

ESREL 2019

SMACS
research
project

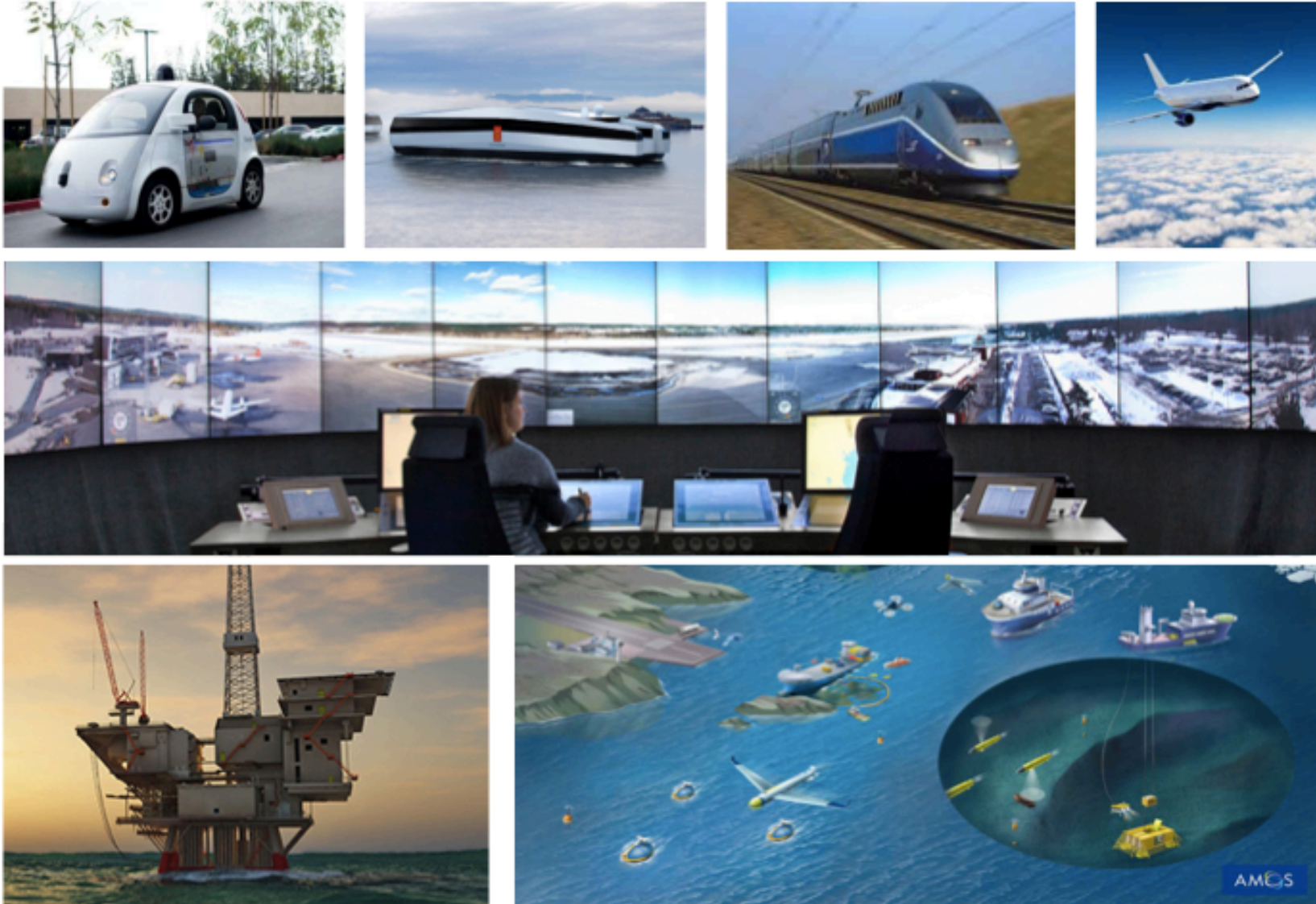
Case:
DP operation

Sensemaking in high-risk situations: The challenges faced by dynamic positioning operators (DPOs)

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Context: A drive towards automatization

