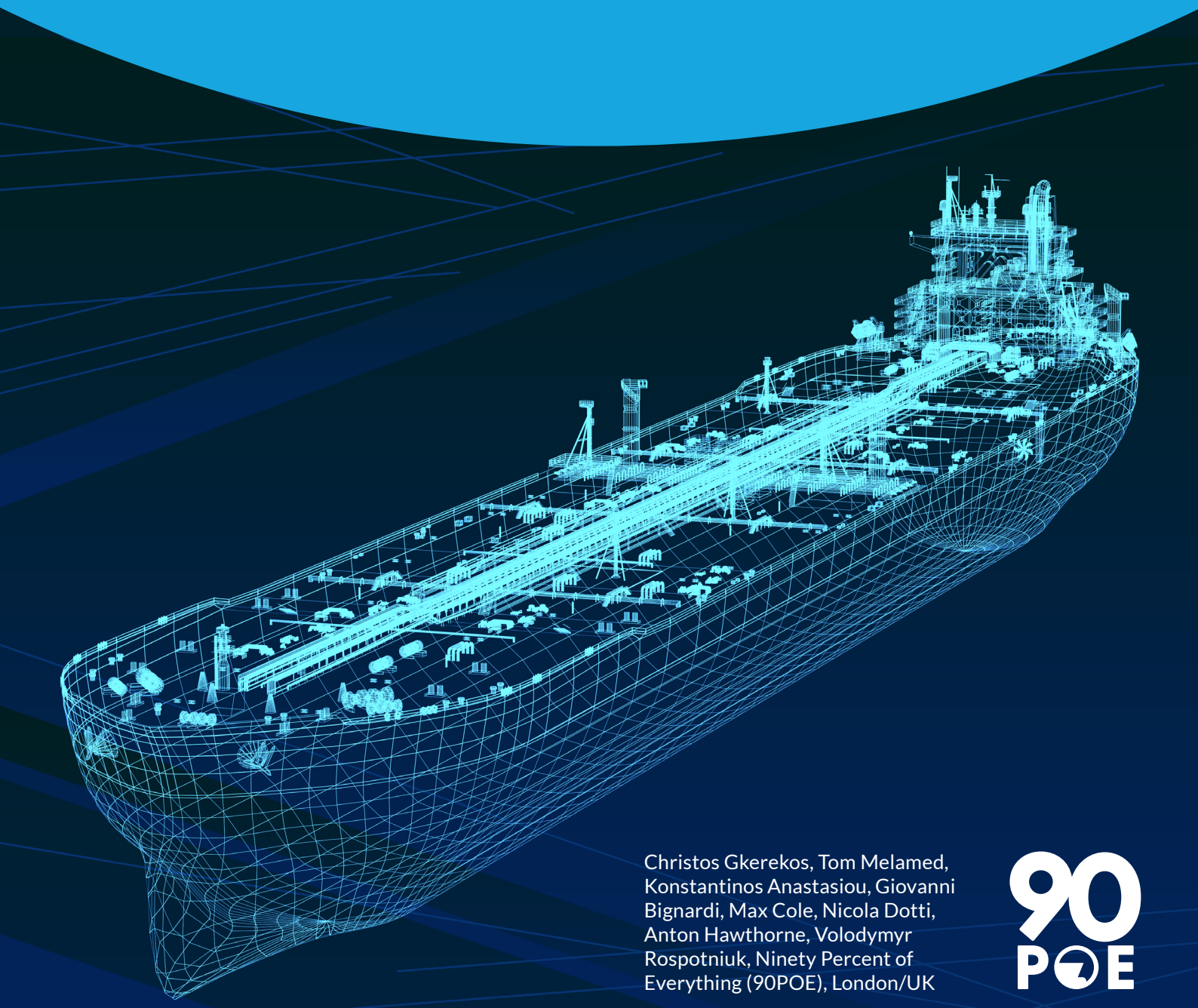
Actionable Insights, Optimal Performance:

The 90POE Digital Twin Advantage for Vessel Performance



Christos Gkerekos, Tom Melamed, Konstantinos Anastasiou, Giovanni Bignardi, Max Cole, Nicola Dotti, Anton Hawthorne, Volodymyr Rospotniuk, Ninety Percent of Everything (90POE), London/UK

90POE

Actionable Insights, Optimal Performance: The 90POE Digital Twin Advantage for Vessel Performance

In the face of rising costs and tightening environmental regulations, the maritime industry is actively seeking a competitive edge.

