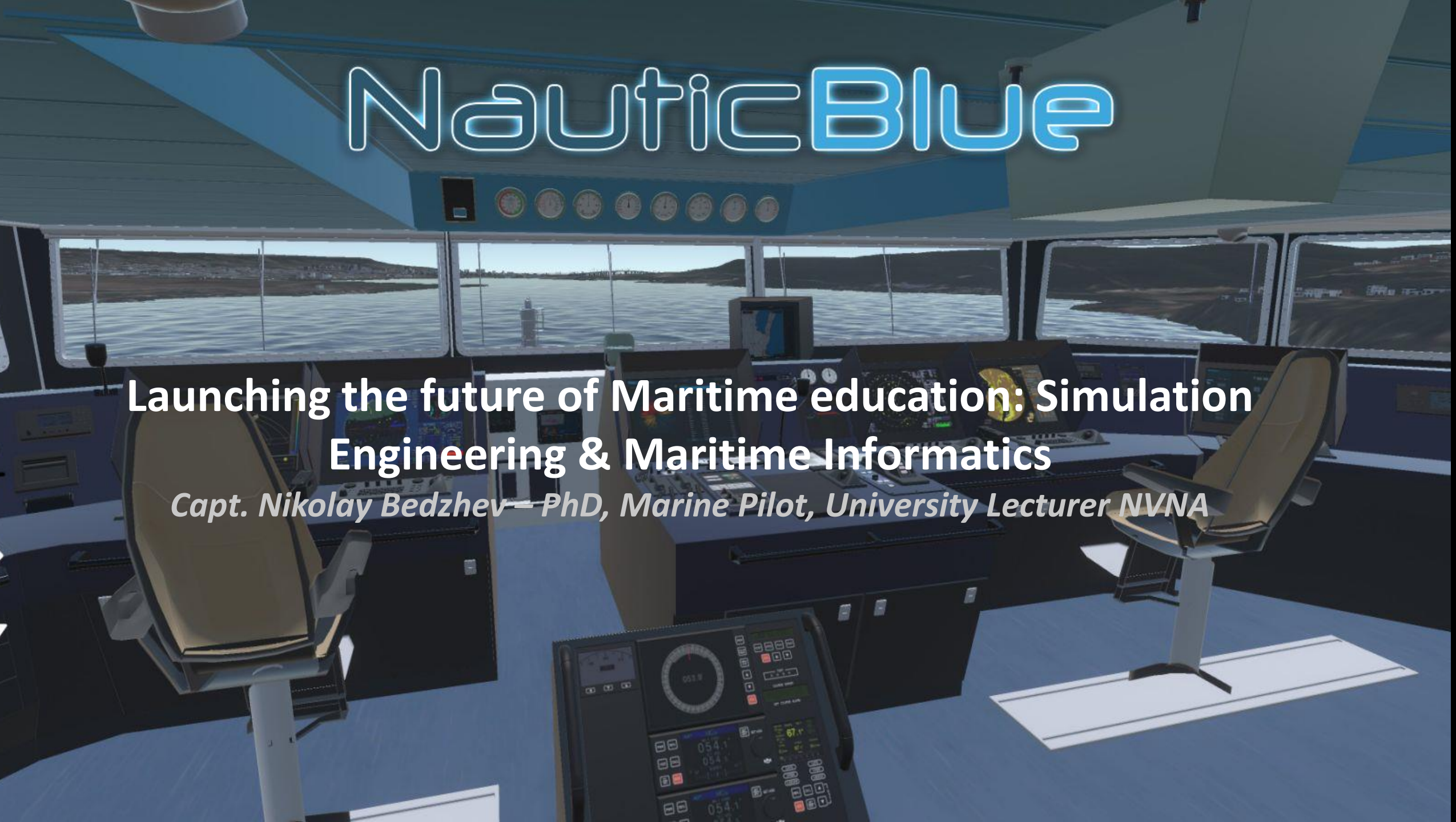


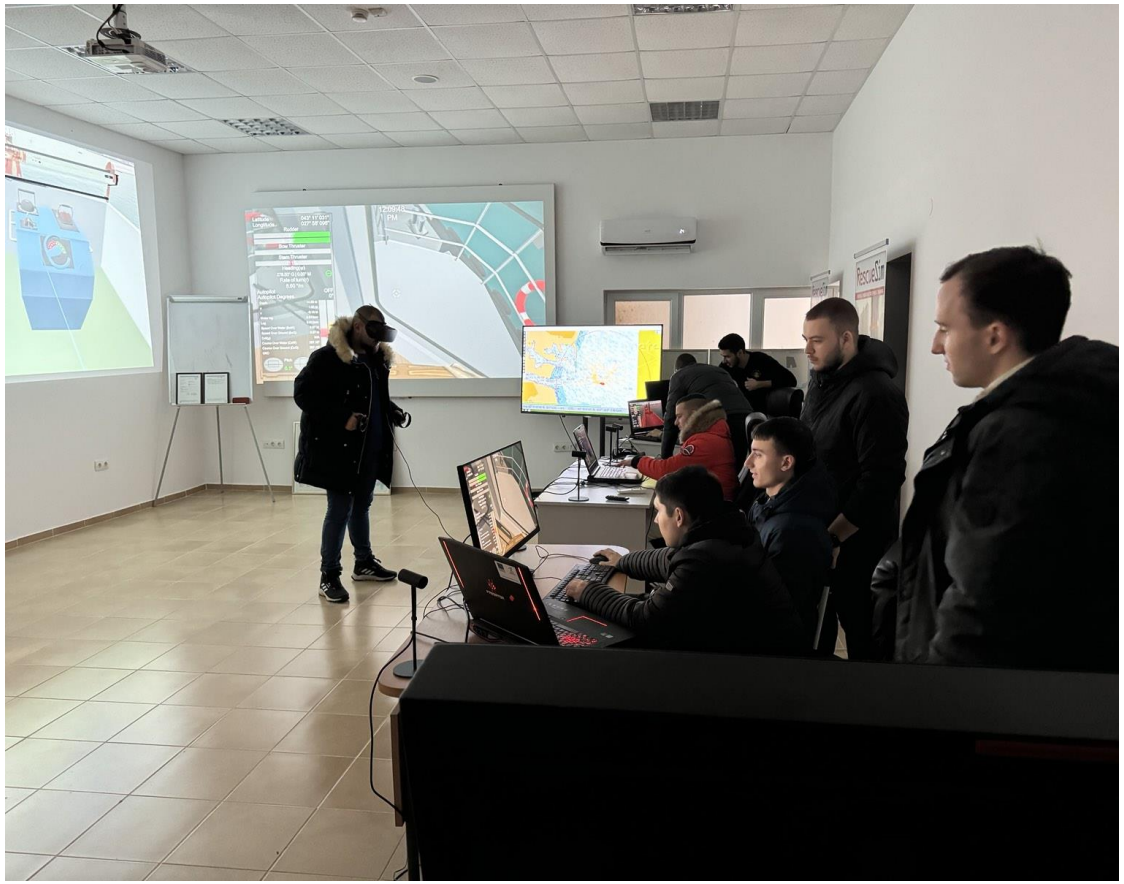
Launching the future of Maritime education: Simulation Engineering & Maritime Informatics

Capt. Nikolay Bedzhev – PhD, Marine Pilot, University Lecturer NVNA

From Dynamic Fidelity to Full Immersion

- VR technology:
- ✓ Remote learning potential
- ✓ Ease of deployment
- ✓ Flexibility across platforms
- Modern simulators combine:
- ✓ High-fidelity ship physics
- ✓ Immersive VR and desktop modes
- ✓ Online access for training anywhere in the world