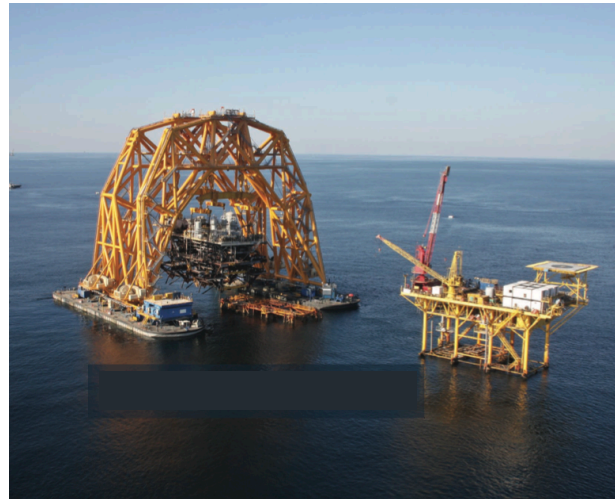


- Increasing levels of automation & autonomy
- This introduces new challenges for human-automation collaboration, and man-machine interaction in general

Dynamic Positioning: Application areas (examples)



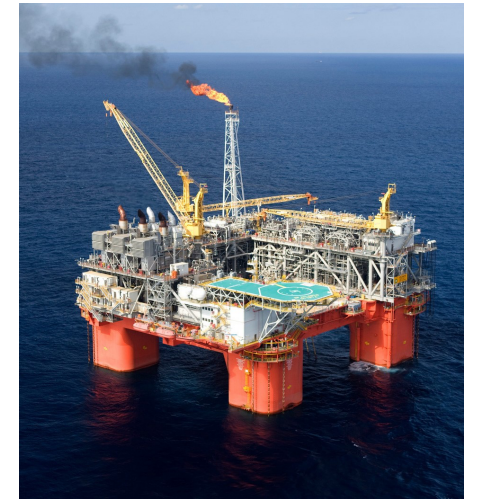
Cable/pipe laying