This whitepaper will explain how our Digital twins combine advanced analytics, machine learning, and domain expertise to allow our platform, OpenOcean STUDIO to provide actionable insights for vessel operators, helping them make data-driven decisions to improve operational efficiency, reduce fuel consumption, and ensure regulatory compliance.

The pressure to optimise vessel performance, reduce environmental impact, and lower operational costs has never been greater. 90POE provides a powerful solution: a comprehensive suite of performance-oriented digital twins within the OpenOcean STUDIO platform, engineered to deliver tangible results.

By combining advanced analytics, machine learning, and unparalleled maritime domain expertise, our platform provides you with the data-driven intelligence needed to make impactful decisions.

Experience accurate performance predictions, real-time degradation monitoring, optimised route planning, enhanced regulatory compliance, and ultimately, a more efficient and sustainable maritime operation.

Key benefits:

Accurate prediction of vessel performance under various conditions

Real-time monitoring of hull and equipment degradation

Basis for optimised route planning and fuel consumption estimates

Enhanced compliance with environmental regulations

Data-driven decision making for maintenance and operations

The Challenge: Vast data, minimal insight

The maritime industry faces unprecedented challenges in today's complex operational environment.

Rising fuel costs and volatile oil prices continue to squeeze profit margins, forcing vessel operators to seek innovative ways to optimise their operations.

Simultaneously, increasingly stringent emissions regulations, including IMO 2020 sulfur caps and the Carbon Intensity Indicator (CII), are reshaping the industry's approach to environmental compliance, requiring significant adaptations to vessel operations and management practices.

These increasing regulatory pressures, along with volatile fuel prices and global sustainability mandates are driving an urgent need for innovation and efficiency.

While vast amounts of data are available from noon reports, onboard sensors and AIS feeds, industry estimates suggest that approximately 90% of this data never leaves the vessel.

This represents a major missed opportunity and a significant loss of potential profit for operators.

90POE's performance-oriented Digital Twins bridge the gap between data collection and actionable intelligence empowering ship operators to transform this untapped data into actionable insights, enabling more efficient operations, reduced fuel consumption and improved environmental performance.

The Solution: 90POE's Performance-Oriented Digital Twins

90POE has developed a comprehensive suite of digital twins within our OpenOcean STUDIO platform, designed to address the complex challenges facing the maritime industry.

Our solution leverages advanced analytics, machine learning, and maritime domain expertise to transform vessel data into actionable insights that drive operational efficiency and sustainability.

The OpenOcean STUDIO platform offers three specialised digital twin models that work together to provide a complete picture of vessel performance. Each model is engineered for a specific layer of vessel performance:

The OpenOcean STUDIO Digital Twin Suite:

- Vessel Propulsion Digital Twins (VPDTs) known as virtualVESSEL
  Physics-informed models combined with machine learning to predict engine power, fuel use, and RPM across varying speed, drafts, and sea conditions.
- Performance Degradation Digital Twins (PDDTs) [Hull & Propeller]

Built on the virtualVESSEL framework, these models track hull and propeller degradation over time, helping determine the ideal timing for maintenance or cleaning. *See Fig.1*

