

# Preliminary hazard analysis of a small harbor passenger ferry

Results, challenges and further work

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Unlocking the potential of autonomous systems and operations through supervisory risk control

- The ferry
- Hazard analysis
- Results
- Challenges and the way forward



# The ferry (1)

- 12 Passengers
- On-demand
- One minute travel
- Shore base for monitoring
- Radio communication
- Operation expected 2020





(Eide 2018)

## The ferry (2)

#### Systems and features:

- Autonomous navigation
- Autonomous docking
- Automatic passenger registration
- All electric power system
  - Charging while docking
- Maximum speed 5 knots





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#### What are harzards and risk?

- Hazard:
  - "A hazard is a potential source of harm"
    - Ferry operation or interaction with the environment
    - Damage to people, environment, property
- Risk:
  - Consequences of an event combined with the associated probabilities
    - To what extend may the ferry's hazards lead to (negative) consequences



#### Why hazard analysis?

- Document assumptions
- Derive requirements
- Improve design
- Demonstrate compliance with regulations
- Convince the public



#### Our approach

#### Two workshops

- 1. Define the goal of the meeting
- Identify hazards and events from checklists
- 3. Estimate categorial frequency and consequences for the events
- 4. Evaluate and rank risk
- 5. Suggest mitigation measures

#### **Experts**

- Navigation
- Control engineering
- Sensor system engineering
- Naval architecture
- Risk engineering
- Industrial design
- Autonomy experts
- Electric propulsion



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### Main results – Hazards and mitigation

- Kayaks and swimmers
- Overlooked by other boats
- Blackout
- Sensor failures
- Control system failure
- Communication
- Hacking and spoofing
- NTNU

- Robust detection
- Clear marking
- Redundant and robust battery
- Functional redundancy
- Robust, tested and verified system
- Encrypted, robust, redundant
- Robust cyber security design

**UNLOCK** 

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#### Hazard/ Risk analysis methods

- Difficult to assess the interactions and deviations.
  - Possible methods: System-Theoretic Process Analysis or Functional Resonance Analysis Method
- Relative timing aspects not covered

#### Quantitative Risk analysis

- Interactions that lead to failure
  - New methods necessary
  - Few data available
- Software failure
  - Data driven modeling not possible
- Assessment of traffic in the canal.
  - Influence of the ferry



#### Baseline and acceptable risk

- No quantitative risk level has been defined previously as baseline
- The existing rules are mainly prescriptive and do not set criteria
- Statistics by the emergency service may give an indication
  - Underreporting
- Public acceptance
  - The ferry should be significantly safer than traditional ships
- Continuous improvement



#### Regulations

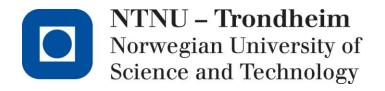
- Several functions executed by seafarers
  - Demonstration that autonomous functions are similarly safe
  - Clear definition of performance criteria
- Certification and training requirements for the onshore operator
- Water-based firefighting
  - All electric
- Recent incidents with battery-driven ferries
  - Safety requirements

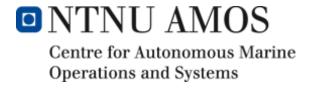


#### **Further work**

- Detailed design
- Detailed risk analysis
- Cooperation with Norwegian Maritime Authority
- Cooperation with other Stakeholders
- Share the experiences to facilitate future autonomous ships







Do you have any questions?

#### THANK YOU FOR YOUR ATTENTION!

The UNLOCK project: <a href="https://www.ntnu.edu/web/imt/unlock">https://www.ntnu.edu/web/imt/unlock</a>

#### References

- Eide, E. (2018). Kick-off meeting autoferry AVIT presentation.
- Rausand, M. (2011). <u>Risk Assessment Theory, Methods, and Applications</u>.
  Hoboken, New Jersey, USA, John Wiley & Sons.