Construction

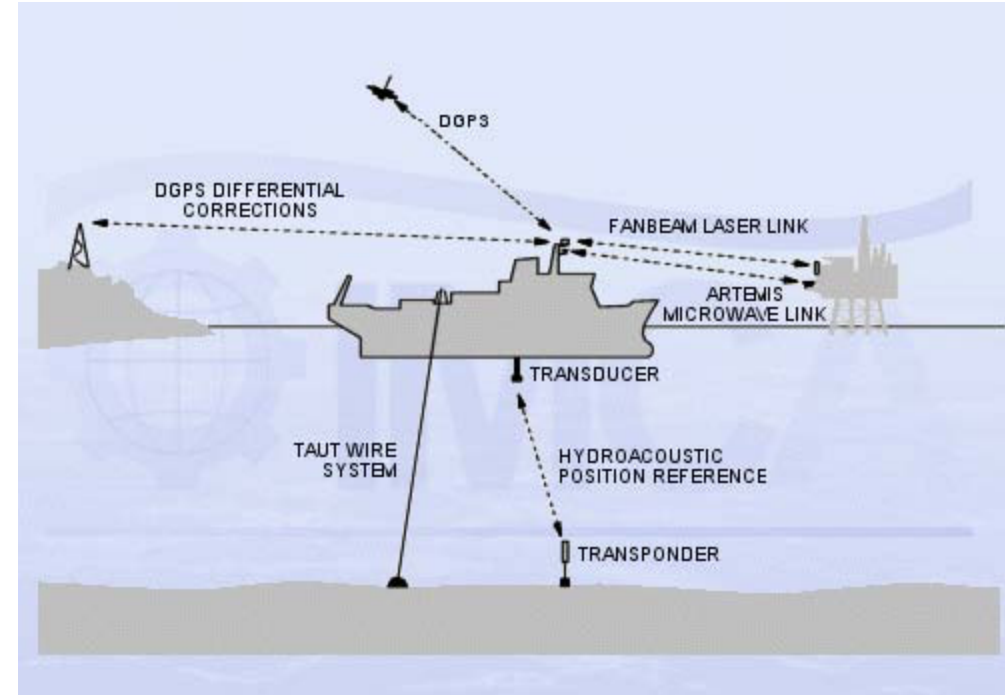
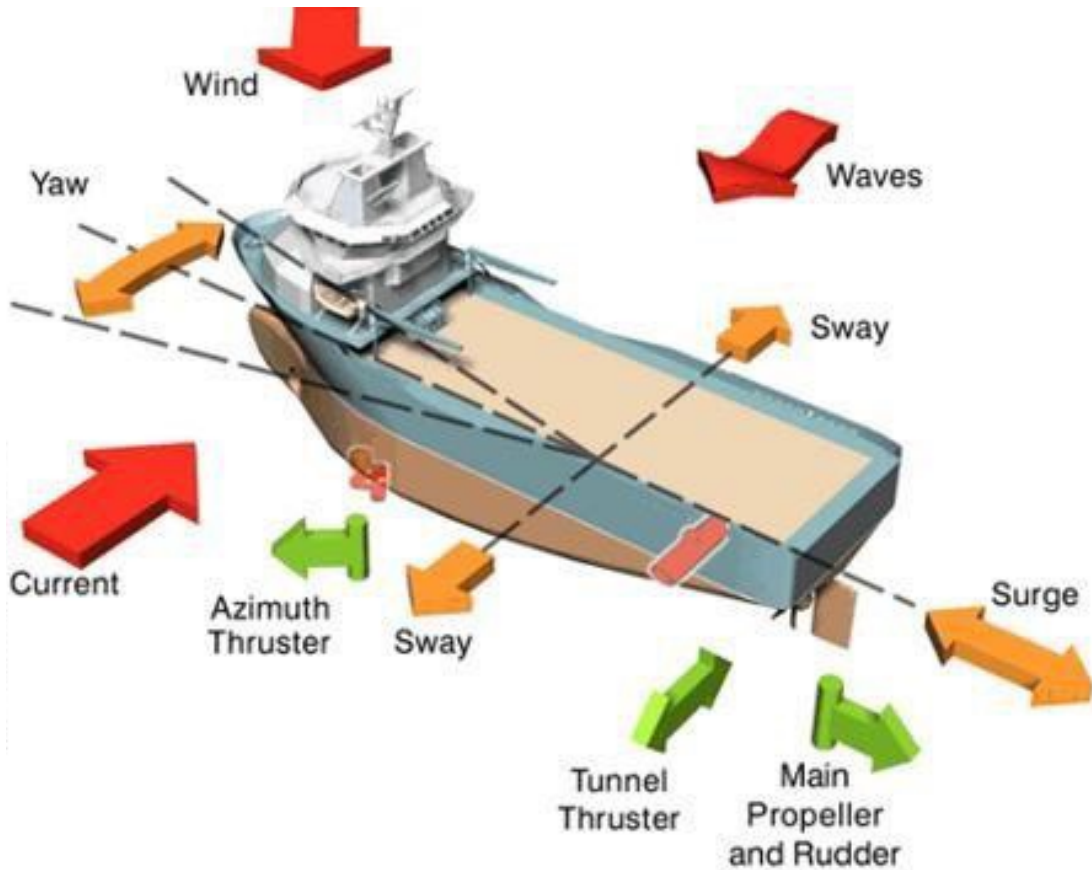


Cargo operations



Floating petroleum rigs

Dynamic Positioning: System structure & functions



Reference systems:

- GPS
- Laser links
- Microwave links
- Hydroacoustic position reference
- Taut wires

