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A **Systems Engineering** Assessment of the

Emergency Disconnect System from the **User Perspective**

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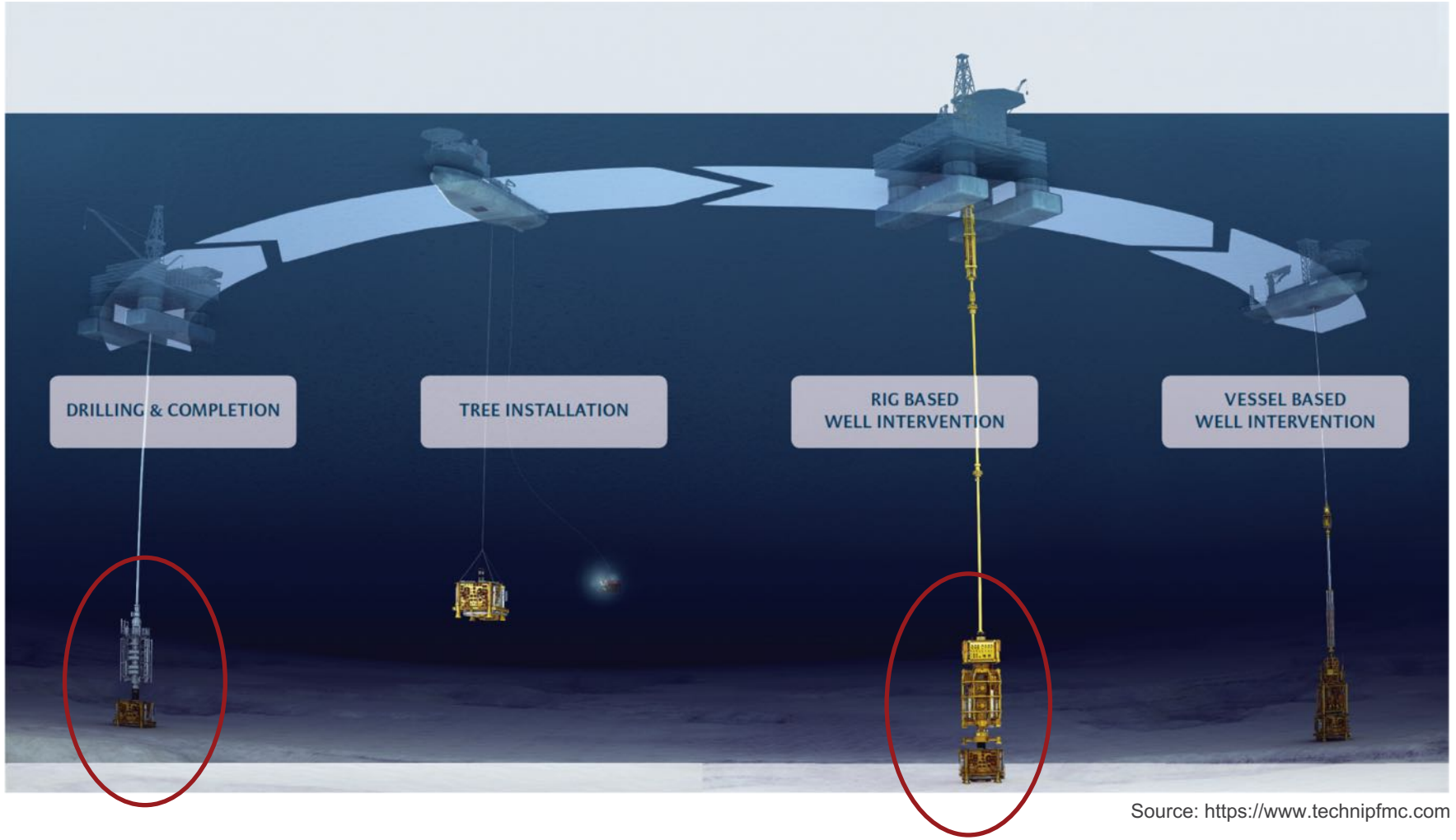
The EDS – a safety system



