Capability prediction: effective anticipation support in ship control

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Abstract

A simulator study was carried out to quantify the potential benefits of prediction information to support operator anticipation in ship control. Twelve participants were asked to navigate a medium size vessel across a busy vessel traffic separation scheme. Three integrated navigation display types were used: i) basic automatic radar plotting aid (ARPA) information which can be considered as a modern baseline navigation display type, ii) basic ARPA with additional information indicating the predicted boundaries of operation, the so-called Predicted Capability Envelope (PCE), and advising about safest course to select, and iii) basic ARPA with PCE for variable propulsion of the navigator's vessel, advising about safest course and speed to select. The experimental trials were performed under normal and high-workload task conditions. Performance was measured in terms of safe and efficient navigation. Results of the experiment show that navigation performance considerably increased when capability prediction information was provided.

Introduction

The human's task in ship control is changing rapidly. Until the late eighties, the ship's navigator was primarily involved in manual control of single processes and, to a certain extent, in supervising automated stand-alone systems. Today, automated control systems are applied on a large scale, resulting in a considerable change in operator tasks. The role of the navigator as a direct controller has been transformed into that of a supervisor who is monitoring different processes controlled by semi-intelligent subsystems, and also into that of a manager who is performing additional planning and decision-making activities. In this *supervisory control* role the navigator specifies the goals, constraints and procedures in terms of setpoint changes (process tuning actions) for the automated systems rather than controlling the process directly. The computer system transforms information from the operator to the controlled process and from the controlled process back to the operator. At the same time, the computer system closes control loops with the process, making the computer a semi-autonomous controller. Situations exist where the operator directly observes the process state, such as a navigator who observes the movements of his automatically controlled vessel with respect to the environment. In other situations, displays are used to inform the operator about the current state of the process and about the future plans. Sheridan (1992) compares