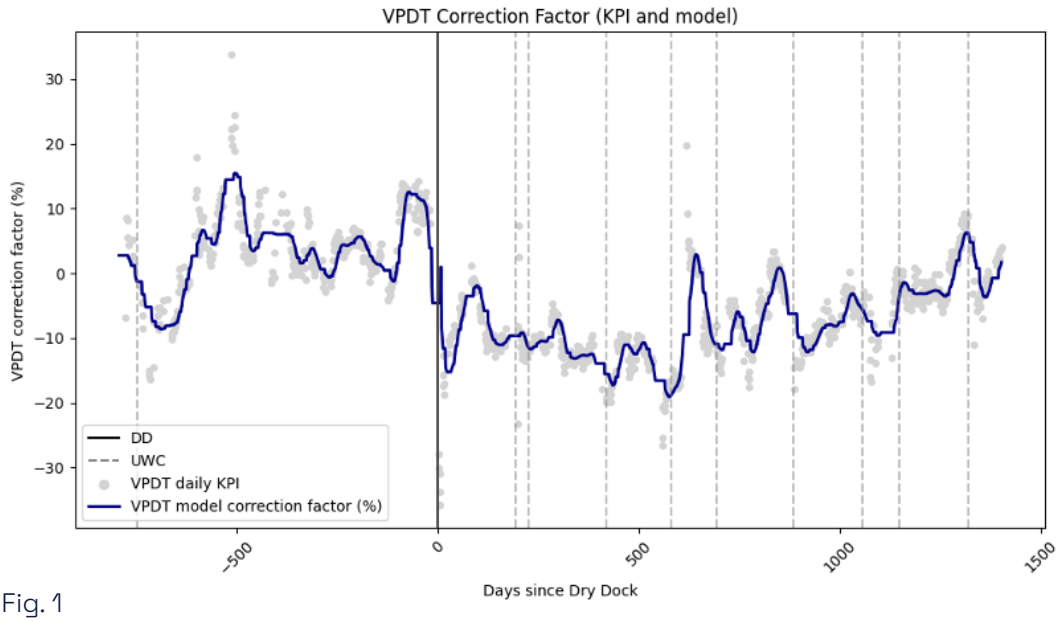


Fig. 1

- Speed-Fuel Curves (SFCs)
  Provide reliable estimates of fuel consumption under good-weather conditions, aiding in route planning, charter pricing, and performance benchmarking.

Together, these models deliver a comprehensive, layered view of vessel performance, each one providing a different lens on operational health, fuel efficiency, and predictive maintenance needs

The Impact: Smarter decisions, better outcomes

By converting raw onboard data into meaningful, actionable insights, these models help operators solve real-world challenges: from rising fuel costs and tightening environmental regulations to inefficiencies in routing and maintenance.

The result is a smarter, more responsive approach to vessel performance management.

Benefits and Advantages

1

Operational improvements and cost savings:

- Identify propulsion inefficiencies and monitor improvements in real time
- Reduce fuel consumption and emissions

2

Smarter maintenance planning:

- Track hull and propeller fouling over time
- Schedule maintenance when it delivers the greatest return on investment

3

Enhanced voyage planning and fuel consumption:

- Optimise routing, speed and loading for fuel efficiency
- Predict vessel performance across various operating conditions

4

Accessible, actionable insights:

- Make data-driven decisions that improve operational efficiency
- Stay ahead of the competition

CASE STUDIES

Real-World Applications of 90POE's Digital Twins

Cape Size Vessel Performance Optimisation

We applied our suite of digital twins to a Cape size bulk carrier, analysing approximately 6.5 years of operational data. The data sources included noon reports, Automatic Identification System (AIS) data, weather hindcasts, and high-frequency data collected at minute intervals and averaged into 10-minute windows.

The VPDT was trained using the most recent 12 months of available data, while the SFCs were trained in rolling 6- and 12-month windows to balance accuracy and responsiveness to changes. The PDDTs used the same underlying model as the virtualVESSEL, with the most recent 12 months serving as the performance baseline.

Key findings include:

- The combined virtualVESSEL and PDDT models achieved a mean Symmetric Mean Absolute Percentage Error (SMAPE) of 4.77% in power prediction, compared to 7.07% for the VPDT alone, representing a significant improvement in accuracy. *See Fig.3*