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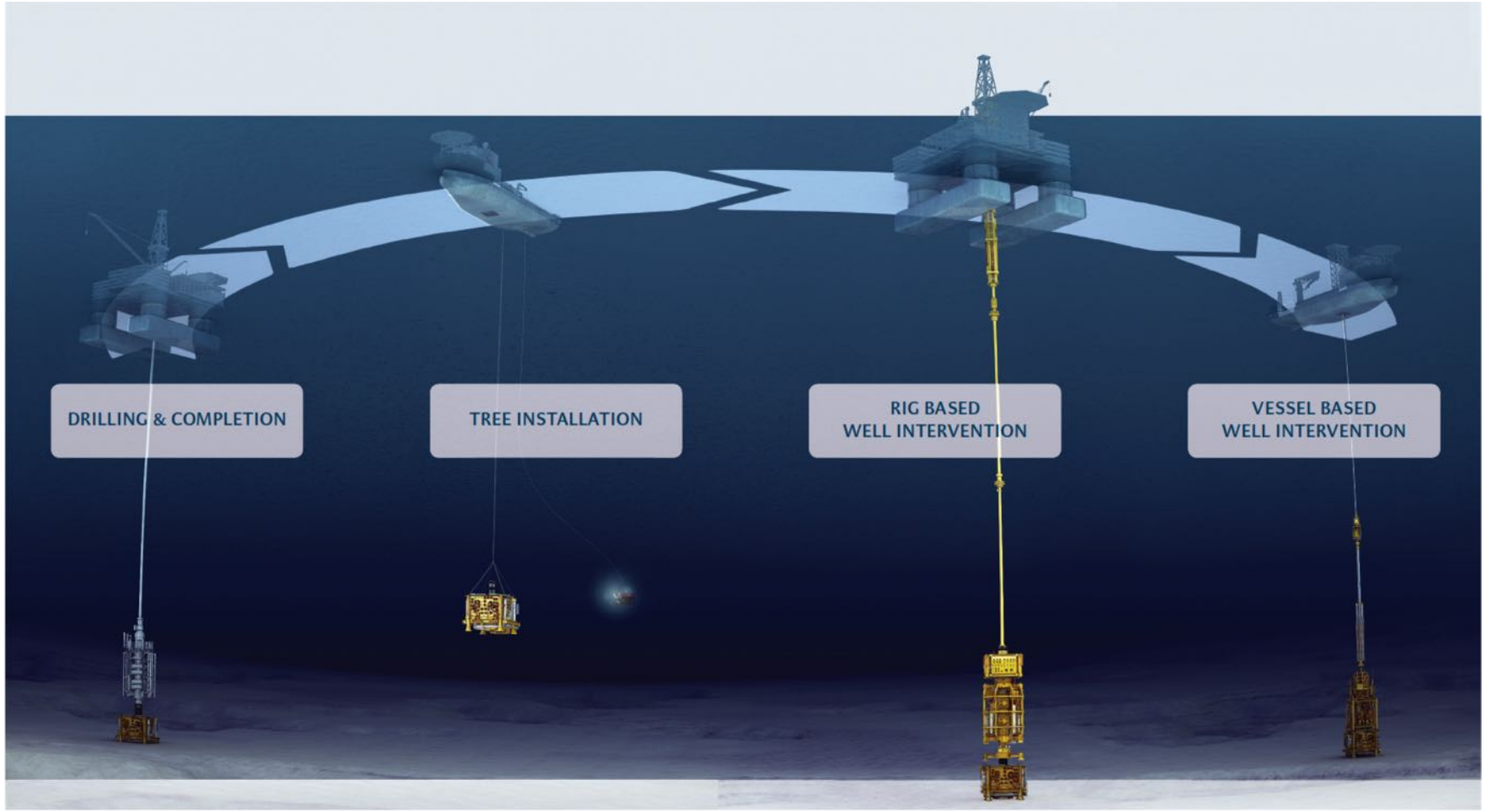
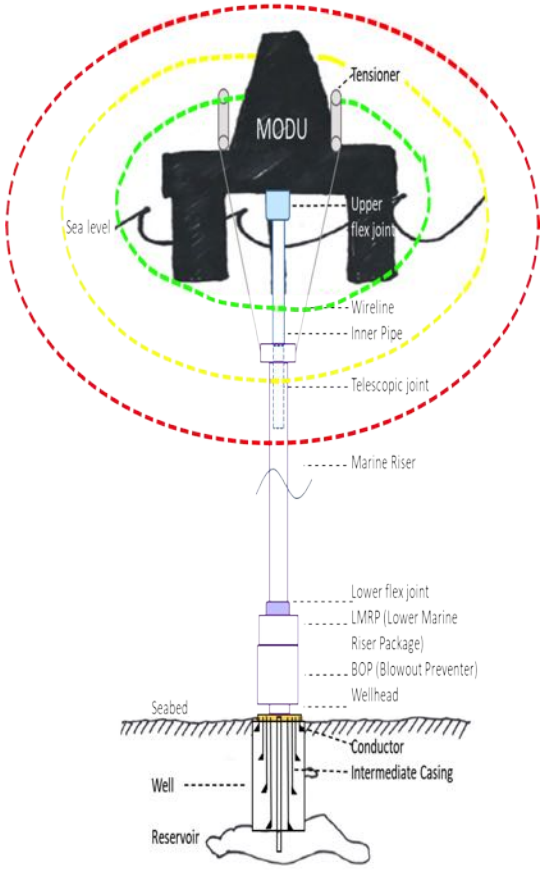




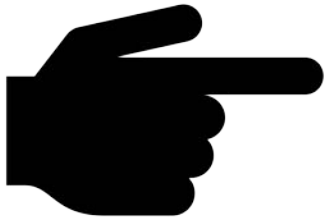
Source: https://www.technipfmc.com

Background

- The subsea industry strives to evolve to a higher level of autonomy
- The existing standards and regulations are falling behind
- A global supplier of subsea systems needs to meet a potential future demand for an autonomous Emergency Disconnect System (EDS)
- Poor communication between supplier and end-user