□ Virtual Reality in Maritime Simulation



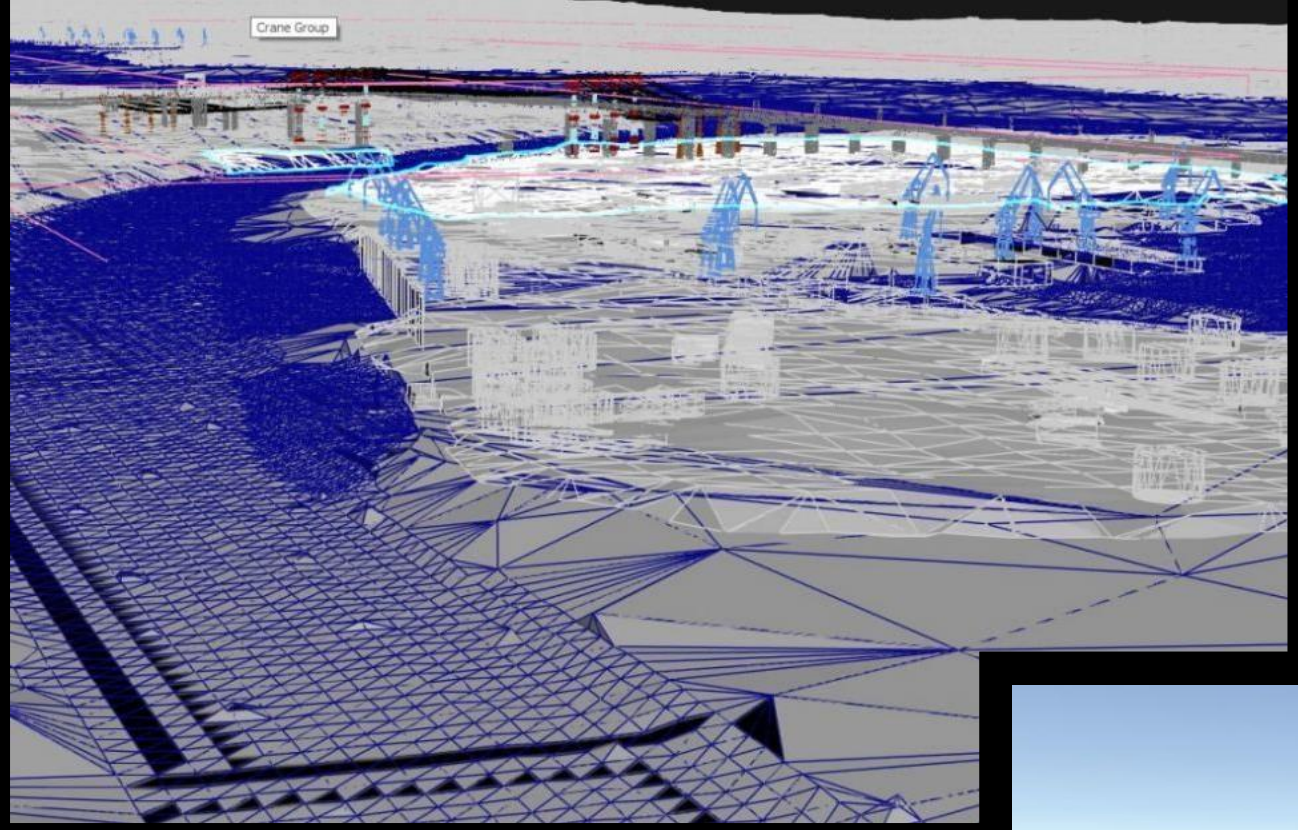
✅ Advantages of VR:

- Full immersion in realistic maritime environments
- Enhanced situational awareness and spatial orientation
- Effective training for emergency situations
- Portable & scalable – ideal for remote or onboard training
- Compatible with cloud-based instructor stations and assessment systems

