

Developing and testing collaborative and automated robots to support the loading process of inland tank vessels

The CoboTank project

General presentation

July 2022 – June 2025



CoboTank

Gefördert durch:



Bundesministerium
für Digitales
und Verkehr

aufgrund eines Beschlusses
des Deutschen Bundestages



IHATEC
Innovative
Hafentechnologien



Automating inland navigation



• Automated driving

- Course control
 - The vessel travels on a predefined or self-calculated path from start to destination
- Environment recognition
 - The vessel recognizes navigationally relevant environmental conditions and objects
- Navigation strategy
 - The vessel reacts to the environment and the behavior of surrounding objects
- Maneuvering in port and in front of locks
- ...

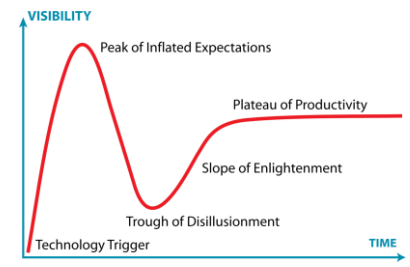
	Level	Designation	Vessel command (steering, propulsion, wheelhouse, ...)	Monitoring of and responding to navigational environment	Fallback performance of dynamic navigation tasks	Remote control
BOATMASTER PERFORMS PART OR ALL OF THE DYNAMIC NAVIGATION TASKS	0	NO AUTOMATION the full-time performance by the human boatmaster of all aspects of the dynamic navigation tasks, even when supported by warning or intervention systems <i>E.g. navigation with support of radar installation</i>				No
	1	STEERING ASSISTANCE the context-specific performance by a steering automation system using certain information about the navigational environment, and with the expectation that the human boatmaster performs all remaining aspects of the dynamic navigation tasks <i>E.g. rate-of-turn regulator E.g. trackkeeper (track-keeping system for inland vessels along pre-defined guide-lines)</i>				
SYSTEM PERFORMS THE ENTIRE DYNAMIC NAVIGATION TASKS (WHEN ENGAGED)	2	PARTIAL AUTOMATION the context-specific performance by a navigation automation system of both steering and propulsion using certain information about the navigational environment and with the expectation that the human boatmaster performs all remaining aspects of the dynamic navigation tasks				Subject to context-specific execution, remote control is possible (vessel command, monitoring of and responding to navigational environment and fallback performance). It may have an influence on crew requirements (number or qualification).
	3	CONDITIONAL AUTOMATION the sustained context-specific performance by a navigation automation system of all dynamic navigation tasks, including collision avoidance, with the expectation that the human boatmaster will be receptive to requests to intervene and to system failures and will respond appropriately				
	4	HIGH AUTOMATION the sustained context-specific performance by a navigation automation system of all dynamic navigation tasks and fallback performance, without expecting a human boatmaster responding to a request to intervene ¹ <i>E.g. vessel operating on a canal section between two successive locks (environment well known), but the automation system is not able to manage alone the passage through the lock (requiring human intervention)</i>				
	5	AUTONOMOUS = FULL AUTOMATION the sustained and unassisted performance by a navigation automation system of all dynamic navigation tasks and fallback performance, without expecting a human boatmaster responding to a request to intervene				

¹ This level introduces two different functionalities: the ability of "normal" operation without expecting human intervention and the exhaustive fallback performance. Two sub-levels could be envisaged.

Source: CCNR

What does the future hold?

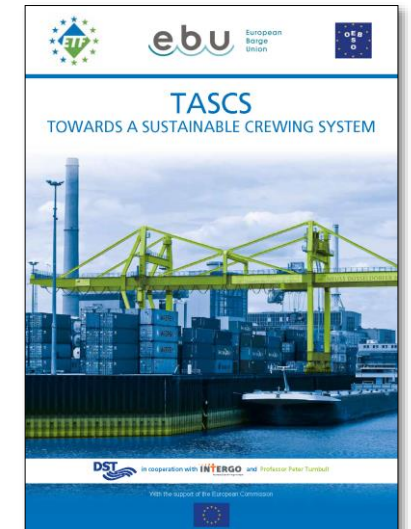
- Automated driving
- Uncrewed on-board operation
- *Autonomous ship operation (?)*
- Automated port handling