- Wind
- Current
- Gyros



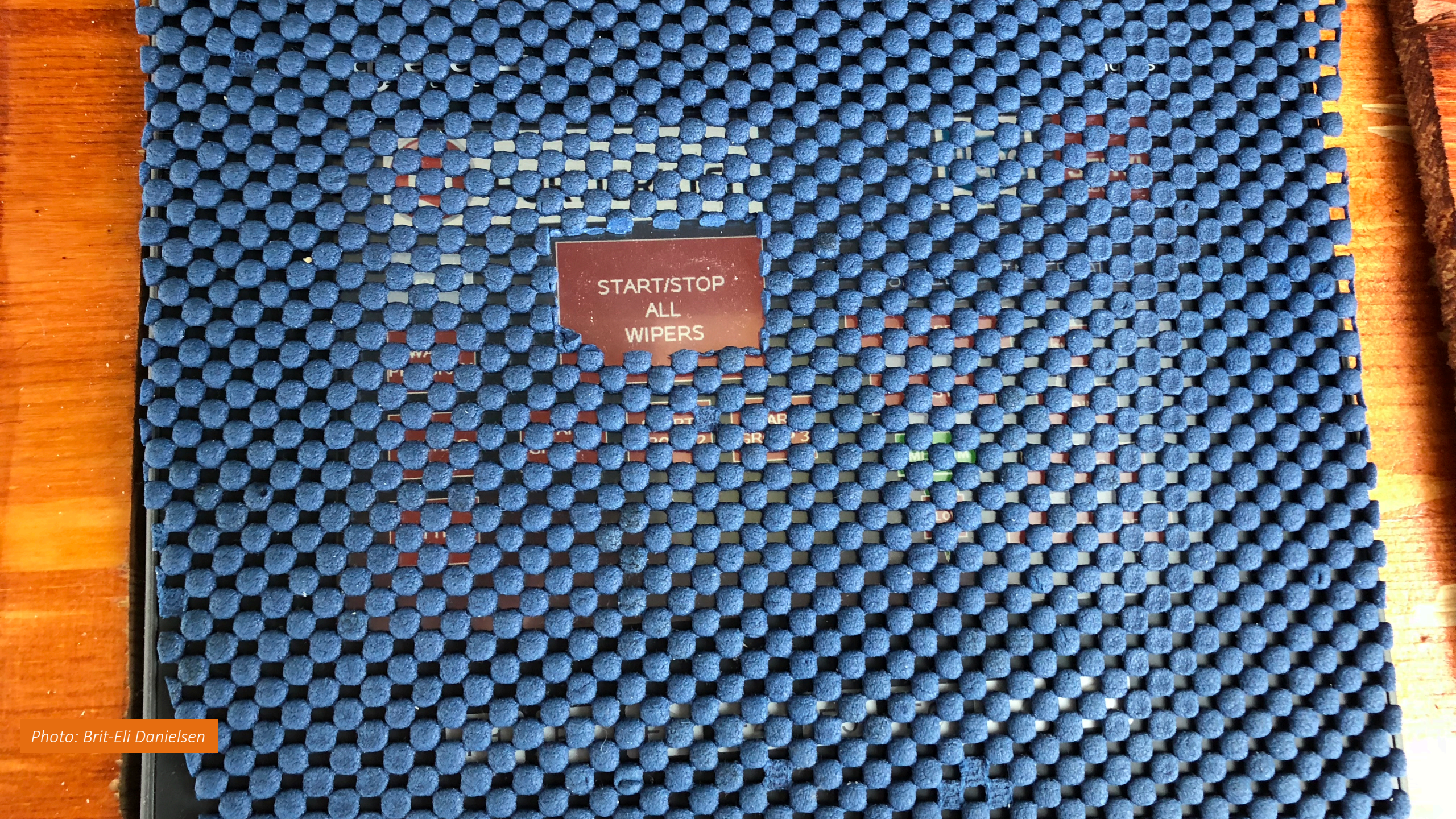
Photo: Brit-Eli Danielsen



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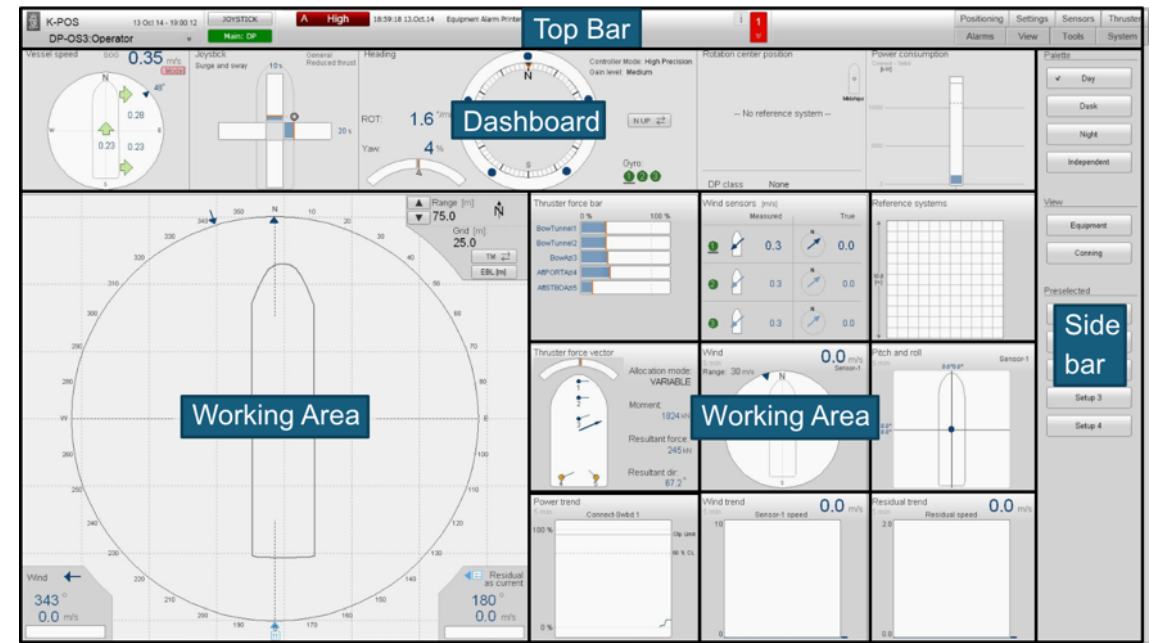
START/STOP
ALL
WIPERS