Problem formulation

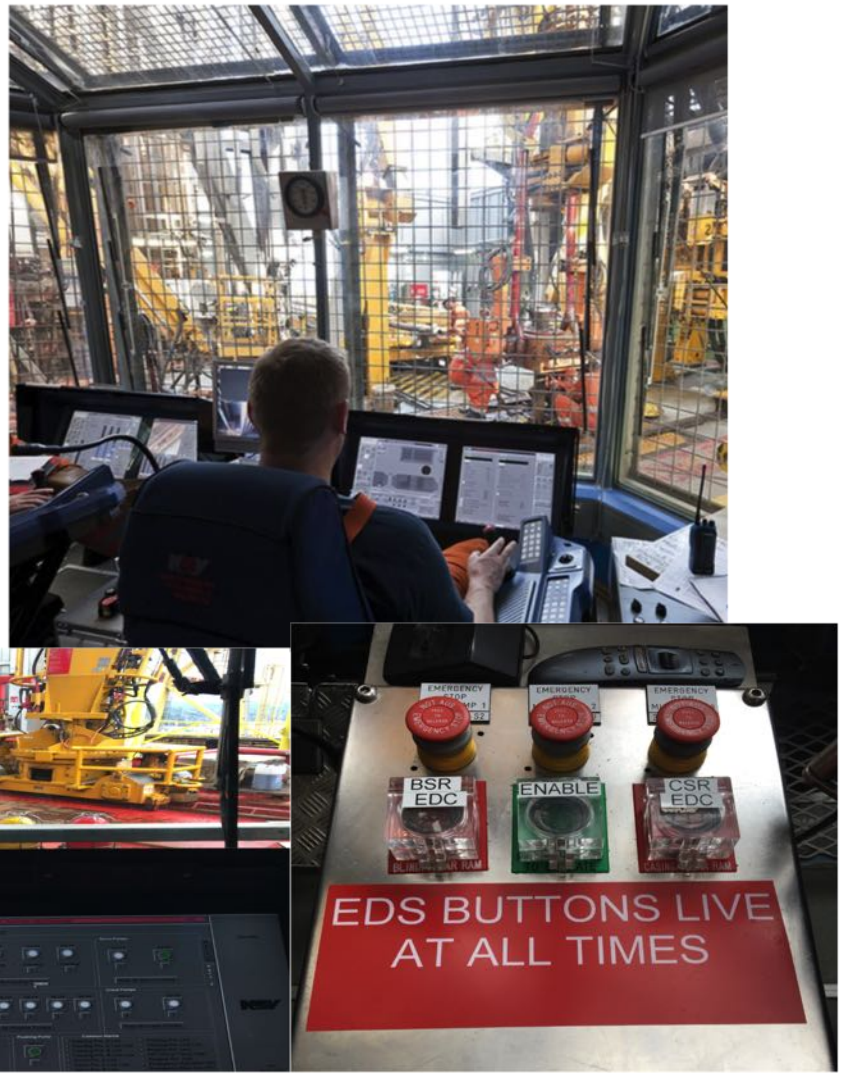
How can we support suppliers of subsea systems to engineer the system with a higher level of autonomy?



- Interviews of users
- Analyzing standards
- Literature review

The decision-making process

- What happens prior to the EDS is activated?
- What are the current operational challenges?
- How may autonomy help?



Source: interviewees

Semi-structured interviews of users

- Key personnel with operational experience from the Norwegian Continental Shelf (NCS)
- Dynamically Positioned (DP) rigs on shallow water on the NCS

Interview profiles

Role	Rig	Water depths (m)	Years of experience	Emergency disconnections experienced
Offshore Installation Manager (OIM)	DP3 rig	250 – 500	16	1
DP Operator (DPO)	DP3 rig	310 – 360	5	1
DP Operator (DPO)	DP3 ship	150 - 200	8	0
Expert Advisor Drilling	DP3 rig	100 – 1700	>20	0
Specialist System Engineer	NA	NA	10	2 (post evaluation onshore)