Source: Wikipedia

Introduction

- "[...] The **physical workload** can be physically demanding due to **heavy hoses** for bunkering in large ships. [...]"
- "[...] The time strain during the voyage is low or moderate for **dangerous goods** and extremely low for other goods [...]"
- "[...] The **mental workload** for skippers and sailors is considered undemanding, with the exception of **dangerous goods** [...]"
- "[...] The **physical workload** is demanding in some cases, such as [...] **handling** [...] **hoses for liquid cargo** [...]"
- "[...] The **management** of cargo handling, especially for **liquid cargo** and container **transportation**, causes additional time demands. [...]"
- "[...] In the **(rare) event of an emergency**, this [occupational safety and accident prevention, author's note] requires full attention and is **very demanding**. [...]"
- "[...] However, some tasks are considered **(extremely) demanding**, such as [...] **handling heavy hoses or** handling hazardous materials [...]"
- „[...] **Technical solutions** are also seen as possible approaches to **reducing the** time and **physical workload** of such additional tasks. Automation approaches [...] are available in principle and can be a solution in certain cases, although safety issues, costs and maintenance must also be taken into account. This also applies to physically demanding tasks such as lifting heavy ropes or hoses from very large vessels. [...]"



Sources: TASCS-Abschlussbericht / DST e. V.

Introduction



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Status quo

- Conventionally human-centered industry
- "Big loads, big muscles"
- Traditional design of systems and processes prevents disruptive innovations



Sources: HHM, DST



Source:
<https://www.discogs.com/de/artist/923852-Popeye-The-Sailor-Man>

Challenges

- **Shortage of skilled workers**
 - Physically and mentally demanding work
 - High sickness rate in the workforce
 - Early retirement of employees
- **Increased potential for errors**
 - Economic losses
 - Environmental damage
- **No consistent use of mechanized solutions**
 - Various solutions, e.g. hose reels, hose towers, loading arms, already in use - but without automation
 - No solutions available for handling different products
- **Low level of automation**
 - Obstacle to the high automation of inland navigation

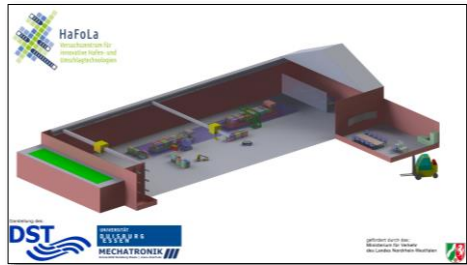


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Sources: DST e.V., Reederei Deymann Management GmbH & Co. KG

Solution approach



- **Introduction of automation**

(by means of a dual research strategy)

- Development and validation of a collaborative robot system (CoboTank)
- Proof of full automation capability in a scaled robot system (RoboTank)

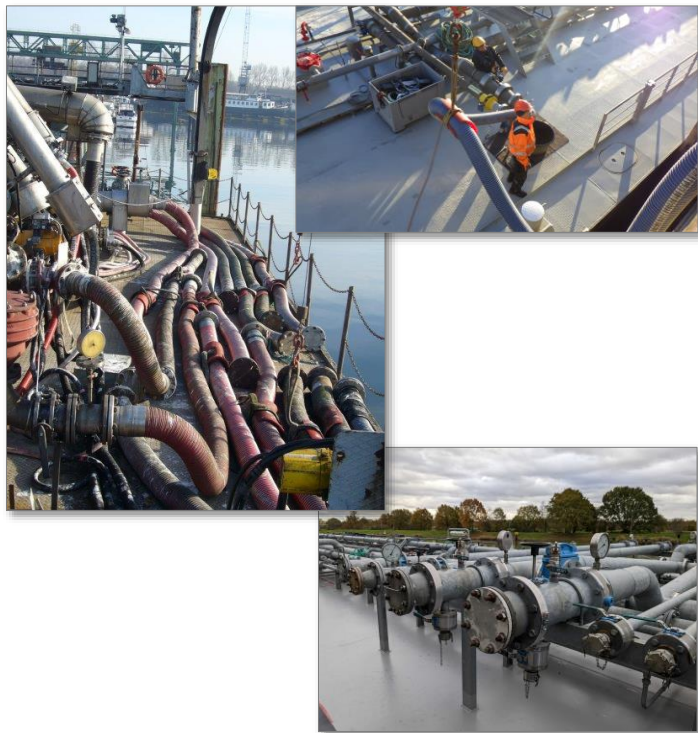
- **Holistic requirements management**

taking into account logistical, technical, physiological and psychological factors