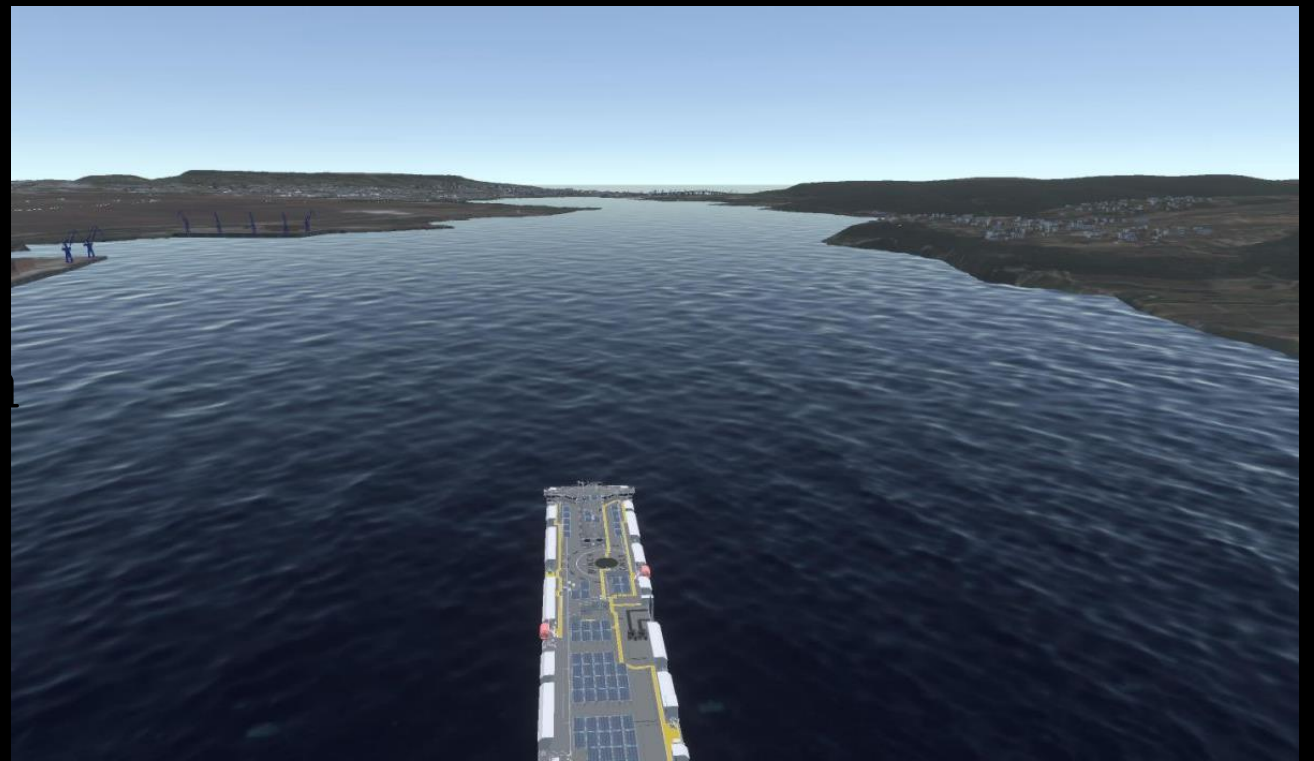
⚠□ Limitations of VR:

- Less precise interaction with complex control panels and instruments
- Possible motion sickness for some usersHardware requirements and maintenance
- Not always suitable for long-duration sessions or precise operations (e.g., ECDIS use)