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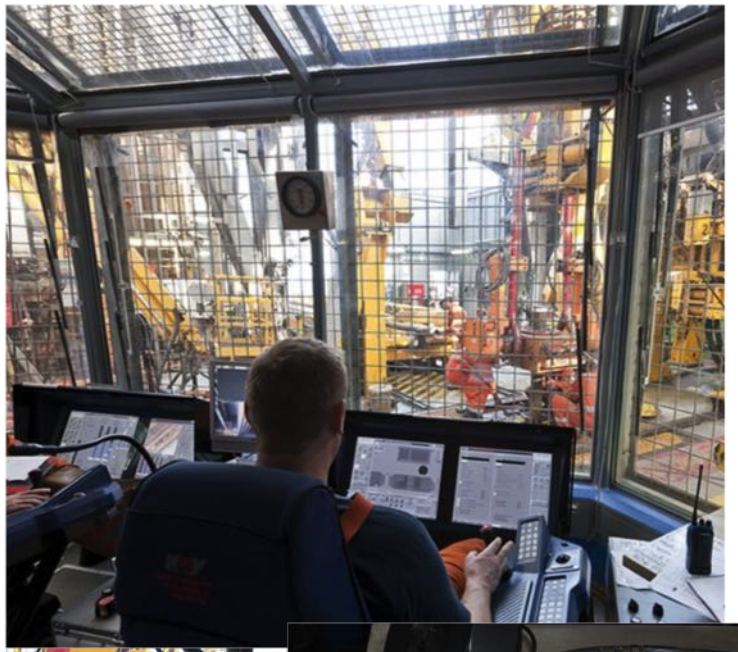
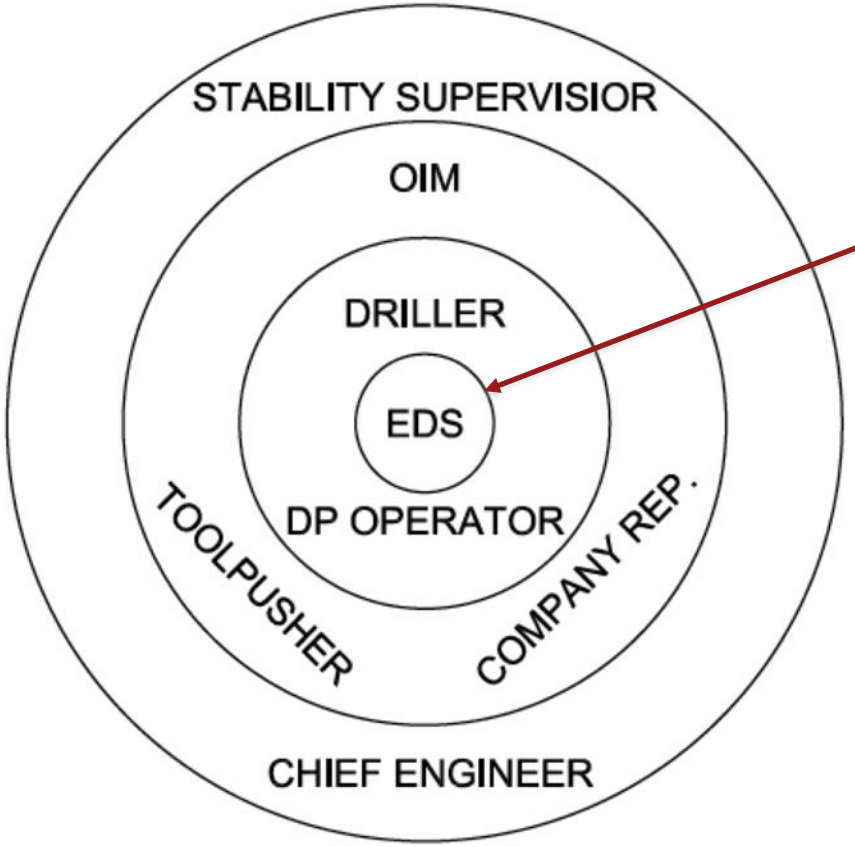