- **Validation in application-oriented environments**

Specific focus groups

- Technical team



- Market analysis team



- Stress analysis team



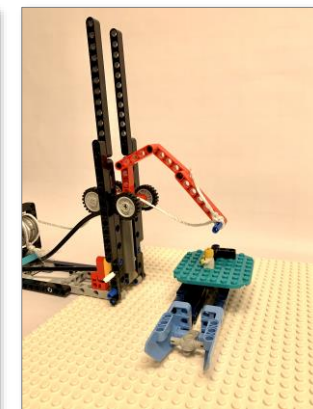
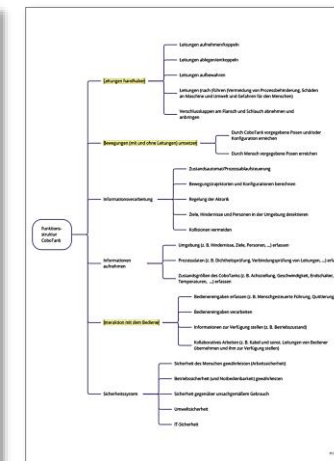
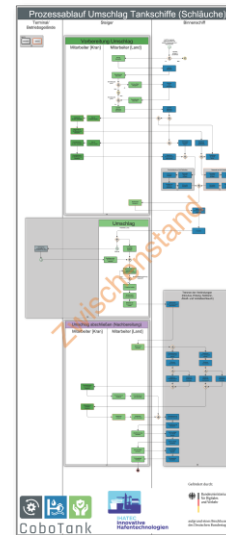
Sources: DST e. V.

Methodology



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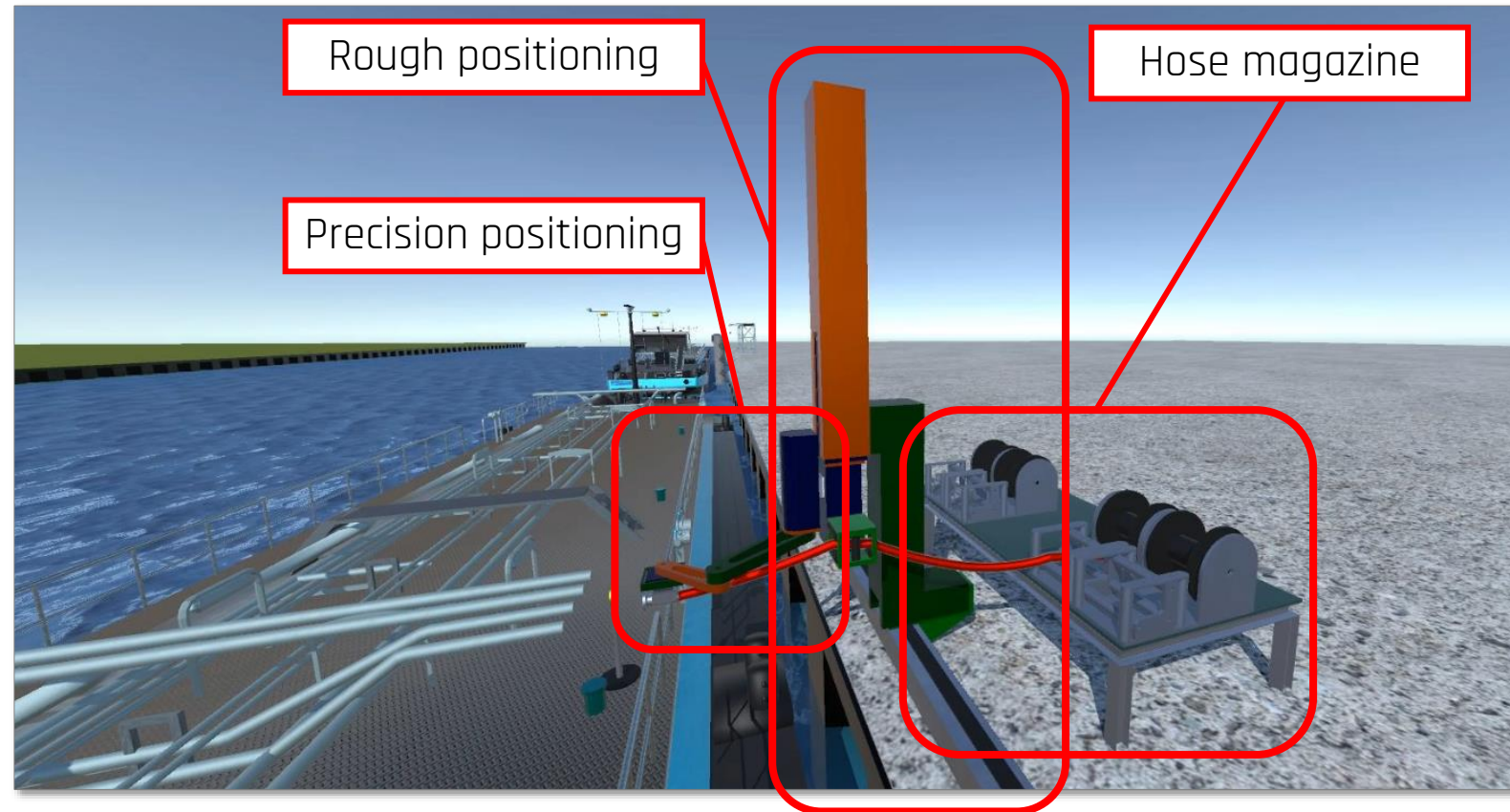
- 1 • Reference visits
- 2 • Reference process flow
• Requirements collection
• Functional structure
- 3 • Concept development
- ... • Realization (1:10 demonstrator)



Source: DST

Basic mechanical structure

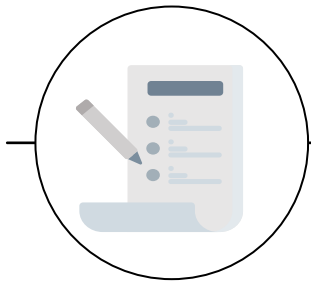
- Separation of the different process steps
 - **Hose handling:** picking up the hose from the hose magazine on the dock
 - **Rough positioning:** overcoming the distance from the storage location ashore to the inland vessel
 - **Precision positioning:** cobot-assisted precision positioning of the hoses in the vicinity of the manifold



Overview of the surveys

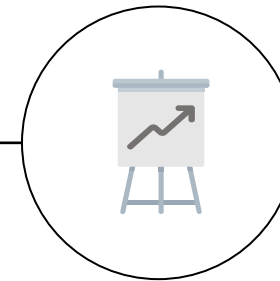
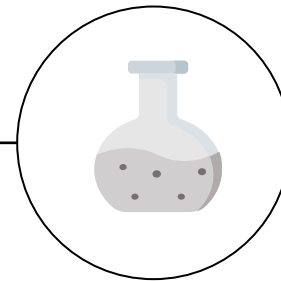
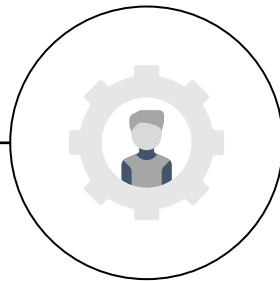
**Stress & mental health
in a maritime context**

Online survey



**Physical & psychological stress
(chemical products)**

Questionnaire



**Physical & psychological
stress (mineral oil products)**

*Physiological measurement (IFA) +
questionnaire*

**Physical & psychological
stress (ESD)**

*Physiological measurement (IFA)
+ questionnaire
(comparison with and without robot)*

Market analysis



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1. Value proposition / Customer needs

2. Market potential analysis

- Target group
- Market volume/ dynamics
- Involved actors and stakeholders

3. Competition analysis

- Competitors
- Positioning
- Market share

4. Business model

- Selection of different methods (e.g., BMC)
- Comparison of results
- Evaluation & feedback

5. Market positioning

- Marketing plan
- Pricing / willingness to pay

Thank you for your attention!



Cyril Alias

Head of Department Logistics & Transportation

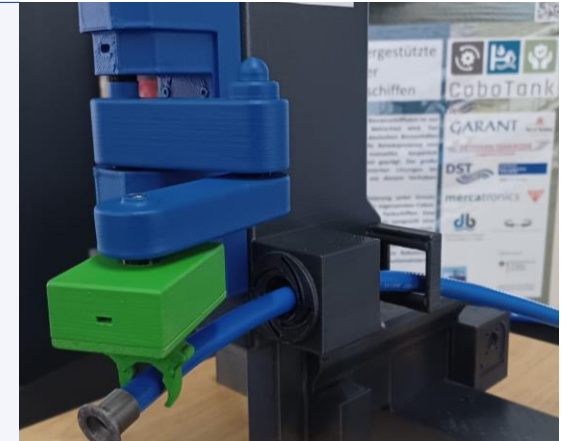
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Offen im Denken



Allgemeine
Psychologie:
Kognition



The CoboTank research project is funded by the German Federal Ministry for Digital and Transport under grant agreement no. 19H2204.



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