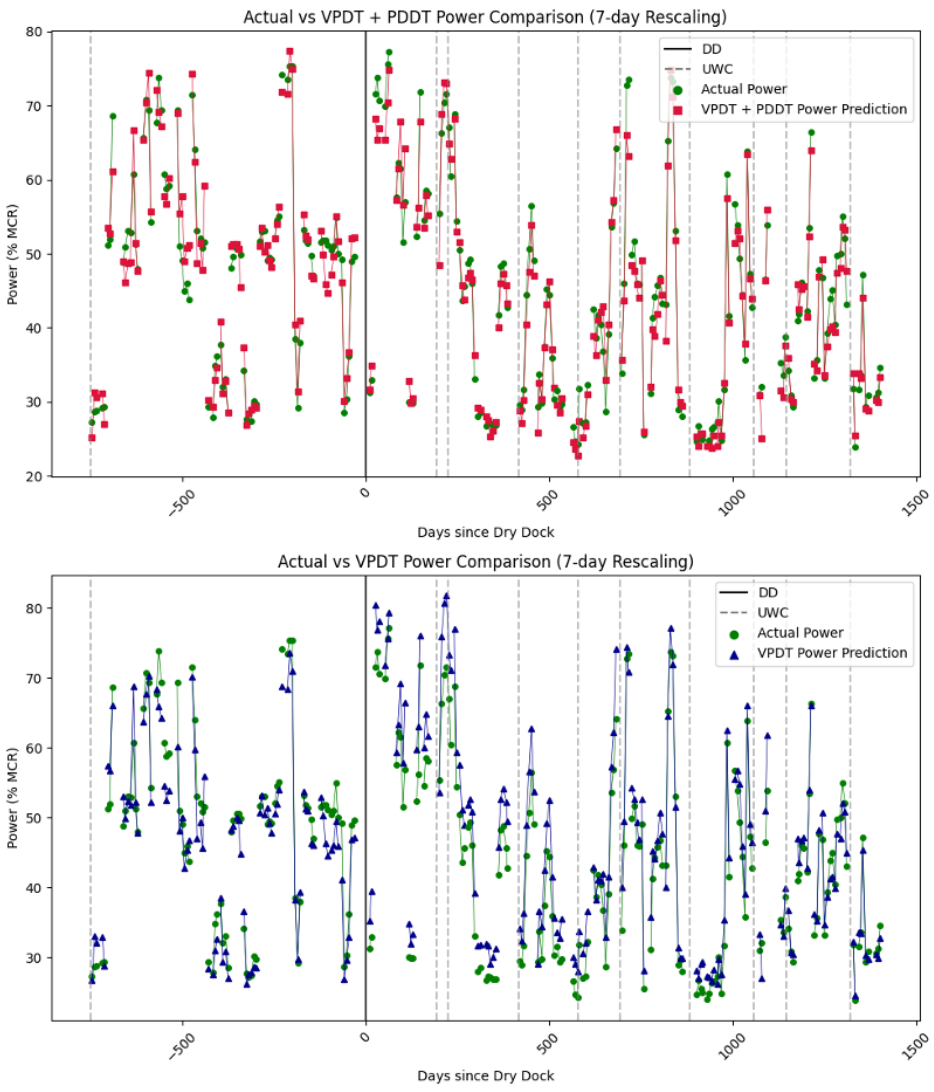