Source: interviewees

Direct stakeholders



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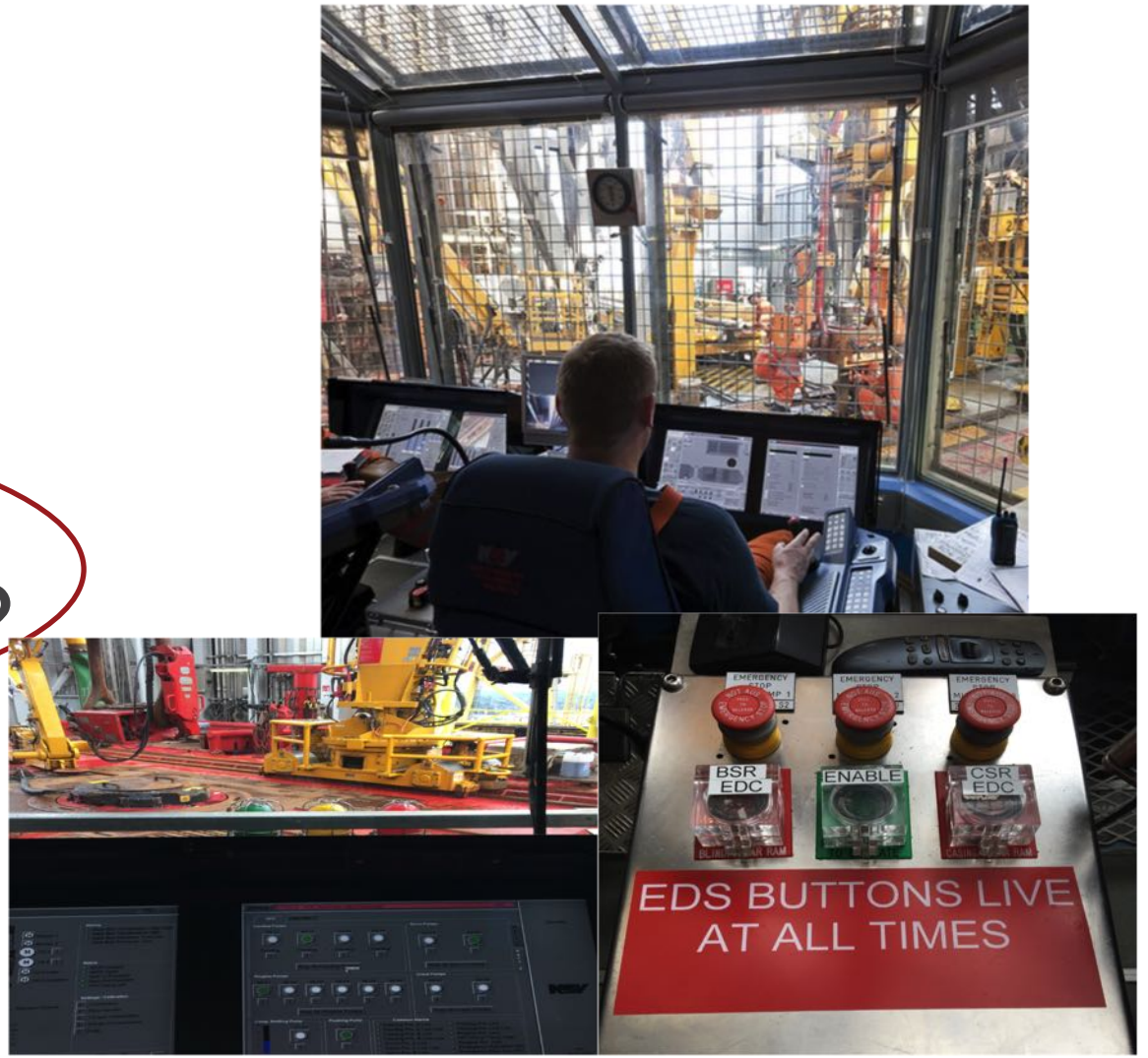
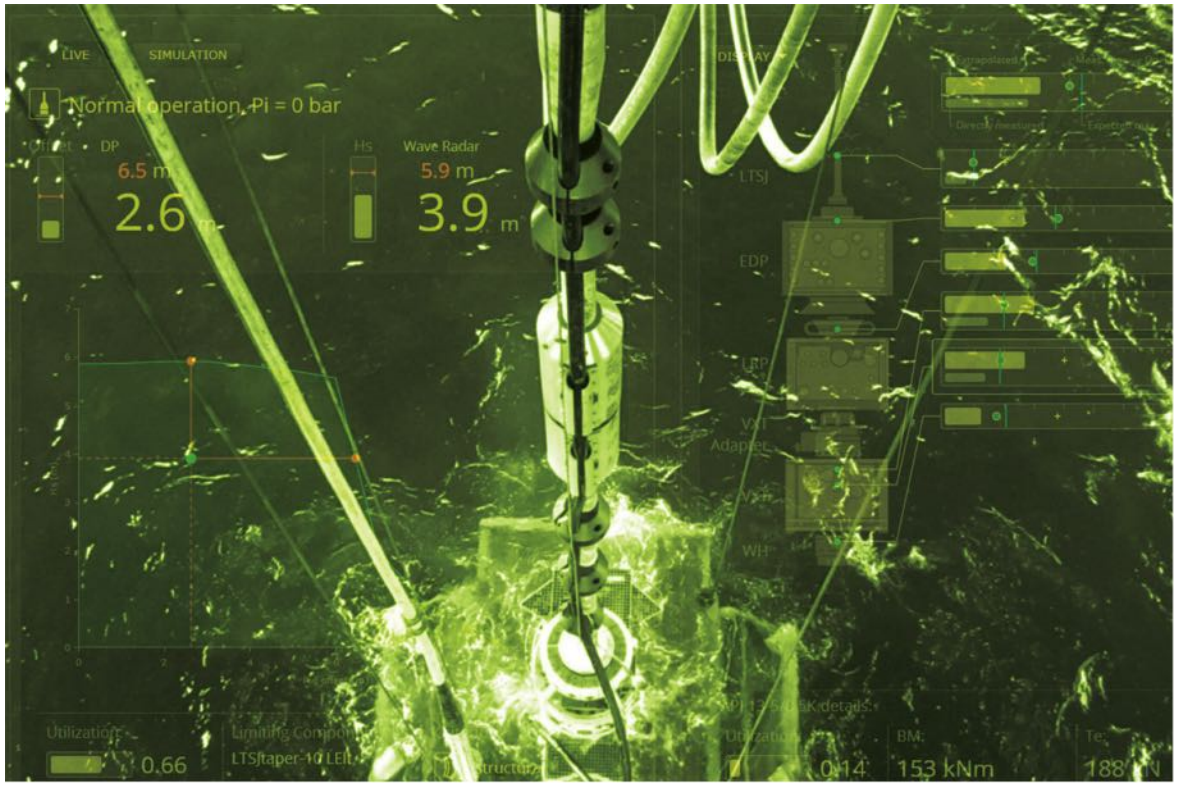


Source: interviewees

Operational scenarios

Planned disconnection preparation phase on a DP rig due to a failure on bearing on the heave compensating system, weather forecast bad.

During this phase, the toolpusher was on his way to the drillers cabin, when suddenly they all **heard a load noise** from the heave compensating system and they saw that a second bearing broke. The **toolpusher gave the order** to the **driller to push the EDS button** at once.

