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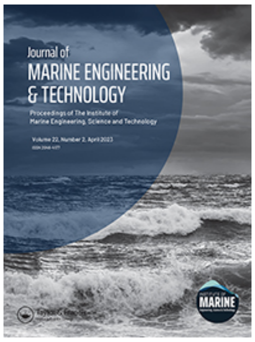


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# Naval engineering and ship control special edition editorial

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EDITORIAL



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## 1. Introduction

During the International Naval Engineering Conference and Exhibition (INEC) 2020, the state-of-the-art of international naval engineering was presented with the theme '*integrating disruptive technologies*'. In parallel, the international Ship Control Systems Symposium (iSCSS) presented the developments in ship control systems under the heading '*surfing the digital revolution*'. These two conferences were held alongside each other online from 6 to 8 October 2020 and this special edition includes the best scientific research that was presented during these IMarEST learned society events, as a second edition after the successful first Naval Engineering and Ship Control special edition (Geertsma 2020). The two themes of this special edition on naval engineering and ship control are:

- The safety and efficiency of automated and autonomous manoeuvring and its required steps in automation and data fusion (Damerius et al. 2023; Liu et al. 2023; Chan et al. 2023);
- The influence of operator decisions, automation systems and the design of hybrid propulsion and hybrid power systems on the energy efficiency and emissions of ships (Damerius et al. 2023; Vasilikis et al. 2023).

## 2. Background

Shipping is utilising increasing levels of automation with the ultimate aim of autonomous navigation (Zaccone and Martelli 2019). Autonomous navigation first requires sufficient levels of situational awareness through a combination of sensors (Liu et al. 2022) and accurate position estimation (Liu et al. 2023), and subsequently demands collision avoidance and path planning algorithms that ensure safe navigation (Oztürk et al. 2022). This could be considered from a collaborative approach in which vessels are aware of other ship's planned route and intentions (Solnør et al. 2022). Alternatively, autonomous algorithms need to respond based on the situational awareness built up by the fusion of multiple sensors and information sources (Liu et al. 2023). However, the path towards fully autonomous navigation requires a gradual approach with increasing levels of human–machine interaction, with increasing levels of automation and intelligence (Damerius et al. 2023; Chan et al. 2023), while safety needs to be ensured at all times (Veitch and Andreas Alsos 2022; Huang et al. 2020; Zheng et al. 2017).

Alongside autonomy and automation, the second key theme for the maritime sector is the need to reduce the global warming impact and other hazardous emissions of ship operations. The emissions of ships can be reduced by changing its operation (Barreiro et al. 2022; Hoang et al. 2022), by changing its design (Geertsma et al. 2017) and by changing its fuels and power sources (van Biert et al. 2016). Advanced path planning and weather routeing algorithms can support increasing efficiency of the operation, thus reducing emissions (Zaccone et al. 2018; Zaccone and Figari 2017; Perera and Soares 2017). In order to evaluate the impact of automated or advisory algorithms and operator decisions, the evaluation of ship energy efficiency is crucially important (Barreiro et al. 2022). This is equally important when evaluating alternative designs, power sources and energy management strategies (Geertsma et al. 2017; van Biert et al. 2016; Xie et al. 2022). Therefore further development of techniques for ship energy systems evaluation is required.

## 3. Research in this special issue

### 3.1. Safety and efficiency of automated and autonomous manoeuvring

Safety and efficiency of ship manoeuvring can be enhanced by automation and ultimately by well design autonomous algorithms and systems (Veitch and Andreas Alsos 2022; Zaccone et al. 2018). Damerius et al. (2023) present a gradual approach from the current level of automation of navigation, via increasingly advanced advisory systems towards, ultimately, autonomous navigation, extending Schubert et al. (2020b). The work demonstrates the development of an advanced manoeuvre plan for ship navigation in port and during berthing and presents an analysis of manual assisted and automatic berthing manoeuvres. Trials in the simulator and with the research vessel DENEB clearly demonstrate that significant energy reductions can be achieved by the proposed manoeuvre plans and automated manoeuvring.

Path planning algorithms require accurate position estimation. Liu et al. (2023) propose to use a novel Unscented Kalman Filter (UKF) algorithm to accurately estimate the position based on data from three sensors: an Inertial Measurment Unit (IMU), a Global Positioning System (GPS) and an electronic compass. This algorithm uses the knowledge on the dynamic behaviour of the vessel using a full non-linear dynamic model of a ship before applying the UKF algorithm presented in Liu et al. (2020). Evaluation of the algorithm with a system measurement model demonstrated that the acquired position during navigation with the UKF-based approach closely correlated with the actual position, and improved upon data from the sensors.

Chan et al. (2023) evaluate the safety of navigation due to the reliance on automated bridge systems in an extension to the work presented in Schubert et al. (2020a). They assess the response of navigational officers to faults in modern bridge systems using a navigational simulator with a novel Event Tree Analysis method. The work demonstrates that sufficient training and sufficient levels of clear alarms are required to ensure faults are identified by the navigational errors before accidents are likely to occur. Further development of increased automation, more advanced advisory systems and, ultimately, partially autonomous navigation requires thorough evaluation of human–machine interaction, in order to ensure safe navigation.

### 3.2. Energy efficiency

To reduce the global warming impact due to $CO_2$ emissions and the impact of other hazardous emissions, evaluation of energy efficiency of ships is crucial. Vasilikis et al. (2023) present a novel methodology to evaluate the energy efficiency of ships using data from a state-of-the-art integrated platform management system as an extension to the work presented during the International Naval Engineering Conference (Vasilikis 2020). This addresses shortcoming of current methods to evaluate energy efficiency using indicators such as the Energy Efficiency Design Index (EEDI) of newbuild vessels, which just considers one operating point and the annual operational carbon intensity indicator (CII), which is only applicable if the ship's operation is consistent over the years. The analysis clearly demonstrates how ship data can be used to provide feedback to the operator for planning ship speeds during a transit and to indicate potential design improvements, in order to reduce part load losses, in particular due to gearbox losses and part load operation of electric motors and power sources. In conclusion, the continuing advance of data logging and analysis is a key enabler for continuing reduction of energy use in ships and thus the reduction of their environmental impact.

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