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## Improving safety and efficiency with autonomous technology

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## Tasks relying on human performance



**Observation**



**Data fusion & positioning**



**Risk assessment**



**Decision-making**



**Control**



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# Combining the strengths of humans and technology



## Human strengths

- Handling of uncertainty
- Applying knowledge and experience
- Creative problem-solving
- Human judgement



## Machine strengths

- Continuity, objectivity
- Repeatability and consistency
- Very slow and very fast occurring events
- Machine does not get tired and does not forget

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# Levels of automation

General principle

Automation/Autonomous  $\approx$  Unmanned

Generally automation has nothing to do with manning principles and these should not be mixed. It causes too much confusion and they are different things.

Remote monitoring/operation

Location of where the human operator is in the loop (workstation) is not relevant for the taxonomy of automation and autonomy.

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## Levels of automation

Purpose – why do we need these definitions?

**For the owners and operators:** "To be able to know what is available and determine with common taxonomy of what kind of ship do they want to have"

**For the industry:** "To be able to offer a solution for the customer request and to be able to market the products with common taxonomy"

**For the regulators:** "To be able to define rules, regulations, and certification policies based on a common taxonomy"

**For general public:** "To be able to understand what is going on"

The automation level / degree definitions need to reflect this purpose!

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## Levels of automation

What is actually essential?

The automation level should refer to "level of human attention" or "level of attendance from human" required for safe operation

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## Levels of automation

What defines the level of human attention / attendance needed?

- 1. Conditions:** The lower the level, the more continuous human attendance is required even in "easy" conditions
- 2. Situation:** The lower the level, the more continuous human attendance is required even in "simple" situations
- 3. Time:** In lower automation levels the system can work safely only very short time or no time without continuous human attention / attendance

"Time is relative to operational margins"

- At open sea and calm weather, margins are large and there is more time
- Maneuvering in tight fairway has small tolerances and time requirement is much higher

# What?

## Levels of automation (modified from SAE-levels)

<b>0</b>	<b>Basic automation</b>	Human controls the vessel manually or with the help of simple unit-automation (e.g. autopilot).	Human controls the vessel.
<b>1</b>	<b>Advisory operations</b>	System provides situational awareness support in single operations by e.g. alerting the approaching quay wall.	Hands-on, eyes-on, mind-on
<b>2</b>	<b>Partial automation</b>	Automatic operation of at least one full function/operational mode. System monitors the actual situation and possibly executes actions to mitigate risks while keeping the operator informed. Operator may approve of action.	Hands-off (sometimes), eyes-on, mind-on
<b>3</b>	<b>Conditional automation</b>	Automatic operation of at least one full function/operational mode. System suggestions are executed automatically. In good conditions human tasks could be replaced by a machine for a short (relative to the situation) period.	Hands-off, eyes-off (sometimes), mind-on
<b>4</b>	<b>High automation</b>	Automatic operation of at least one full function/operational mode. System suggestions are executed automatically. Human tasks (those automated) are executed by a machine to high extent. Machine alerts human if situation is unclear.	Hands-off, eyes-off, mind-off (sometimes)
<b>5</b>	<b>Autonomous</b>	Fully autonomous operation of at least one full function/operational mode. Human operator is not needed in those functions/operational models which are automated.	Hands-off, eyes-off, mind-off = human-off

Level of human attention



**Human + technology**  
= safer and more efficient ship operations



**AABB**