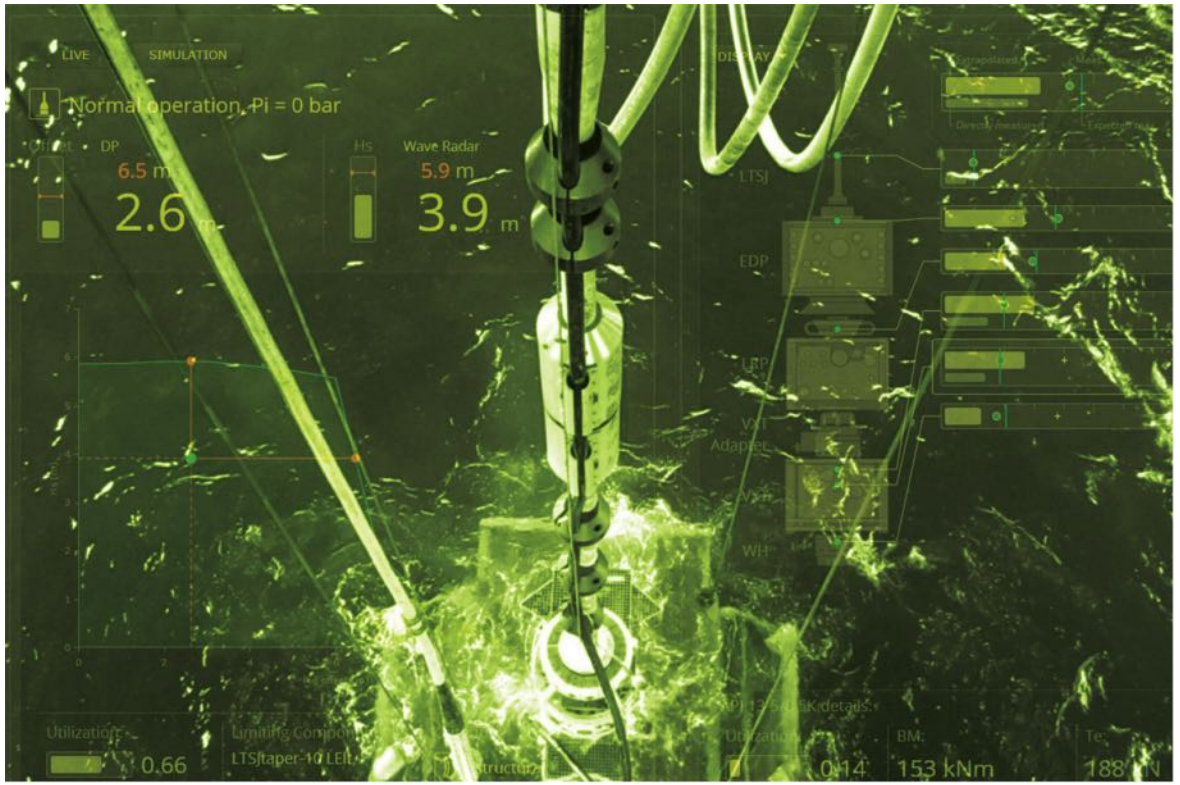


Source: https://www.technipfmc.com

Operational scenarios

During **normal operation** on a DP rig, the weather suddenly is turning bad.

A **sudden wave** pushes the rig from a good position keeping straight out of the red watch circle. It happens so fast, that the DP system was not able to read the sudden move in position and ended up with **disabling the auto-EDS** function. Then based on GPS raw data, the **DPO** immediately **took the decision** to activate the EDS pushbutton.



