

USING A SWATH VESSEL AS A PASSENGER TRANSFER CRAFT: SHIP MOTION EFFECTS ON HUMAN PERFORMANCE AND SAFETY

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INTRODUCTION

Two "Small Waterplane Area Twin Hull" ships (SWATHs) were procured by the UK Ministry of Defence to be used in support of Royal Naval Operational Sea Training. These craft are used to transfer staff to and from naval vessels around the Plymouth Sound. Clearly, severe ship motions will limit the ability to transfer passengers effectively; indeed, there may be occasions where it would be unsafe to transfer personnel at all. Therefore, a SWATH was selected as the most appropriate passenger craft to ensure minimal motions during the potentially hazardous task of ship transfers at sea. The task requires that, in a few minutes, teams of up to 30 personnel transfer to and from the craft across a hydraulically adjusted gangway fitted aft on the upper deck. The outboard end of the gangway will be held against the hull of the receiving ship, with any motion being corrected for by sensors linked to the hydraulic system.

Much importance has been placed on an assessment of passenger safety during the transfer operation. The aim of this work was to perform an experiment using simulations of the SWATH to assess the suitability of using this type of craft to transfer passengers and to supplement data obtained from previous experiments (1).

METHOD

An experiment was undertaken at the Defence Evaluation and Research Agency in Bedford, UK, in a Large Motion Simulator which can respond in 5 degrees of freedom (heave, sway, pitch, roll and yaw) and is able to replicate realistic ship motions. Six Royal Navy volunteers performed a simple task routine (standing facing aft and athwartships, walking on a treadmill, a loading task and a simple psychomotor task), which lasted approximately 1 h. In terms of their sea experience, the trial subjects ranged from complete novices to fully experienced sailors with up to 66 months sea time. Each subject was asked to perform this task routine in 2 motion profiles taken from computer generated predictions of the SWATH operating alone in a high-sea state 3 and mid-sea state 4. Current mathematical techniques are not sophisticated enough to model between-ship interactions.

Models that predict the frequency at which a crewmember will slide or lose their balance have been developed (2,3). These events have been called motion-induced interruptions (MIIs). During the experiment, the occurrence of MIIs

was recorded by independent observers and from the subjects' self reporting these events.

Additionally, a battery of questionnaires was administered allowing each subject to report their opinions on the mental and physical effects of performing the tasks under motion. The questionnaires examined in particular were as follows: motion illness, fatigue, task performance and the physical effort required to complete the tasks.

RESULTS AND DISCUSSION

The results of the experiment closely matched theoretical predictions of human performance. It was expected that motion sickness (in terms of incidence of vomiting) would not present a problem. During the experiment only 2 subjects reported motion sickness symptoms, and those were low level feelings of nausea. No one vomited. It was also hypothesised that subjects with a high threshold of tolerance to acceleration (i.e., experienced sailors) would not experience problems with postural control and subjects with low threshold levels may have some difficulties. This expectation was largely confirmed in the experiments using both the objective measures (incidence of MIIs) and subjective measures (performance questionnaires). Both measures indicated that the 2 most inexperienced subjects had some difficulties in coping with the moving environment.

The low levels of motion illness and fatigue reported during this trial are unlikely to interfere with the safe and effective execution of the transfer task. However, some degradation in performance due to the motion was recorded; some subjects had to interrupt their task in order to maintain their balance. This problem may compromise the safety and effectiveness of the transfer. The task that caused the most concern was standing facing athwartships (see Table 1). As the transfer task involves periods of standing and walking athwartships, the safety of passengers may be compromised.

Table 1. Number of MIIs per min*

Task	High-Sea State 3		Mid-Sea State 4	
	Mean	SD	Mean	SD
1. Standing facing aft	1.2	1.1	0.6	0.8
2. Loading	2.7	2.6	2.9	3.4
3. Standing with arms aloft	1.9	1.8	1.5	1.3
4. Walking on treadmill	1.4	1.4	0.8	1.0
5. Standing facing athwartships	5.7	3.4	5.3	3.3
6. Psychomotor	1.0	1.1	0.8	0.4

*(mean and standard deviation --all subjects)

The results indicate quite strongly that personnel with little or no sea experience or those with experience on large vessels only, may have difficulty in coping with the transfer. Without sufficient training and/or safety provisions these

personnel may be exposed to a high risk of injury; however, it is not possible to quantify this risk. The presence of learning effects between conditions demonstrates the potential usefulness of familiarization training for personnel intending to use the SWATH. Improvements in safety and effectiveness may result from a brief practice session on the use of the gangway.

On much larger SWATHs, there tends to be a problem from spray, causing deck wetting and reduced visibility in "moderate" seas (around the levels in which these vessels operate). Much of this is due to waves slamming against the side of the windward strut following the emergence of part of the lower hull. Alleviation of this would require large and impractical changes to the underwater hulls. However, the spray problem may have a bearing on the best way to operate these vessels when alongside receiving ships.

These experiments have provided more data for validating the human performance models currently under development. These data present the first opportunity to validate the MII model in a motion environment that creates sufficiently large forces from more than one principal direction.

CONCLUSIONS AND RECOMMENDATIONS

The motion profiles driving the simulator represent predictions of the SWATH operating alone in sea states 3 and 4. Motions likely to be experienced during transfer operations with a receiving ship alongside the SWATH cannot currently be modeled due to their complexity. The small number of subjects trialed also necessitates that care should be taken when translating the data obtained from the experimental scenario to "real life."

Within the limitations of these experiments, it has been shown that the SWATH is suitable to operate as a passenger transfer craft up to a high-sea state 3. However, to counter potential problems for personnel with little or no sea experience, or those with experience on large vessels only, some ergonomic measures that may improve the safety and effectiveness of the transfer task are recommended:

- a familiarization training routine for the safe and effective use of the gangway should be implemented;
- the amount of time spent standing should be reduced to a minimum. To improve safety, passengers should remain seated until their disembarkation is imminent. Additionally, personnel embarking should be seated as soon as possible;
- the amount of time spent standing facing athwartships should be reduced to a minimum;
- grab rails and nonslip surfaces should be positioned at appropriate places along the gangway and disembarkation route;
- personnel should have both hands free while using the gangway. If necessary, luggage should be transferred separately;
- the number of personnel allowed on the gangway should be limited, and areas around the embarkation and disembarkation positions should be marked "out of bounds";

- the gangway should be supervised such that an unobscured view of the gangway is possible at all times;
- during the transfer operation, careful thought should be given to the vessel heading in relation to the direction of the waves to minimize potential problems of deck wetness and reduced visibility due to spray.

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