

Use of a navigation simulator to assess the human factor on fuel consumption

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1. GENERAL INFORMATION

A. Description of the practice

Antwerp Maritime Academy (AMA) is preparing a simulator experiment where a group of test participants will perform an identical voyage (see Fig. 1), including several maneuvers with a tugboat using a navigation simulator. All participants will operate the same vessel under identical weather conditions. The only variable will be the operator executing the exercise.

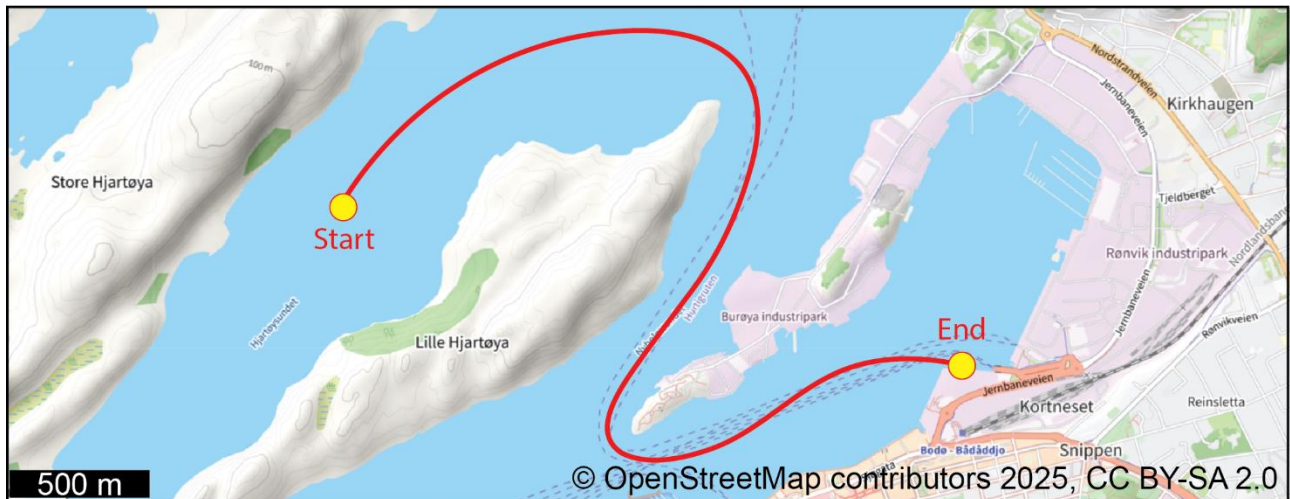


Fig. 1: Voyage to be realised to enter the port of Bodo, Norway.

B. Specific goals

The simulator will collect and store ship-related parameters in a CSV file, including fuel consumption over time, position, speed, etc.. The following objectives are defined:

- Calculate total fuel consumption, maximum fuel consumption peak, and the frequency of fuel consumption peaks and valleys of the entire operation.
- Establish a baseline benchmark for energy-efficient vessel operation by comparing individual performances against the group average.
- Assess the impact of the human factor by evaluating variations in fuel consumption between operators and determining potential efficiency gains through targeted training.
- Identify causes of fuel consumption peaks during specific maneuvers and correlate these with participant characteristics (e.g., experience level).

C. Direct impact of the practice

- Quantify the effect of experience and training on fuel consumption to optimize simulator-based training programs.
- Identify behavioral factors influencing fuel consumption.
- Define essential elements for training to reduce energy consumption effectively.

D. Place of implementation

The experiment will be conducted using the full-mission navigation simulator at AMA. Data will be collected from all participant exercises.

E. Start and end date or duration of the pilot project

The simulator experiment is scheduled to take place in May 2025.

2. CONTEXT AND DESCRIPTION

A. Description of the practice

Simulator-based training enables analysis of fuel consumption differences resulting from various maneuver execution styles while maintaining controlled environmental conditions. By monitoring and analyzing collected data, the impact of the human factor on fuel efficiency can be assessed. The findings will contribute to refining training programs to enhance energy-efficient ship handling. Furthermore, simulator experiments will help evaluate participants' competencies in fuel-efficient vessel operation.

B. Driving factor behind the adoption of the green practice

- Cost reduction and environmental impact mitigation in port operations through improved crew training.
- The necessity of using simulators to quantify fuel consumption differences before and after training.
- Enhancing awareness of fuel consumption patterns among participants by providing visual feedback on efficiency improvements.

c. Stakeholders involved

- AMA will organize the experiment using its full-mission simulator.
- Stakeholders such as pilots, tugboat masters, commercial vessel officers, and maritime students will be invited to participate.

3. IMPLEMENTATION

A. Description of the adopted practice

The simulation experiment will follow a structured process to ensure reliability:

- Design the simulation exercise, defining objectives and parameters.
- Develop a briefing outlining the task participants must complete.
- Create a questionnaire to gather basic participant characteristics.
- Prepare an observation guide for assessors to assess participants' performance during the task.
- Establish a data processing method to analyze collected operational data effectively.

A similar simulation experiment can be used as part of the training to assess the competences of the learners. This parts of the course/assessment may include the following steps:

- Define and design the simulation exercise.
- Conduct pre-training simulations and collect baseline data.
- Provide training sessions focused on energy-efficient maneuvering techniques.
- Conduct post-training simulations and collect comparative data.
- Analyze results and evaluate training effectiveness.

B. Technologies used (if applicable)

- Full-mission 360° navigation simulator at Antwerp Maritime Academy.

C. Competencies required

- Participants must have basic knowledge of ship maneuvering and navigation.
- The exercise is designed to minimize the advantage of prior familiarity with the specific vessel and operational area.
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4. COLLECTED DATA

A. Before implementation

- The simulator records all ship parameters over time, generating a time-series dataset.

B. After implementation:

- The same exercise is performed post-training, allowing for direct comparison of fuel consumption improvements.

5. ECONOMIC AND ENVIRONMENTAL ANALYSIS

A. Initial investment required

- The experiment utilizes existing AMA infrastructure, minimizing costs.
- Investment is limited to exercise design, use of the simulator, data processing, and staff involvement.

B. Key savings or economic impact

- Increased fuel consumption awareness among participants.
- Potential long-term fuel cost savings in real-world operations.

C. Contribution to environmental goals

- Reducing fuel consumption directly lowers greenhouse gas and particulate emissions.
- Improved operational efficiency contributes to sustainability goals.

6. CONCLUSIONS

A. Success of the green practices

- The experiment aims to provide insights into how human factors influence fuel consumption.
- Success will be measured through efficiency improvements and participant feedback.

B. Lessons learned:

- Identified challenges and corresponding solutions.
- Training requirements derived from experiment findings.
- Recommendations for integrating findings into maritime education and professional development.

C. Next steps

- Explore the possibility of scaling the experiment to a broader audience.
- Investigate additional variables influencing fuel efficiency.
- Implement improvements based on findings to optimize future training sessions.

7. ANNEXES (TO BE PROVIDED)

- Graphs and tables comparing fuel consumption before and after training.
- Visual documentation of the simulator setup.
- Participant testimonials and feedback.

- Exercise script will be provided shortly.

Exercise Script (To Be Provided)

The exercise script will include:

- A detailed step-by-step description of the maneuvers to be performed.
- Predefined environmental conditions, including weather, currents, and visibility settings.
- Expected operational parameters, such as speed limits and optimal fuel usage.
- Evaluation criteria for assessing participant performance.
- Guidelines for instructors on conducting the simulation and debriefing participants.