DP HMI

Example: Kongsberg K-POS



Physical buttons for key DP-mode selections



User configurable status screens (1-3)

Modern ship bridge with DP-console (HMI)



Research approach

Broad approach data collection

- Observations of DPOs in simulator training
- Interviews with instructors and experienced DPOs
- Equinor Captain Forum: Group discussions with experienced bridge personnel
- Event reports

The sensemaking perspective

- Human-Automation collaboration (HAC)
- Situation Awareness
- Man Technology Organization (MTO)

Team experience

Safety- and design-oriented research across many high-risk domains, such as:

- Nuclear
- Petroleum
- Aviation
- Railway
- Maritime

Expertise:

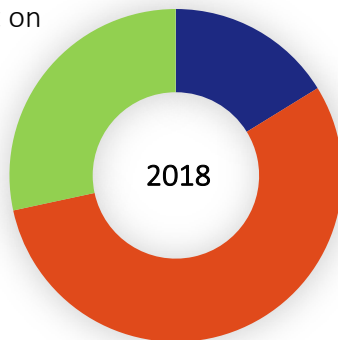
- HMI design
- Training

DP-related incidents

Frequency

- 2977 to 3911 annual hours of DP operation between events is reported for the years 2015 to 2018.
- In 2018, a total of 238301 hours of DP operation was recorded for 100 member vessels which together reported 147 events:

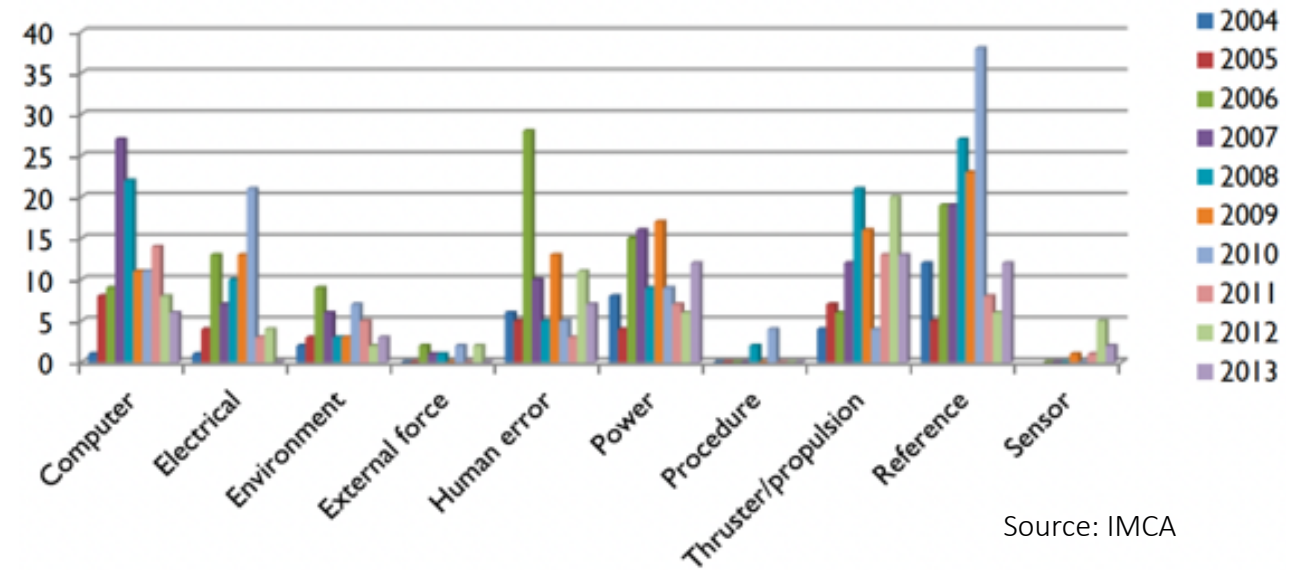
42 “observation reports” (no effect on DP capability)