🔀 Best Practice: Hybrid Setup VR + Desktop + Real Bridge Hardware

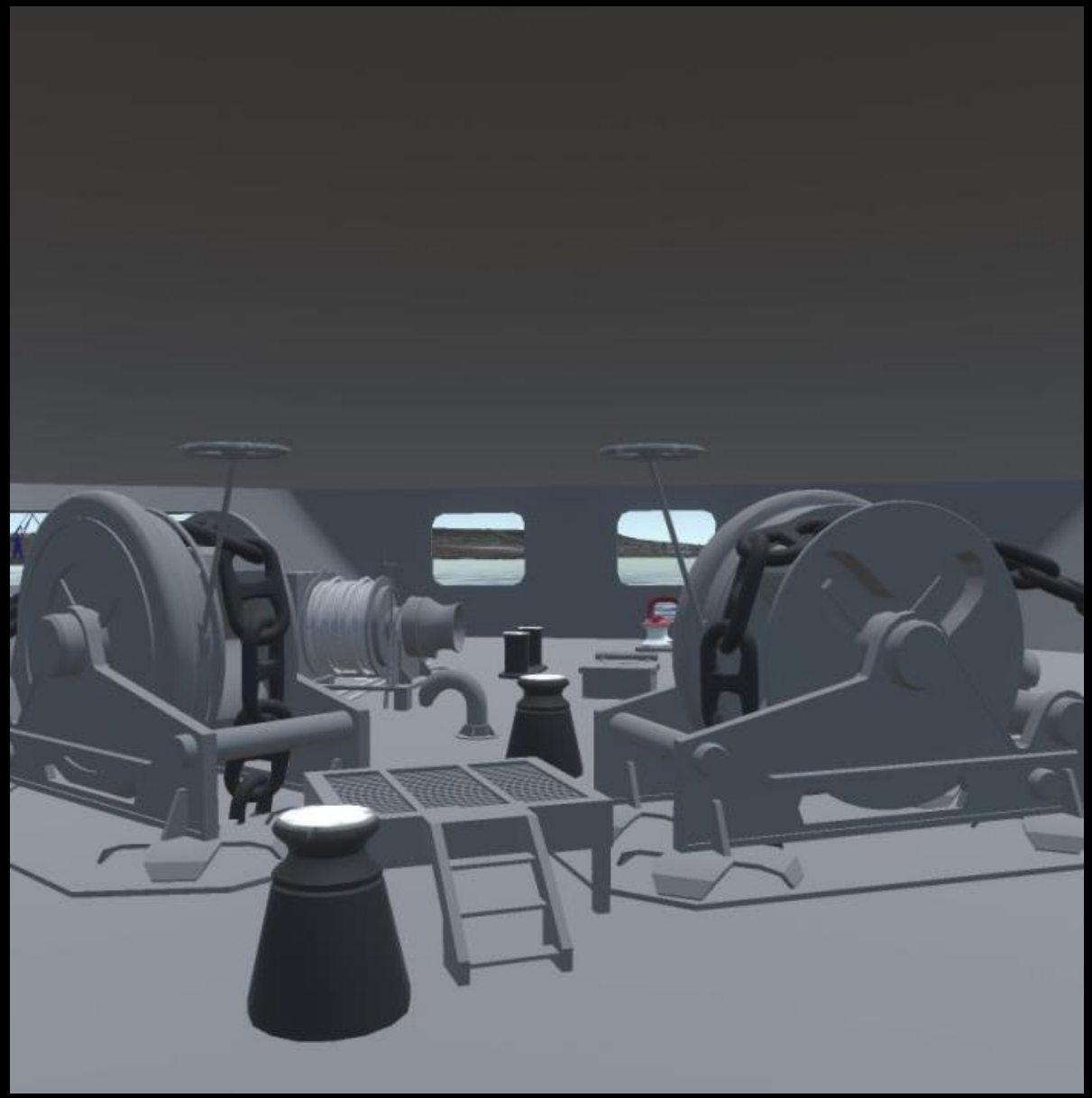


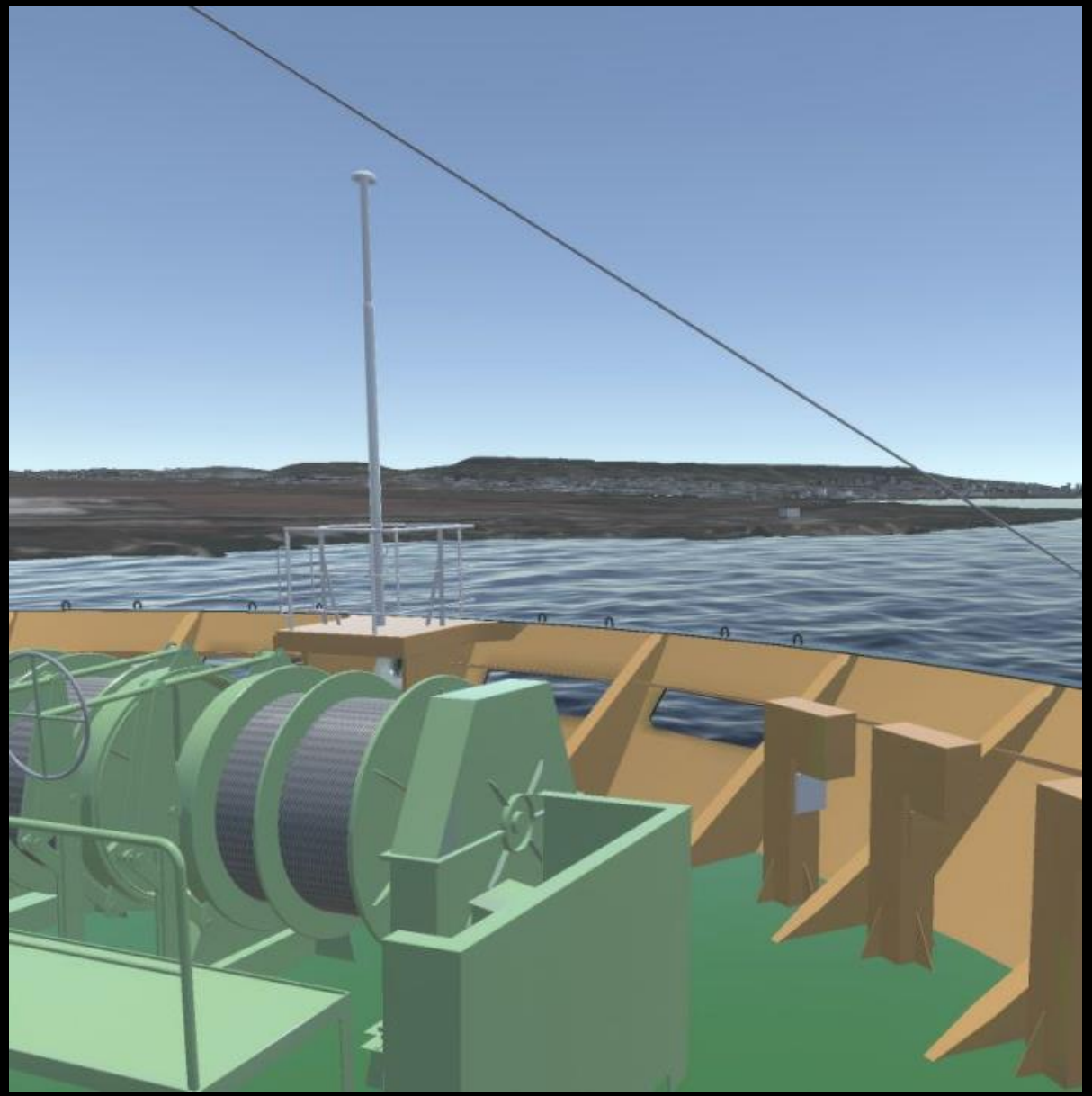
GIS and the Ocean



