MOTION INDUCED INTERRUPTIONS DURING SIMULATED SHIP MOTIONS

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INTRODUCTION

Seagoing vessels are designed to minimize the effects of environmental forces in order to reduce the stresses acting on both the structure and those working aboard. However, the external perturbations created by the environment can be considerable in magnitude and unpredictable in occurrence, even in reasonably benign weather conditions. The purpose of this study was to measure the number of motion induced interruptions (MII) a participant will experience while performing manual materials handling tasks typically executed on a seagoing vessel. A MII is defined when a person has to temporarily abandon the task or else execute alterations in the base of support in order to maintain balance [1].

METHODS

A ship motion simulator was employed to produce three different platform motions during which volunteer participants lifted loads. The platform motions where described as pitch, roll and quartering seas. The loads (10 and 15kg) were connected to a handle which could be easily gripped symmetrically with two hands. The connection between the mass and the handle was made by either a solid metal column (i.e. stable load) or a series of chain links (i.e. unstable load). The participants were instructed to ready themselves in a stable position in order to execute a two-handed sagittal plane lift. An audible signal was employed to direct the participants to execute a lift every 10 seconds. The origin and destination of the lift were clearly identified and controlled between subjects. The load began on the floor and was lifted a distance of 750mm in the vertical direction and translated a horizontal distance of 300mm away from the subject at the conclusion of the lift. The load was returned to the ground by an investigator in preparation for the next lift. A handheld signal was used by one of the investigators to identify any MII incidents that may have occurred. This temporal marker was sampled by an A/D converter and stored on a computer for subsequent analysis. Each trial lasted approximately 2 minutes.

RESULTS AND DISCUSSION

A repeated measures ANOVA indicated that there were significant differences in the number of MII per minute for both the motion ($p<0.001$) and load ($p<0.001$) effects (Figure 1). A LSD post hoc analysis revealed that the pitch motion produced significantly more MII.min^{-1} compared to the other motion conditions. There were no significant differences between the three remaining motions. Maintaining balance requires that the vector projection from the system's centre of mass remains within the boundaries of the base of support. In the para-transverse plane located at the foot-floor interface the shortest distance this projection has to travel to leave the boundaries of the base of support is the antero-posterior direction, thus a pitch motion is likely to produce the most MII. Given the significant increases in the MII.min^{-1} for the pitch direction compared to the other motions it would not be unreasonable to recommend that lifting activities be restricted when a vessel is faced with oncoming waves.

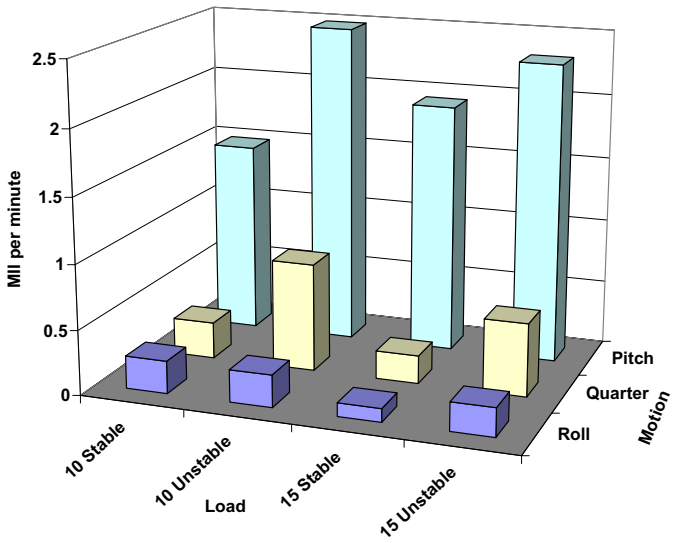

Figure 1: Number of MII per minute as a function of simulated ship motion and load characteristics.

Unstable loads produced significant increases in the rate of MII compared to the stable loads. Interestingly, there were no significant differences in the MIIs.min^{-1} between the 10 and 15kg loads and in some cases the rate of MII was greatest for the lighter load. It is likely that as a person attempts adjustments to regain balance with an unstable load an asynchronicity between the load, segment and floor accelerations occur, making the dynamic corrections to regain stability much more complex and prone to MII.

CONCLUSIONS

Balance control in a complex moving environment is related to the direction of platform motions and the type of load handled. Workers in such environments should be made aware that some situations have a greater risk of accident or injury.

REFERENCES

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