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Strategic questions of a modal and thematic nature:
Inland water transport

Autonomous shipping and Inland Navigation

Note by the secretariat

Summary

The Working Party on the Standardization of Technical and Safety Requirements in Inland Navigation (SC.3/WP.3) at its fifty-second session held a workshop on autonomous shipping in inland navigation, organized jointly by ECE and De Vlaamse Waterweg nv (Belgium). The presentations made at the workshop and the round table discussions highlighted the opportunities and challenges of autonomous shipping for the inland water transport sector and issues for further consideration. The Working Party on Inland Water Transport (SC.3) continued the discussion at its sixty-second session and asked the secretariat to prepare a working document on this issue for the eighty-first session of the Inland Transport Committee.

The Committee may wish to **take note** of this information and provide guidance for SC.3 on the next steps.

I. What is autonomous shipping?

1. Autonomous ships are the next generation of vessels that are essentially an extension of remotely operated vessels. Such vessels will be monitored and controlled from an onshore operating centre and will be able, to a certain degree, to operate independent of human interaction. It is now expected, however, that crew members will not entirely disappear, but their profile and task will certainly change in the coming period.

2. The benefits of autonomous shipping are obviously an increased safety and a reduction in crew-related operational costs that, in case of an inland waterway vessel, may amount to one-third of the total operational costs, including indirect costs related to

personnel. On unmanned vessels, energy-consuming crew facilities, such as heating and sanitary facilities, may be dispensed with. Reducing the crew can thus significantly reduce the total operational costs of a vessel. Furthermore, this approach, on the one hand, will give the sector a chance to attract specialists with new qualifications and, on the other hand, will help to cope with the shortage of crew members.

3. Autonomous shipping might also reduce the human-related errors, as the influence of the human factor in the long run will be minimized or excluded. Furthermore, an autonomous vessel can navigate full-time, as there is no crew that needs to rest. This will economize the travel time and allow cargo to arrive faster at the destination.

4. Autonomous shipping could pave the way for new business models, such as smaller inland waterways that today are not in use. This will, furthermore, support the modal shift from road and railways to water transport. However, there are still many questions concerning autonomous shipping on inland waterways that need further consideration.

5. This issue has been addressed by international organizations such as European Commission, Central Commission for the Navigation of the Rhine (CCNR), International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), IMO, World Association for Waterborne Transport Infrastructure (PIANC), as well as several member States, classification societies, industry and other key players who are currently engaged in smart and autonomous shipping projects for the maritime sector and inland waterways. Some examples are:

- joint work of Flanders (Belgium) and the Netherlands on establishing a common test area for autonomous vessels.
- The Marine Autonomous Systems Regulatory Working Group (MASRWG) under the auspices of the Government of the United Kingdom of Great Britain and Northern Ireland.
- The Norwegian Forum for Autonomous Ship (NFAS).
- Projects “Advanced Autonomous Waterborne Applications Initiative” and “One Sea Autonomous Maritime Ecosystem” (Finland).
- Projects “Maritime Unmanned Navigation through Intelligence in Networks” (MUNIN) of the European Commission and “Safety and Regulations for European Unmanned Maritime Systems” (SARUMS) by the European Defence Agency;
- The International Network for Autonomous Ships (INAS), and others.

II. Workshop “Autonomous shipping and Inland Navigation”

A. How it was organized and the speakers

6. The workshop “Autonomous shipping and Inland Navigation” was held on 14 February 2018, at the fifty-second session of SC.3/WP.3, organized jointly by ECE and De Vlaamse Waterweg nv. The workshop focused on introducing smart and autonomous shipping on inland waterways, advantages and implications, possibilities for synergy with maritime transport and a selection of items for further consideration with a view to supporting member States that intend to guide the inland waterway sector towards more automation.

7. Key speakers were MASRWG, De Vlaamse Waterweg nv, the ECE secretariat, International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), Central Commission for the Navigation on the Rhine (CCNR), Lloyd's Register (LR), NFAS and SINTEF Ocean, DIMECC, Maritieme Academie Harlingen and World Maritime

University (WMU). The workshop was moderated by Mr. J. Fanshawe, the Chair of MASRWG and attended by: European Commission, Danube Commission, Mosel Commission, International Sava River Basin Commission, European Boating Association, European River-Sea-Transport Union and International Association for the representation of the mutual interests of the inland shipping and the insurance and for keeping the register of inland vessels in Europe (IVR) who took part in the discussion. The workshop programme and the presentations are available on the SC.3 webpage at www.unece.org/trans/main/sc3/wp3/wp3doc_2018.html (tag "Workshop").

