the continuous repetition of the same work.

Then, the grade for each workplace profile was expressed, ranging from 1 to 4. This was done with the help of the special method mentioned above, along with some alterations, Table 4.

In using this method, it should be mentioned that the specified work postures in the different spaces of a ship and the needed corrections should, usually, be based on past experience, either of the individual doing the analysis or of someone familiar with similar systems already in use.

Table 1. Work postures.

	Work Posture
a	Sitting, vertical trunk
b	Sitting, trunk bent forwards
c	Sitting, trunk bent sideways
d	Sitting, trunk bent backwards
e	Standing, vertical trunk
f	Standing, trunk bent forwards (20 deg.)
g	Standing, trunk bent forwards (40 deg.)
h	Standing , trunk bent forwards (60 deg.)
i	Standing, trunk bent sideways
j	Standing, trunk bent backwards
k	Standing, legs bent
l	Kneeling
m	Squatting

Table 2. Work posture points.

	Work Posture	Points
a	Sitting, vertical trunk	1
b	Sitting, trunk bent forwards	2.5
c	Sitting, trunk bent sideways	2.5
d	Sitting, trunk bent backwards	5
e	Standing, vertical trunk	2
f	Standing, trunk bent forwards (20 deg.)	2.5
g	Standing, trunk bent forwards (40 deg.)	3
h	Standing, trunk bent forwards (60 deg.)	5
i	Standing, trunk bent sideways	4
j	Standing, trunk bent backwards	5
k	Standing, legs bent	4.5
l	Kneeling	4.5
m	Squatting	5

Table 3. Correction table.

Stairs (Easy) 0.3-0.5 m	Stairs (Awkward) >0.5 m	Correction	Movement (if P>4) Speed
3-5 time/min	1 time/min	+ 0.5	<2 m/min
> 5 time/min	2 time/min	+ 1	>2 m/min

Table 4. Workplace profile.

Score	1-2	2-3	3-4	4-5
Profile of Workplace	Good	Acceptable	Hard	Very hard
Workplace Grade	1	2	3	4

RESULTS

In this work, the most probable work postures at each workplace were distinguished by distributing the prepared questionnaire among crew of different ranks, by observation and interview.

The work postures were scored and corrections were made for any individual work posture and, then, the scores of each individual place were averaged. The final scores of all places were resulted (Table 5) and, then by using these scores, the final grade and the final profile for each place were recorded (Table 6).

By these results, one can understand the priority of paying attention to improving each workplace. According to the authors' work results, the engine room is the hardest place, which should be improved immediately. In this regard, some common work in the engine room and many other places could be reviewed and some proper solutions, regarding ergonomic aspects, could be presented.

DISCUSSION AND CONCLUDING REMARKS

There are many other analyses in different fields of work for a specific work. The journal of Ergonomics represents many such works, but, not the same as described in this paper. Those works could be considered

Table 5. Form of questionnaires and final scores.

Place / Posture	Bridge and Radio Room	Deck	Control Room	E.R. and Maintenance Work	Work Shop	Galley	Mess	Cargo Hold	Store	Others (Dispensary, Offices, etc.)
A	X		X		X	X	X		X	X
B			X		X	X				
C			X							
D										
E		X	X	X	X	X	X	X	X	X
F	X	X		X	X	X	X	X	X	
G			X	X	X					
H		X		X	X					
I										
J				X						
K		X		X	X			X	X	
L				X						
M		X		X	X			X		
Score	1.9	3.7	2.5	4.1	3.2	2.9	2.4	3.6	2.8	1.3

Table 6. Final workplace grade.

Place / Posture	Bridge and Radio Room	Deck	Control Room	E.R. and Maintenance Work	Work Shop	Galley	Mess	Cargo Hold	Store	Others (Dispensary, Offices, etc.)
Score	1.9	3.7	2.5	4.1	3.2	2.9	2.4	3.6	2.8	1.3
Work Place Grade	1	3	2	4	3	2	2	3	2	1

as being micro studies of posture and this work as a macro study. The only such work has been started in [4,5].

This work is measured on a chosen population and is used to show that the workplaces of ships depend on different work postures.

The work in this paper presents a new idea, which could be considered as a starting point.

For further research, it is possible to determine a weight factor for different postures, based on the mathematical method mentioned in [4,5] and, also, considering their different applied duration in the same place, instead of taking a simple average over all the posture points.

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APPENDIX

In this approach, a multi-purpose type vessel is chosen because of her broad range of usage. This kind of vessel is briefly introduced in the following : As the name implies, this refers to a ship which can be employed for any type of cargo or route. With this, the ship-owner has at his disposal a tool which can be best adapted to the unpredictable changes in the state of the market and which diminishes the risks involved in his business. The shipyards, on the other hand, attempt to reach the greatest possible circle of customers by way of this multi-purpose freighter. The popularity of this type of ship, the most common amongst bale cargo freighters, is proof of this. However, the multi-purpose freighter is also used in bulk shipping. The multi-purpose freighter is best suited to tramp shipping, because like a taxi in the city, it welcomes any cargo. In liner shipping, a regular service for one or several sorts of cargo must be maintained; in our analogy, such as in trams or railways. The principal particulars of IRISL vessels, which are used in our approach, are given in Table A1.

Table A1. Principal particulars of the vessels.

Ship's Name	**1st Vessel Iran Bagheri**	**2nd. Vessel Iran Makin**	**3rd. Vessel Iran Sattari**
L.O.A	169.88 m	174 m	168.46 m
LBP	158 m	162 m	159.40 m
Breadth (MLD)	23.17 m	25.6 m	26 m
Depth (MLD)	13.3 m	14.2 m	13.6 m
Draft (Full)	9.75 m	9.5 m	9.7 m
Displacement	24402 t	31036 t	30231 t
D.W.T.	16641 t	22950 t	22882 t
GT	12597 t	16620 t	15670 t
N.T.	6469 t	8758 t	8524 t
Complement	30	32	36
Keel Laying	1977	1992	1998
Place of Berth	Poland	China	China