24 “incidents” (loss of DP capability)

82 “undesired events” (loss of redundancy or compromised DP ability)

Causes



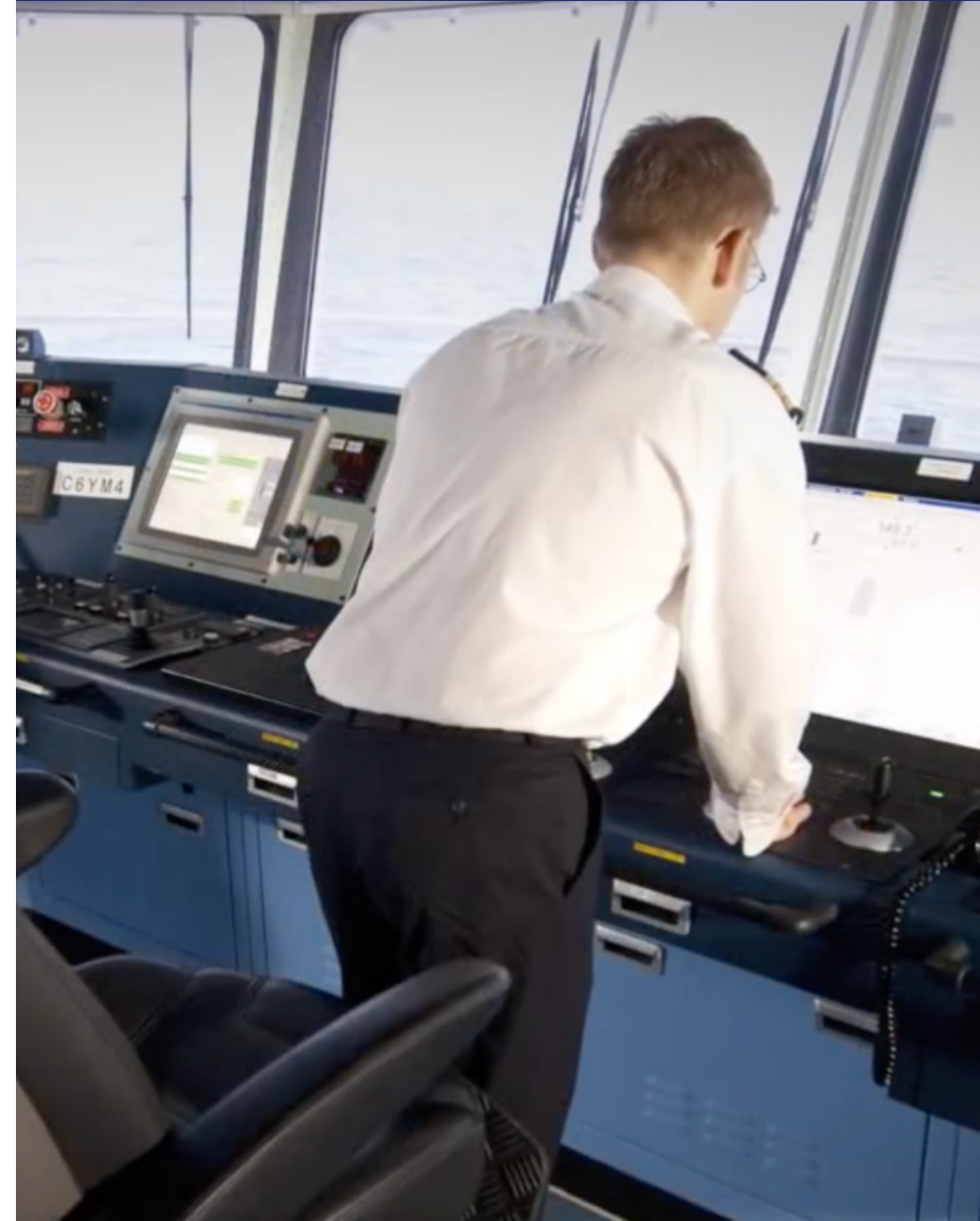
Source: IMCA

“... no accidents/incidents were a result from single technical failure or human action, while seven out of nine accidents and incidents were due to a combination of technical, human, and organizational failures”.

