AUTOMATED NAVIGATION

International definition of levels of automation in inland navigation (edition 2022)



PRELIMINARY DEFINITIONS

For the purposes of this definition of levels of automation, the word "boatmaster" has to be understood as a human boatmaster.

LEVEL OF AUTOMATION	is understood as the level in which an automated craft may be operated during its voyage. Depending on the context, an automated craft may achieve different levels of automation.
NAVIGATION	is understood as all tasks (like planning, steering, controlling, manoeuvring etc.) taken to direct a craft in a waterway from one place to another.
DYNAMIC NAVIGATION TASKS	are understood as the set of navigational craft operations, such as operation of rudder apparatus, propulsion, anchor winches or elevating wheelhouse. The complexity of these tasks is dependent upon the context considered (for example, the mooring of the craft can be excluded from a context).
CONTEXT-SPECIFIC	is understood as confined navigational conditions such as navigation on specific river waterway sections or lock crossing, as well as craft arrangements with convoys or platooning. The context includes infrastructure relevant for automated navigation, for example type and capacity of radio transmission networks. The context also includes the influence of natural conditions like current or weather or limitations due to the infrastructure like water level or bridge clearance.
NAVIGATIONAL ENVIRONMENT	is understood as fixed and dynamic conditions such as the waterways' shape, water level, weather, visibility, craft crossing, etc. The navigation automation system can use only part of the information available on the navigational environment (for example, under level 1, rate-of-turn indicators do not use information on craft crossing). The response to the navigational environment includes the radiocommunication with boatmasters of other craft.
COLLISION AVOIDANCE	is the critical task in responding to the environmental conditions (other crafts, bridges, etc.).

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	Level of automation[1]	Designation	Craft command (steering, propulsion, wheelhouse, etc.)	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 boatmaster of all aspects of the dynamic navigation tasks, even when supported by warning or intervention systems			
	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 boatmaster performs all remaining aspects of the dynamic navigation tasks			
	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 boatmaster performs all remaining aspects of the dynamic navigation tasks			
SYSTEM PERFORMS THE ENTIRE DYNAMIC NAVIGATION TASKS (WHEN ENGAGED)	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 boatmaster will be receptive to requests to intervene and to system failures and will respond appropriately			
	4	**HIGH AUTOMATION** the sustained context-specific performance and fallback performance by a navigation automation system of all dynamic navigation tasks, without expecting a boatmaster responding to a request to intervene[2]			
	5	**AUTONOMOUS = FULL AUTOMATION** the sustained and unconditional performance and fallback performance by a navigation automation system of all dynamic navigation tasks, without expecting a boatmaster responding to a request to intervene			

[1] Different levels of automation may make use of remote control but different conditions to be defined by competent authorities might apply in order to ensure an equivalent level of safety.

[2] 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.