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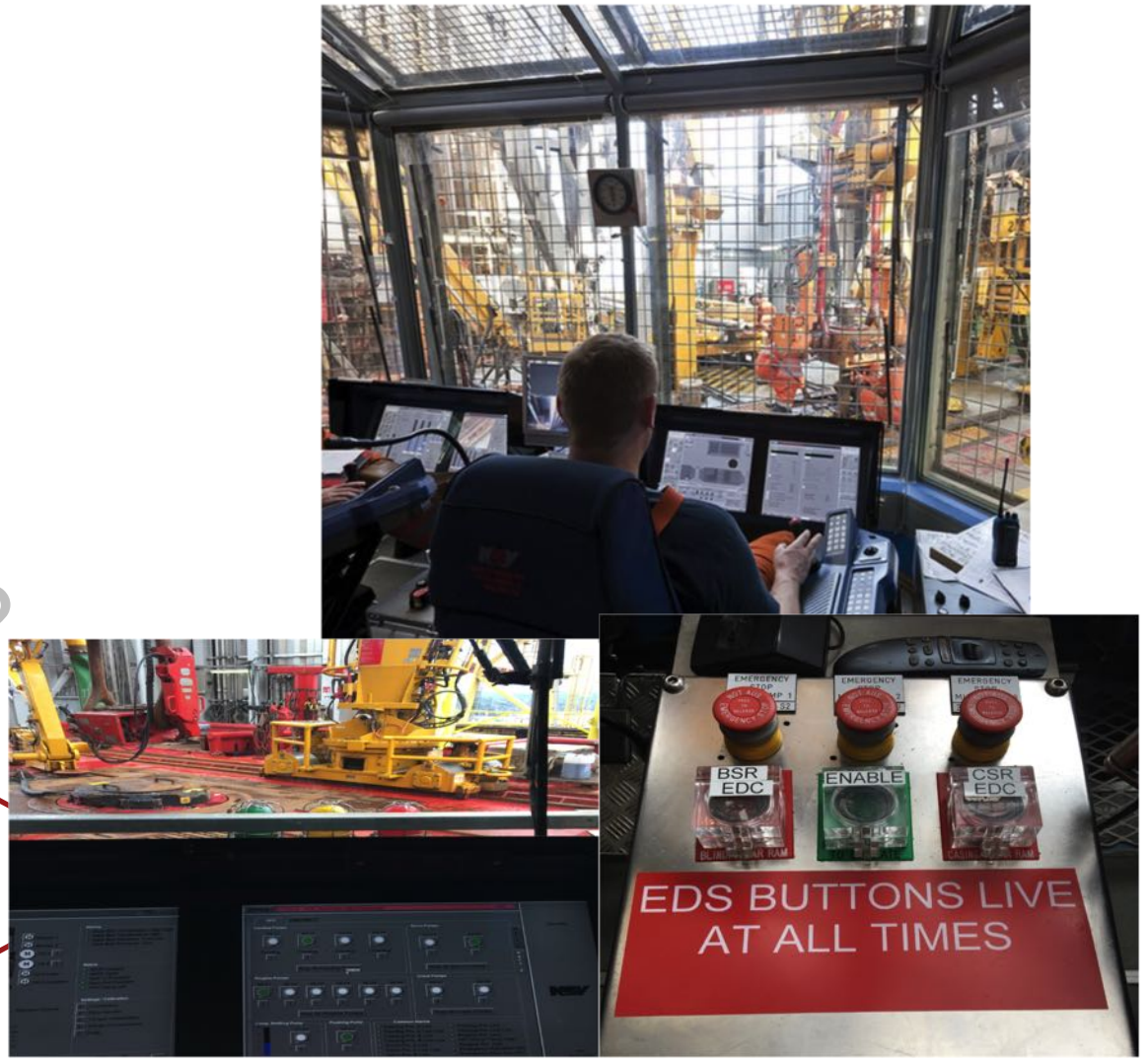