Dong, Y., Vinnem, J.E., Utne, I.B. (2017). Improving safety of DP operations: learning from accidents and incidents during offshore loading operations.

Sensemaking in high-risk situations: The challenges faced by dynamic positioning operators (DPOs)

- Alarms/Alerts: Too many or too few
- Mode surprises
- Critical information hidden from view
- «Private» HMI limits shared SA
- Deskillling
- Out-of-the-loop



Sensemaking in high-risk situations: The challenges faced by dynamic positioning operators (DPOs)

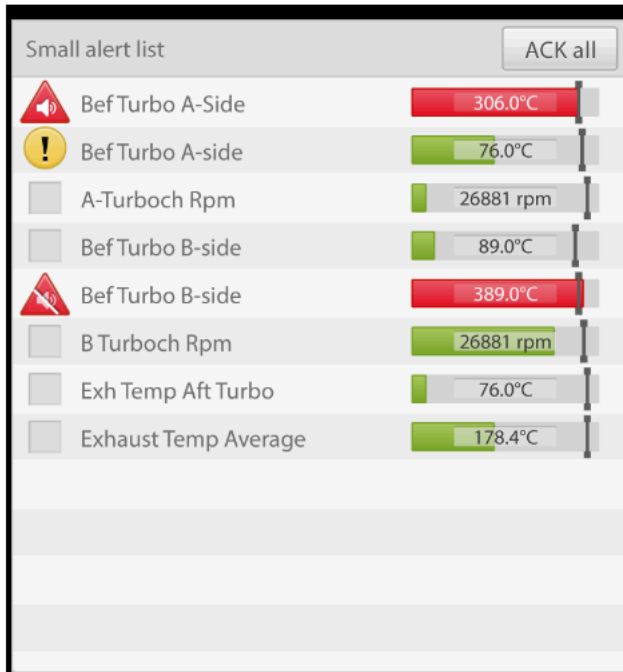
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99% of the time nothing happens. Then it hits you and you have very little time to respond.



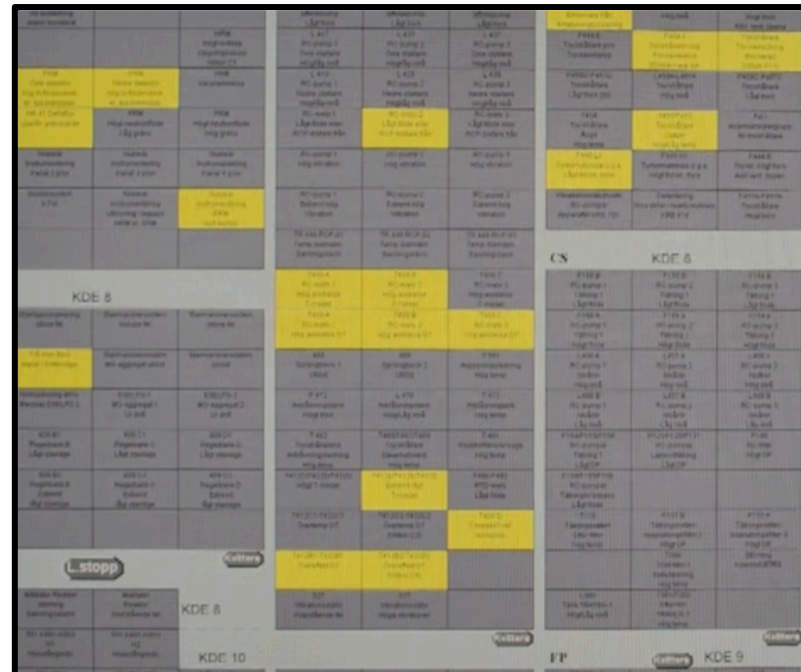
- *Alarm presentation.* Numerous alarms in lists with much text to read seem ineffective as the only means of informing operators that need to make decisions fast.
- *Important alarms are missing or not salient enough.* Even though alarms are presented in the HMI they are not always noticed, especially if there are many of them.
- *Rare alarms are not understood.* Some alarms occur so rarely that operators struggle with their meaning even if they notice them.

Alarm presentation



List

- Support slow sensemaking based on filtering and sorting
- Exception: Few alarms



Tiles

- Supports fast sensemaking based on pattern recognition



Mimic

- Support sensemaking based on visible cause-effect relationships
- Can be fast or slow sensemaking depending on interface management scheme / layering

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The DPO was uncertain how the DP system handled the mode change from “weather wane” to “autopos”.