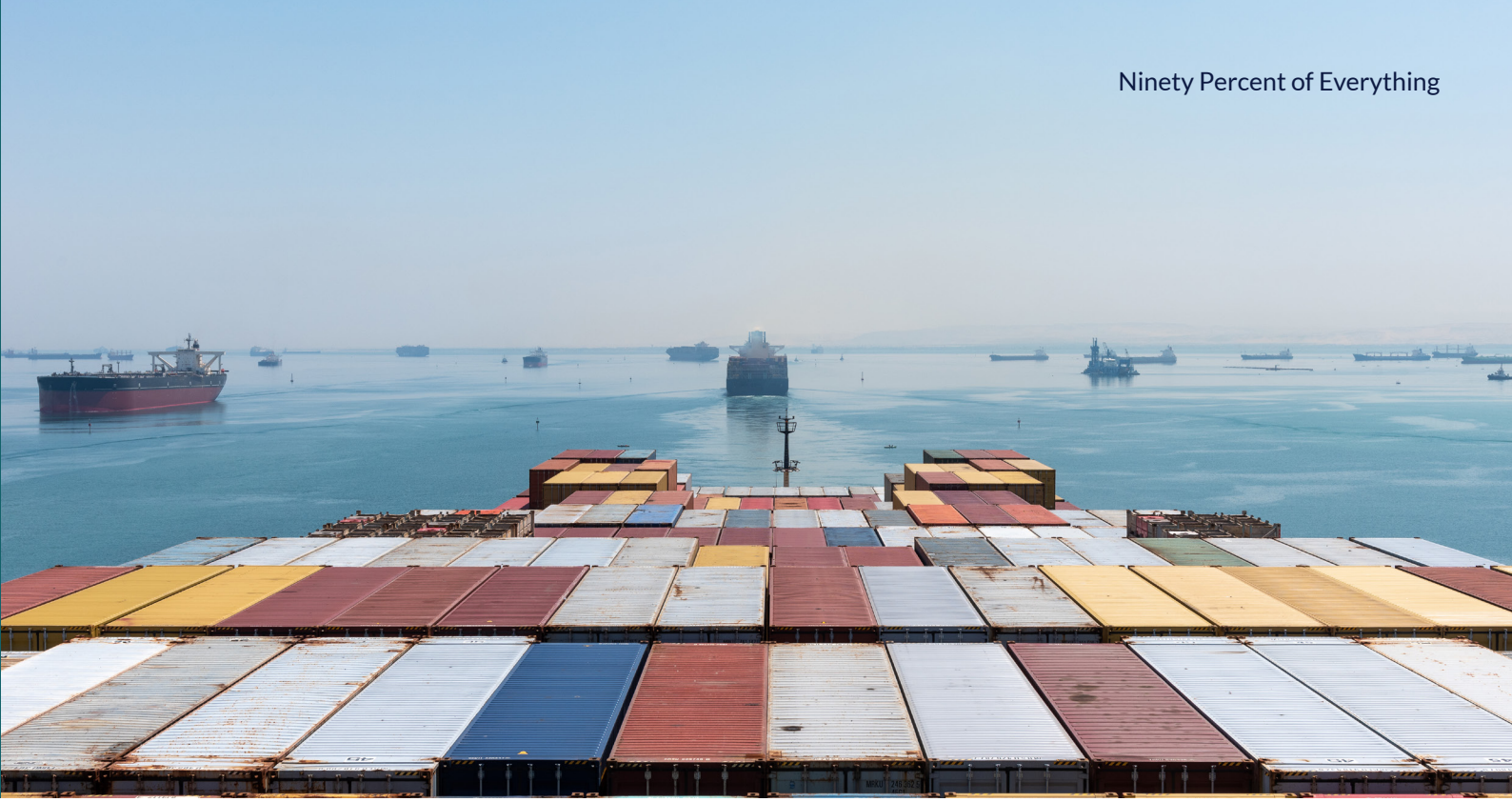