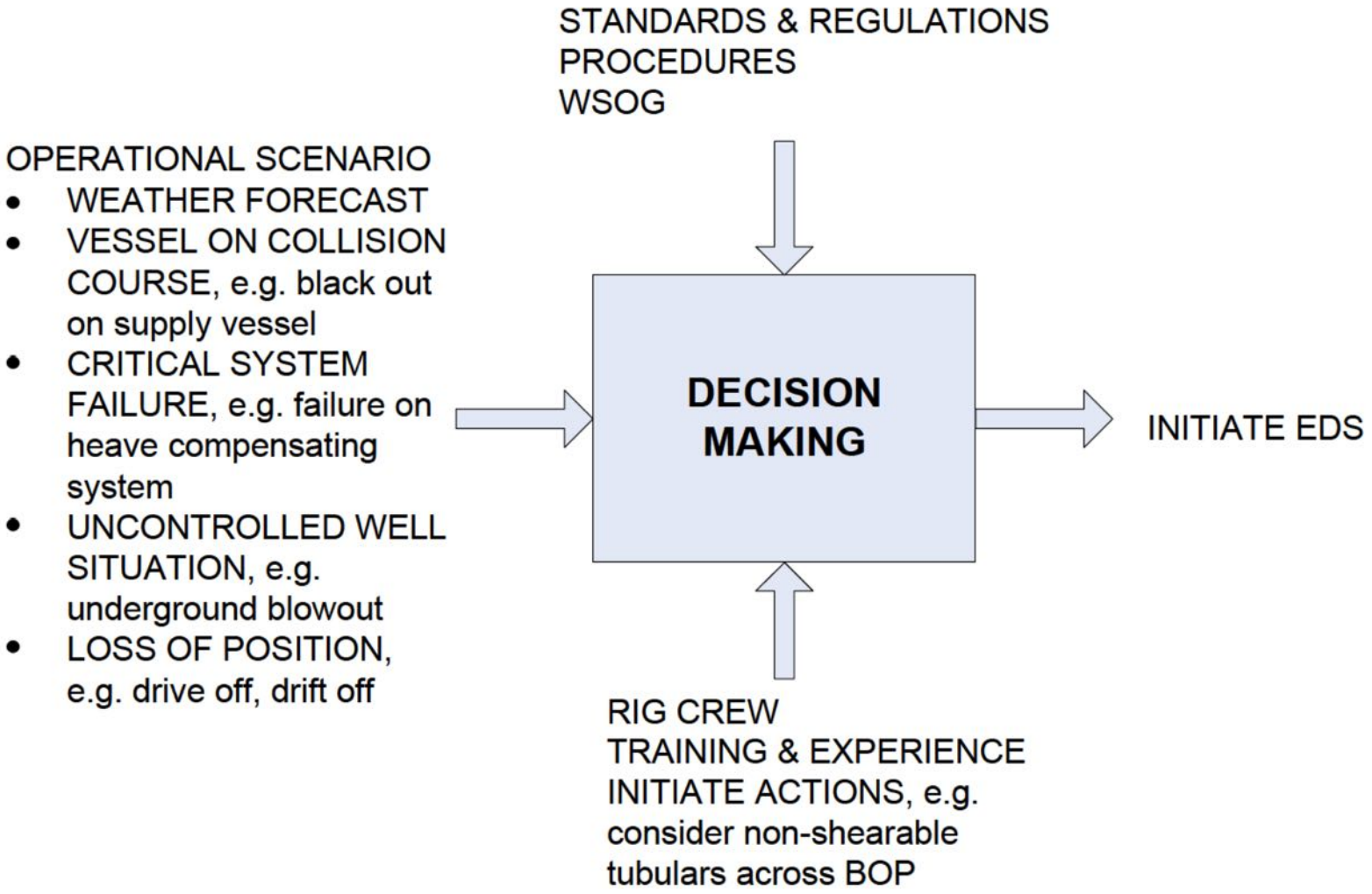
Source: interviewees

Auto-EDS vs. manual EDS

"A **manual EDS allows you to go a bit outside the red watch circle.** It requires knowledge of the seaworthiness of the rig, and nerves of steel"

"**The pros with the auto EDS** is when you go outside the DP circle, e.g. limit 20 m and goes to 20.1 m, then the disconnection sequence starts. It is not possible to stop. The advantage is that you are **according to procedure**, WSOG circle, and you can later claim that the system initiated the sequence based on the preset parameters."

Actuating factors



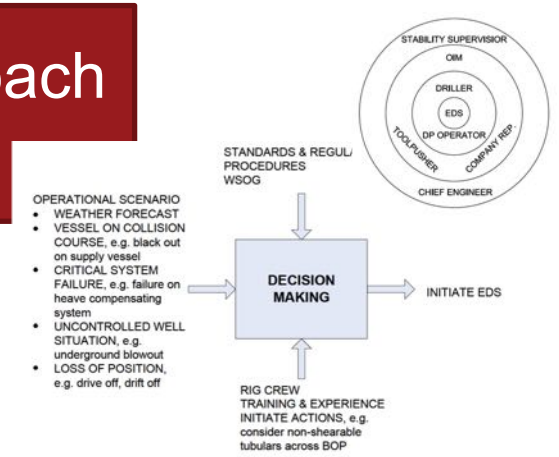
Current standards applied by suppliers

- ISO 13628-7 / API 17G
- NORSOK Standard D-010

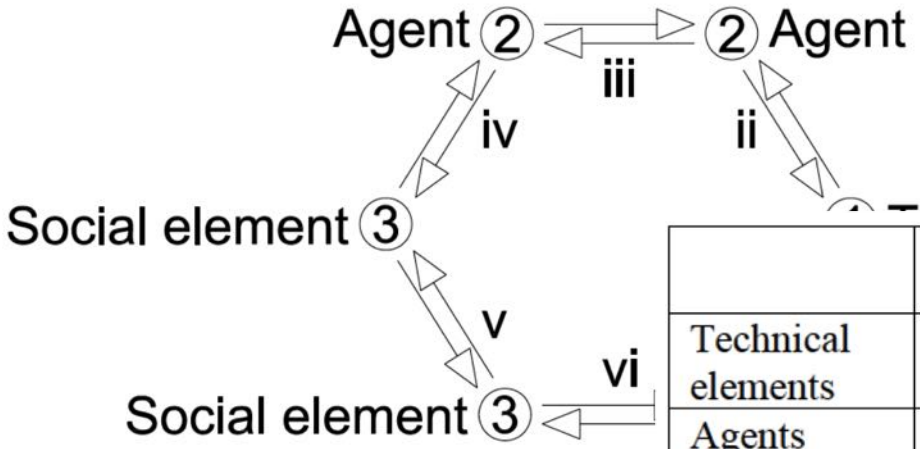
Functional
requirements to the system

Requirements to the
use of the system

Human centered approach
(ISO 9241-210)



EDS as a socio-technical system



Source: Ottens, M. et al., 2005, Systems engineering of socio-technical systems, INCOSE International Symposium 2005

	AGV (Ottens et al. 2005)	**EDS (by authors)**
Technical elements	Vehicles, stops, lanes, central command center	The rig, its systems, well, reservoir
Agents	Users, mechanics, owners, noncooperative users	Rig crew, rig company, operator company
Social elements	Agreements about use of the system, special regulations regarding the pilot projects.	License to perform the operation, regulations regarding design and use of the system
Primary relations	Physical and functional relations are evident, normative relations exist between regulations and agents and technology	Physical and functional relations between agents and technology, normative relations between regulations and agents, and regulations and technology, organizational relations between agents
Function aim/goal	Transportation of people Pilot for new technologies	Secure the well and disconnect the riser from the well, enabling the rig to move to safe area
System boundaries	?	?

Looking towards the car industry

The four main bottlenecks when developing autonomous systems (Behere, 2016)

1. World model
2. User interaction
3. Complexity
4. Reliable and robust safety system

Socio-technical elements and relations of the EDS

Transparency of the EDS that ensure user awareness

Conclusion

How can we support suppliers of subsea systems to engineer the system with a higher level of autonomy?

- The **socio-technical elements** of the EDS, and their **relations**, needs to be considered when evolving to a higher level of autonomy
- A **human-centered approach** (such as ISO9241-210) might be a proper supplement to the currently applied standards

Thank you

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