8. The current progress in the maritime sector discussed at the workshop covered:

- the work carried out by IMO and MASRWG on safety of Maritime Autonomous Surface Ships (MASS), the Codes of Conduct and Practice for Maritime Autonomous Systems developed by the Marine Industries Alliance.
- the e-Navigation concept by IALA that included onboard navigation systems. shore side vessel traffic information management and ship-to-shore and shore-to-shore communication infrastructure.
- activities of SINTEF and NFAS in the field of autonomous and unmanned ships.
- the project "One Sea" an autonomous maritime ecosystem aimed at creating an operating autonomous maritime ecosystem by 2025 based on the digitalization of the maritime industry.
- a study on the integration of autonomous ships into existing traffic schemes by WMU.

9. Intelligent Transport Systems (ITS) and the ongoing work of the Working Party on Braking and Running Gear in automatically commanded steering functions and cybersecurity demonstrated the recent progress in automation in other transport modes.

10. Perspectives of autonomous shipping on inland waterways were highlighted through:

- the activities of De Vlaamse Waterweg nv on developing a framework for autonomous shipping on Flemish inland waterways and establishing test areas jointly with the Netherlands in the cross-border area with a view to enable autonomous shipping on inland waterways by 2020.
- ongoing work by CCNR in automation and autonomous shipping aimed at creating a basis for international regulations on autonomous shipping in inland navigation.

11. Classification societies made special emphasis on ensuring safe operation of autonomous vessels and cyber security, as currently there were no prescriptive rules or international standards for this innovative technology: special class notations for ships, procedures and guidelines for the type approval of components with cyber enabled systems.

12. Maritieme Academie Harlingen addressed new challenges for education institutions related to special professional qualifications, training and skills required for autonomous vessels and shared their approach and experience on this issue.

13. The presentations were followed by statements and comments that addressed the need for making autonomous shipping attractive for investments in terms of future development, relevant experience from other transport modes, existing platforms and the role of River Information Services (RIS), specific features of inland navigation and related aspects. It was proposed to consider autonomous shipping as an intelligent inland water transport system on a service-based approach.

B. Round table discussions and the questionnaire

14. The round table discussion was dedicated to priorities, advantages, opportunities and challenges of autonomous shipping on inland waterways and interaction with the maritime sector. The main topics were: (a) a common terminology, (b) economic benefits, (c) possibilities for making autonomous navigation attractive for investments, (d) synergy with the maritime sector and the need for a more flexible approach in both sectors, (e) autonomous shipping and digitalization, (f) insurance policies, (g) public approval, and (h) ethical issue.

15. The participants were invited to complete a multiple-choice questionnaire distributed by the secretariat (see the annex). The following preliminary observations were made:

- the autonomous shipping concept was becoming relevant for the inland waterway sector, however, it needed further assessment.
- for inland navigation, short-manned vessels, hybrid solutions and smart vessels seemed to be more preferable.
- in general, all types of craft could be suitable for autonomous operation, however, some particular vessel types could be preferable.
- the most important advantages were minimizing the human factor risks, improving navigation safety and operational efficiency, cost savings over time and reducing the environmental impact.
- the most important risks and challenges were a lack of the regulatory basis, additional costs, need for automated technologies, new safety management principles, new qualifications and assessment principles.

C. Automation levels proposed by the Central Commission for the Navigation of the Rhine

16. Automated navigation covers a very wide range of technical solutions and addresses cases ranging from simple navigation assistance to fully automated navigation. Although technology synergies are expected with the maritime sector, CCNR considers that inland navigation has its own specificities that should be taken into account such as the composition of crews, enclosed and restricted navigation, the passage of locks, the height of the water level and under bridges and some other features. With a purpose of establishing a comprehensive, internationally accepted definition of automation levels and support further works such as an analysis of regulatory needs, CCNR proposed for discussion the definitions of automation levels which are given in the table below. This definition of levels of automation for river vessels is being finalized within CCNR bodies with a view to adoption in December 2018.

Automation Levels of River Vessels proposed by CCNR

	Level	*Designation*	*Vessel command (steering, propulsion, wheelhouse, ...)*	*Monitoring of and responding to navigational environment*	*Fallback performance of dynamic navigation tasks*
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 enhanced by warning or intervention systems *Example: navigation with the support of the radar installation*			
	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 *Examples: rate-of-turn regulator; track pilot (track-keeping system for inland vessels along pre-defined guiding lines)*			
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			
	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 operation, without expecting a human boatmaster responding to a request to intervene *Example: 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)*			
	5	**Full automation** the sustained and unconditional performance by a navigation automation system of all dynamic navigation tasks and fallback operation, without expecting a human boatmaster will respond to a request to intervene			

D. Outcome of the workshop

17. The following observations were made:

- the added value that autonomous shipping could bring at the pan-European level were: (a) harmonizing and exchanging best practices, (b) fostering innovations, (c) making the sector more competitive and attractive, (d) ensuring navigation safety, and (e) enhancing mobility.
- the priorities and next steps could be: (a) research and development on automated technologies, pilot projects and tests, (b) development of the legislative basis, (c) dissemination of information, and (d) development of an insurance policy.