Fig. 3



- Clear performance degradation trends were identified through the PDDT, allowing for targeted maintenance interventions.
- Speed-fuel curves revealed the impact of hull fouling over time, with the curves for the period immediately after dry docking showing the lowest Daily Fuel Oil Consumption (DFOC) in both load conditions, and a gradual increase observed in the windows before and after dry docking. *See Fig.4*
- The analysis suggested that another dry docking would be highly beneficial at the current point, as the vessel's DFOC was higher compared to the last windows before the previous dry docking.

This case study demonstrates how 90POE's digital twins can provide comprehensive insights into vessel performance, enabling data-driven decisions about maintenance scheduling, operational optimisation, and long-term fleet management.

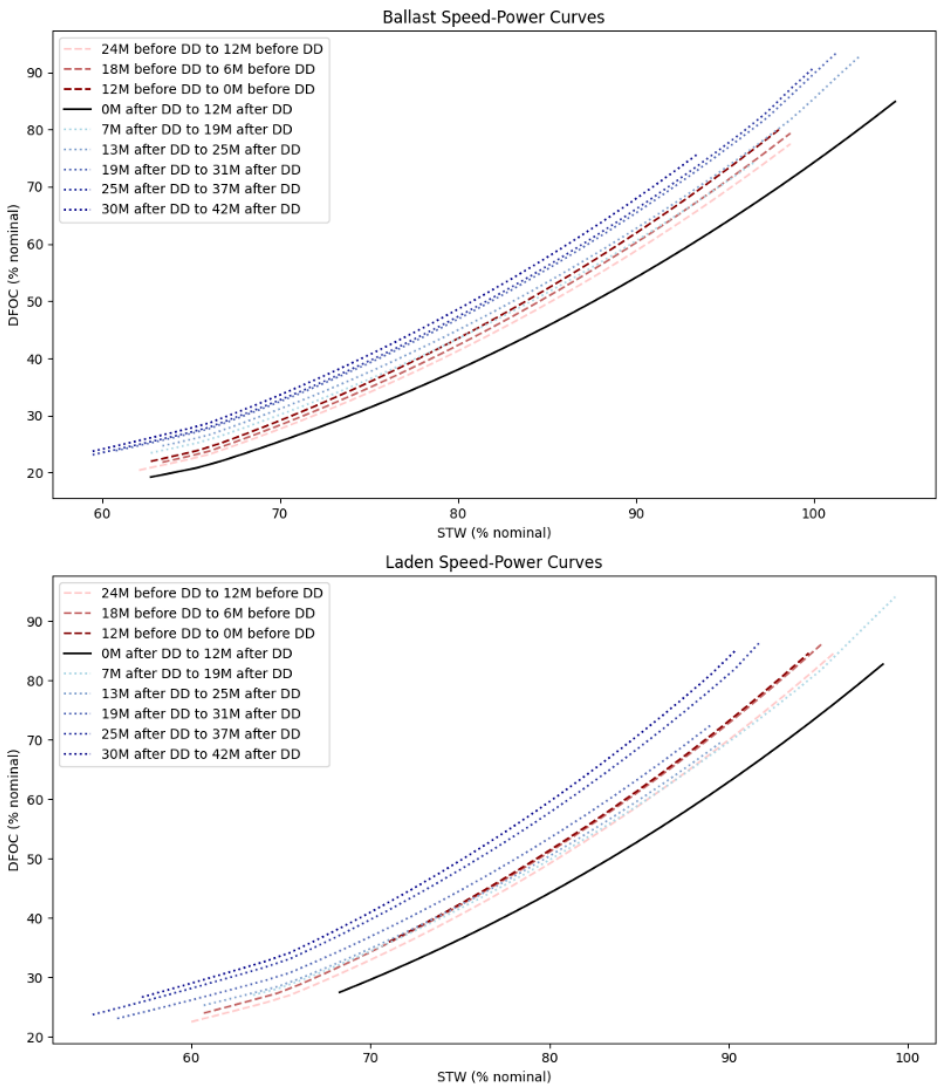


Fig. 4

Future Trends and Implications

The maritime industry is poised for further digital transformation, with several key trends shaping the future of vessel performance optimisation. As technology continues to advance, the capabilities of digital twins will expand, offering even greater insights and value to maritime operators.

One significant area for future development is improving sensor reliability and developing methods to trust and validate sensor data. This will enhance the accuracy and reliability of the digital twin models, ensuring that the insights they provide are based on high-quality data.

Additionally, leveraging extensive datasets to create typical models for vessels based on their principal particulars could further enhance the accuracy and applicability of digital twins. This would enable more precise performance predictions for vessels with limited historical data.

The integration of advanced Machine Learning models in maritime operations represents a necessary step toward achieving significant operational improvements.

By continuously refining these models and exploring new research avenues, the maritime industry can remain at the forefront of technological innovation.

Conclusion

90POE's suite of performance-oriented digital twins offers a comprehensive solution for maritime efficiency optimisation. By leveraging advanced analytics and domain expertise, vessel operators can make data-driven decisions that lead to significant cost savings, improved environmental performance, and enhanced competitiveness in the global maritime market.

The combination of Vessel Propulsion Digital Twins, Performance Degradation Digital Twins, and Speed-Fuel Curves provides a holistic view of vessel performance that enables informed decision-making about maintenance scheduling, route planning, and operational optimization. This multi-faceted approach drives significant improvements in fuel efficiency and emissions reduction, addressing the key challenges facing the maritime industry.

As the industry continues to evolve in response to regulatory pressures, economic challenges, and environmental concerns, the role of digital twins in optimizing vessel performance will become increasingly important. By embracing these technologies and the insights they provide, maritime operators can navigate the complex landscape of modern shipping with greater efficiency, sustainability, and profitability.

Appendix: Glossary of Terms

- VPDT: Vessel Propulsion Digital Twin - A model that combines physical propulsion principles with machine learning to predict vessel power, fuel consumption, and engine RPM.
- PDDT: Performance Degradation Digital Twin - A model that assesses day-to-day vessel performance and tracks degradation over time, particularly hull and propeller fouling.
- SFC: Speed-Fuel Curve - A model that provides reliable estimates of fuel consumption under good weather conditions based on vessel draft and speed.
- SMAPE: Symmetric Mean Absolute Percentage Error - A measure of prediction accuracy that treats over- and under-predictions equally.
- CII: Carbon Intensity Indicator - An IMO regulation that imposes increasingly strict operational efficiency targets to reduce emissions.
- IMO: International Maritime Organization - The United Nations specialized agency responsible for regulating shipping.

For more information contact

contact@90poe.io
www.90poe.io