Marlow Blue Simulator

- Specialized VR and Desktop-Based Simulator for Master-Pilot Exchange Training with Emphasis on Operational and Cognitive Skill Development



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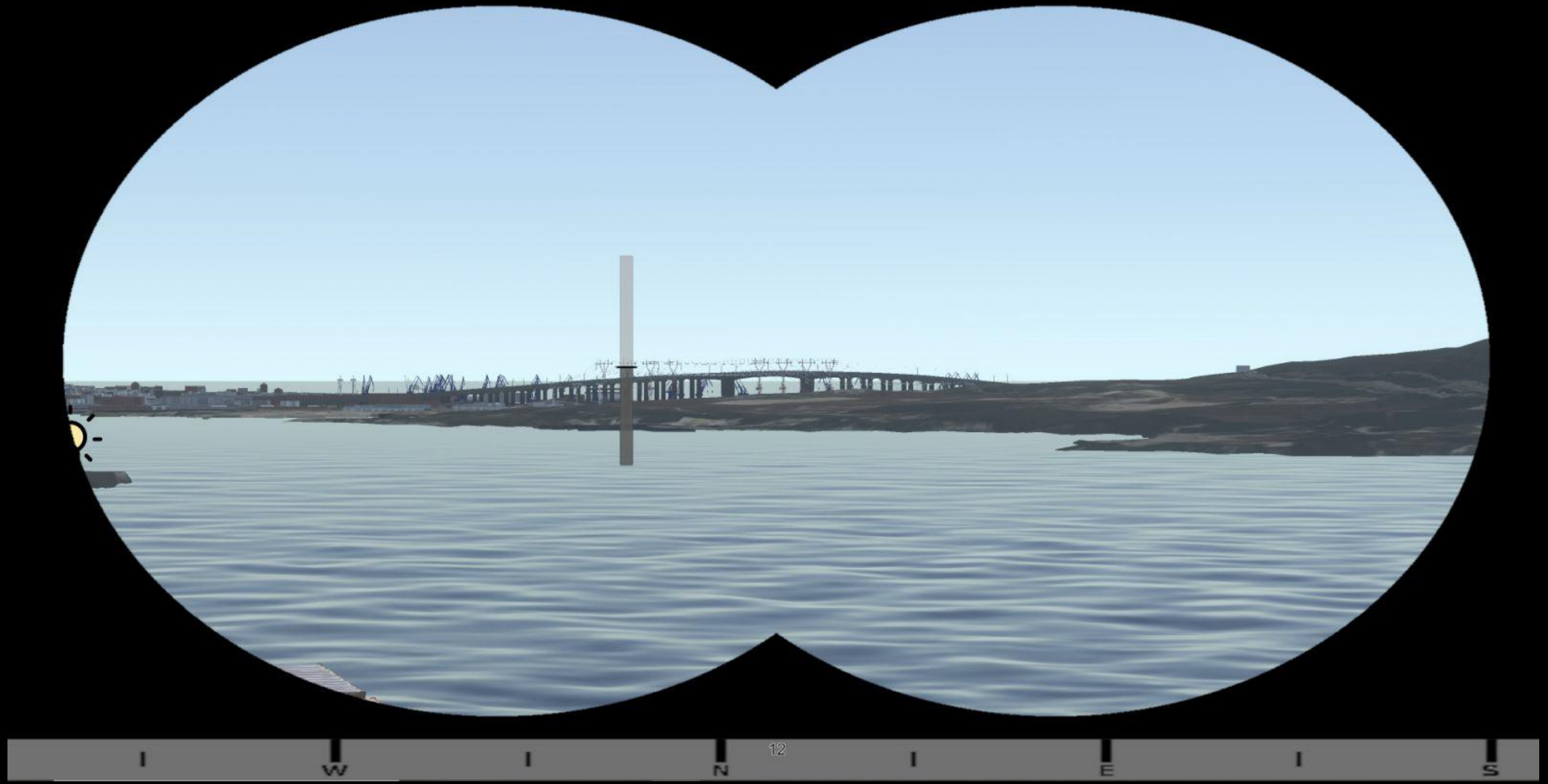
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Advanced Modeling in Maritime Simulation