Accident investigator

- *Changing from one mode to another may surprise the DPO.* DPOs sometimes struggle to anticipate how the DP behaves during mode transitions.
- *Noticing and handling a degraded or loss of DP capability.* Determining when and how to intervene “manually” seem challenging in certain situations.
- *Inadvertent mode changes.* DPO putting an item on, or leaning over, the push-buttons.

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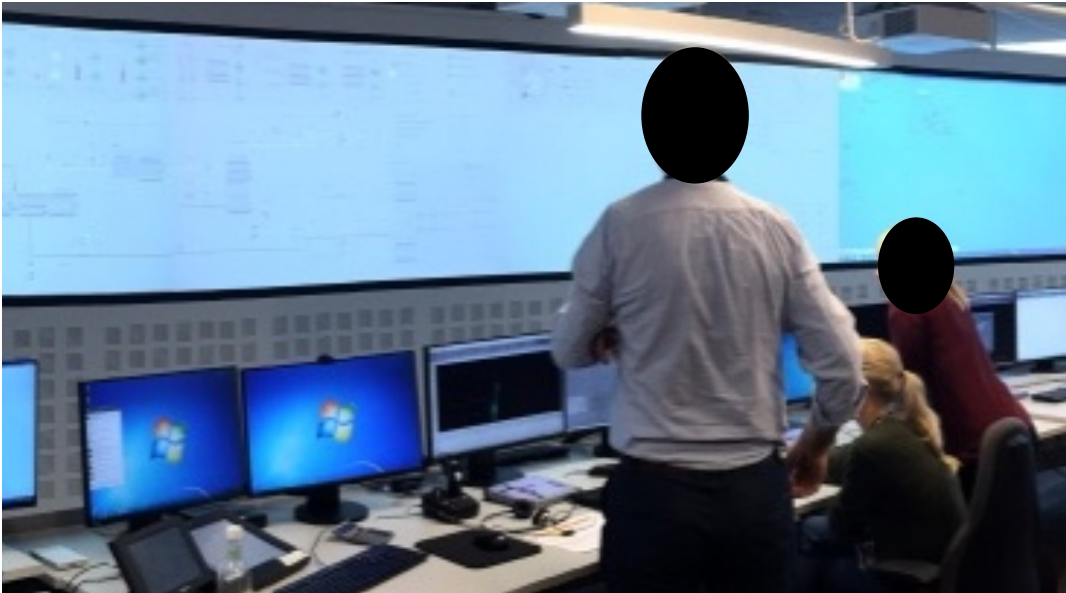
If the information is not already on the screen it will not be used.



- *Surprises do occur.* “Of the 42 incidents recollections analysed (Martinsen, 2013) 19 were unexpected, and in five cases the DPO had no previous experience with the particular situation.”
- *The risk of personalization.* When individual DPOs are responsible for selecting and arranging the information visible on the DP screens, critical information may be hidden from view and not used when an unforeseen situation occur.

At-a-glance overview support

Nuclear control room



Petroleum control room



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I like to bring up the DP screen displaying the heading and setpoint of the vessel



Captain

- *Shared situation awareness.* When the DP interface is targeted towards the DPO exclusively, it can be difficult for colleagues on the bridge to determine the state and activities related to this system.
- *Assessing DPO experience level and performance.* Captains stressed the importance of them assessing the experience level of the DPO in order to calibrate his own involvement to ensure safe operations

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...and then you are left monitoring. Except for dealing with alarms on the wind sensors, as one of these will always be sheltered, the work is very monotonous.”



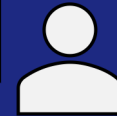
DPO

- *Ironies of automation.* “Perhaps the final irony is that it is the most successful automated systems, with rare need for manual intervention, which may need the greatest investment in human operator training” -Bainbridge
- *Manual takeover can be challenging.* Navigation systems are increasingly optimized for DP, and the DPO may have limited navigation training, especially on a rig.

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“It’s impossible for even a highly motivated human being to maintain effective visual attention towards a source of information on which very little happens, for more than about half an hour.”



Bainbridge

- *Can be seen as the result of the challenges described.* Alarm handling, SA, Mode surprises, hidden information, etc.
- *Hidden risk.* The out-of-the-loop performance may remain unnoticed unless a high-risk situation enters the picture