18. The participants pointed out that the approaches used in inland navigation and maritime shipping had much in common, however, differences between them should be taken into account while seeking for synergies in terms of technologies, cyber security and other aspects.

19. The participants agreed that international cooperation was of major importance for developing this concept and elaborating an internationally harmonized legislative framework.

III. Follow-up and next steps

20. At its sixty-second session held from 3 to 5 October 2018, SC.3 continued exchanging information on smart and autonomous shipping:

- international events held in 2018 that were dedicated to this issue, in particular, the seminar on automation in inland water transport held by the European Transport Workers' Federation on 4-5 September 2018 in Saint Petersburg (the Russian Federation).
- the progress reached by IMO, including the regulatory scoping exercise for the use of MASS, and the establishment of the IMO Working and Correspondence Groups.
- the opening of a test area for smart shipping in Flanders, a project on autonomous sailing in Westhoek and other achievements made by De Vlaamse Waterweg nv.
- the project TASCS (Towards A Sustainable Crewing System).

21. The discussion continued on testing requirements, manning provisions, lessons learned from other transport modes, the applicability of existing approaches to MASS and river vessels, and the need for developing international regulations. The examples of existing MASS were marine scientific research, oil and gas supply ships, tugboats, ferries and vessels engaged in passenger transportation.

22. Some aspects of smart and autonomous shipping were addressed further at the workshop "Digitalization in inland water transport" held on 4 October 2018.[1]

23. SC.3 supported the proposal by CCNR about automation levels. It was pointed out that the role of cooperation between member States was essential for developing international regulations. SC.3 decided to include autonomous shipping and digitalization in its agenda and agreed on the following steps:

[1] Detailed information about the workshop is available in the report of the sixty-second session of SC.3 (ECE/TRANS/SC.3/207).

- consideration and acceptance by SC.3 of the definition of automation levels introduced by CCNR.
- analysis of bottlenecks and the preparation of a road map for international cooperation for the promotion and development of autonomous shipping.

Annex

Answers to the multiple-choice questionnaire

Question	*Answer options*	*Percentage of respondents*
1. Is the concept of autonomous shipping relevant for inland waterways?	Yes, it will become relevant	50
	It needs further assessment	43
	Yes	14
	For certain types of craft or under other conditions	14
	For certain waterways	14
2. Which automation levels could be relevant for inland navigation?[2]	Hybrid solutions	62
	Short-manned vessels	54
	Smart vessels	38
	Remotely operated unmanned vessels	31
	Fully autonomous vessels	23
	Other levels of automation	14
	Other (shore-controlled vessels, other relevant solutions)	14
3. Which types of craft could be suitable for autonomous operation?	All types of craft	43
	Barges in assemblies of craft	21
	Motorized cargo vessels	14
	Ferries	14
	Motorized tankers	7
	Supply vessels	7
	Other types	21
	Other (more vessel types, repetitive operations, etc.)	21
4. Is your administration or organization engaged in autonomous navigation projects?	Yes, on inland waterways	21
	Yes, in the maritime sector	14
	No, it is not foreseen	14
	It is planned for the coming years	7
	It can only be possible after the regulatory framework is available or other preparatory work is made	7
	Not applicable	14
5. What could be the advantages of autonomous shipping?	Minimizing the human factor risks	64
	Improving navigation safety	57
	Cost savings over time	43
	Improving operational efficiency	43
	Reducing the environmental impact	36
	Introducing new jobs	14
	Insurance-related issues	14
	Enlarging the navigation zone	7

[2] See definitions in ECE/TRANS/SC.3/WP.3/2018/1.

Question	*Answer options*	*Percentage of respondents*
6. What could be potential risks and challenges of autonomous shipping?	Lack of the regulatory basis	71
	Additional costs	57
	Development of automated technology	50
	New safety management principles	43
	New qualifications and assessment	36
	Decrease in diligence of crew members	29
	Potential job losses	14
	Public acceptance and consumer preference	14
	Other	7
7. Which added values could bring autonomous shipping at the pan-European level?	Harmonization and exchanging best practices	57
	Fostering innovations	57
	Making the sector more competitive	43
	Ensuring navigation safety	36
	Enhancing mobility	21
	Security	14
	Common education standards and competencies	14
8. What could be priorities and next steps for the development of autonomous shipping on inland waterways?	R&D work related to automated technology	71
	Development of the legislative basis	64
	Dissemination of information	43
	Development of insurance policy	36
	Developing education standards and competencies of crews	29
	Developing certification models	29
	Experience of the maritime sector and IMO	14
	It is premature to propose any actions	7