Dynamic Models • CFD • PINNs • Data-Driven Models (DDM)

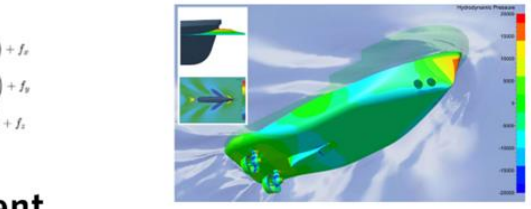
Dynamic Simulation | Hydrodynamic Theory | Computational Fluid Dynamic (CFD)

$$\frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z} = 0$$

$$\frac{\partial V_x}{\partial t} + V_x\frac{\partial V_x}{\partial x} + V_y\frac{\partial V_x}{\partial y} + V_z\frac{\partial V_x}{\partial z} = -\frac{1}{\rho}\frac{\partial p}{\partial x} + \nu\left(\frac{\partial^2 V_x}{\partial x^2} + \frac{\partial^2 V_x}{\partial y^2} + \frac{\partial^2 V_x}{\partial z^2}\right) + f_x$$

$$\frac{\partial V_y}{\partial t} + V_x\frac{\partial V_y}{\partial x} + V_y\frac{\partial V_y}{\partial y} + V_z\frac{\partial V_y}{\partial z} = -\frac{1}{\rho}\frac{\partial p}{\partial y} + \nu\left(\frac{\partial^2 V_y}{\partial x^2} + \frac{\partial^2 V_y}{\partial y^2} + \frac{\partial^2 V_y}{\partial z^2}\right) + f_y$$

$$\frac{\partial V_z}{\partial t} + V_x\frac{\partial V_z}{\partial x} + V_y\frac{\partial V_z}{\partial y} + V_z\frac{\partial V_z}{\partial z} = -\frac{1}{\rho}\frac{\partial p}{\partial z} + \nu\left(\frac{\partial^2 V_z}{\partial x^2} + \frac{\partial^2 V_z}{\partial y^2} + \frac{\partial^2 V_z}{\partial z^2}\right) + f_z$$



python™ C# ANSYS Fluent

🔁 Dynamic Models (FDM/FEM):
Used to simulate ship motion, control, sea forces and maneuvering. Essential for training in realistic physics environments.

🌊 CFD (Computational Fluid Dynamics):
CFD is used to model flow around hulls, wave resistance, propeller interaction and shallow water effects.

🧠 PINNs (Physics-Informed Neural Networks):
These are AI models that learn from data but obey physical laws (PDEs).

📈 Data-Driven Modeling (DDM):
Combines sensor data, simulations, and AI to predict ship behavior and support decision

Simulation Engineering and Maritime Informatics

✓ Tailor-made solutions to meet the specific needs of each shipowner or fleet manager
✓ Mobile and cost-effective setup, deployable on board, in offices, or in training centers
✓ Highly realistic and dynamic simulation, with scientifically validated fidelity
✓ Seamless integration of AI, sensors, and human factors assessment
✓ Easy installation and cross-platform compatibility
✓ Designed for education, professional training, and advanced research

⚓ Future Plans – Saving Lives at Sea and Higher Education

Engine Room Simulator:

Safety and Fire Equipment Simulation:

Mooring and Anchoring Equipment Handling: