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NOVIMAR
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Deliverable D5.2

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1 EXECUTIVE SUMMARY

This summary provides the results of the deliverable D5.2. A public summary can be found in Annex A.

1.1 Problem definition

Work package 5.2 is concerned with analysing the human element in the new system concept: the vessel train (VT). It is a new system and an illustration of the introduction of automation in the waterborne transport sector, which can have a significant influence on human tasks and performance (Woods & Hollnagel, 2006) [1]. Because the tasks, roles and responsibilities will change for the operators taking part in the VT, these changes are addressed and researched to understand the effects on operator performance and system performance.

1.2 Technical approach and work plan

To gain an understanding of the VT concept, control system, and the possibilities and constraints in operating the VT by human operators, several methods were used and activities performed.

- Interviews with skipper were held, to identify which tasks for the crew will change, based on the Novimar vessel train concept.
- Task analysis for identifying the VT related tasks for the crew. The tasks are described in terms of goals, plans and subtasks.
- Real-time Full Mission Bridge (FMB) simulations are performed, to gain insight into the VT related tasks, the impact of the VT related tasks on the workload, human failure possibilities and training needs.
- Human failure analysis and Human reliability analysis (HRA), to gain insight into human failure possibilities and human reliability issues.

Planning

The task deadline was rescheduled to project month 33, instead of the original project month 24. The main reason to extend the deadline is that Task 5.2 would miss important requirements from WP3, such as details on the operational and navigational procedures, control system and interfaces, this interaction was overlooked in the project proposal. In consequence, the Task 5.2 activities would be constrained by the limited input and be excluded from any design phases that will take place after M24. To match the research on human factors with the technical developments better, Task 5.2 requested to extend the planning to month 33, this request which was granted.

Input from the following tasks was used: T1.1, T3.1, T3.2, T3.3., T3.5, T5.1. The output of this WP will be used, in line with the DoA, by tasks T1.3 and T5.4.

1.3 Results

The results indicate that it is technically feasible to sail with the VT on inland waterways, however, there are several operational limitations. The main limitation is that VT cannot cope with all everyday dynamic navigational situations on the tested navigational area (IWT setting with dense traffic). To name an example: overtaking a vessel with the VT while encountering traffic from the other direction (upstream or downstream).

The LV operator tasks become more complex, despite the automated navigational tasks. The maximum length of a shift is estimated, by experience skippers, by four hours with two follower vessels. Above three follower vessels, the majority of the skippers hold the view that an extra LV operator is required because the task demand would become too high. However, context matters: less traffic and more space to manoeuvre would positively impact the maximum amount of working hours. The same result applies to how many FV operators are needed. The operational context strongly informs the needed crew attendance on the FV bridge. Based on the used inland scenarios, it is estimated that attendance on the bridge of FV operator is required, for inland navigation on busy and bendy waterways. Other navigation areas, such as Short Sea – with more space and less traffic - might be more suitable to allow the FV operator to have other tasks and not having any navigational tasks.

A summary of more specific results:

- The participants of the simulator study had a lack of in-depth understanding of the control system throughout the simulations, indicating that the system is not easy to understand.
- Information on predicting the course of the vessels would support the operator in the assessment, decision-making, and determination of action when navigating with the VT.
- There are several error opportunities that can easily lead to hazardous situations.
- There is a lack of error-recovery opportunities.
- The interface design is subject to further improvement.
- Training is vital to understand and to be able to operate the VT safe fully.

The result can be used to improve further the user-system interaction to improve the operational system performance.

1.4 Conclusions and recommendation

Based on the inland test-case used for understanding and analysing the VT concept and control system the following conclusions can be drawn:

- It is technically possible to couple and uncouple with vessels, and to sail a VT without the FV operator having any navigational tasks.
- However, the control system needs further development or changes utilising the feedback from the MARIN FMB tests to allow a safe use on inland waterways.
- The current system cannot solve the same dynamic traffic situations as a single vessel could and therefore limiting the navigational areas where the VT could sail safely or alternatively make chances to the VT legal status, changes to regulations, changes on procedures, the number of LV and FV operators, or changes on the control system itself.
- Operating the VT can be a very high demanding task, which has a negative impact on maximum allowable working hours.
- Training for the VT operators is vital. The new VT tasks involve new competencies, similar to competences of a skipper/ boatsman and a VTS operator. Training needs can be compared with VTS education and training/ education for new navigational equipment.

The following recommendations give directions on how to improve human operator performance:

- Provide control abilities that are in line with the mental model of the human operator in manoeuvring a vessel.
- Further develop the HMI of the control systems to enhance the usability and therefore human performance.
- Support the operator in predicting future navigational states with information on future states of vessels, such as the location, speed and relative distances to objects and traffic.
- Increase automation transparency to enable operators to understand better and predict the behaviour and performance of the control system.
- Exclude the possibility to enter unwanted system states, such as coupling with the wrong vessel, to prevent immediate danger when operators error.
- Provide adequate alerting to the VT operators for any vital system change that is tailored to the operational phase. For example, alert the LV operator when the trackpilot of a FV is turned off.
- Ensure easy understandable and accessible information to monitor the system effectively for both the LV and FV operator.
- Extend the operational procedures to clarify each step and required information, and which procedures are more safety-critical.
- Extensively train the operators to understand the system well and to be able to estimate control performance for different types of vessels. Ensure that operators are well-known with the delicate of the system, and can sail with the VT adequately. Use accurate real-time simulations with accurate hydrodynamic modelling of the VT vessels and accurate performance of the control system, as developed in T3.4, to train and develop a correct mental model of VT vessel controlled by the VT control system.