

Application of systems safety principles for O&M of floating offshore wind.

David Rowell, David McMillan, James Carroll

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Energy Systems
& Structures CDT



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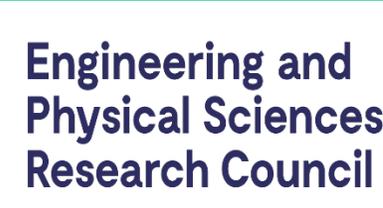
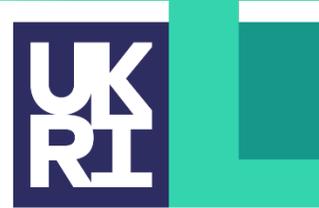


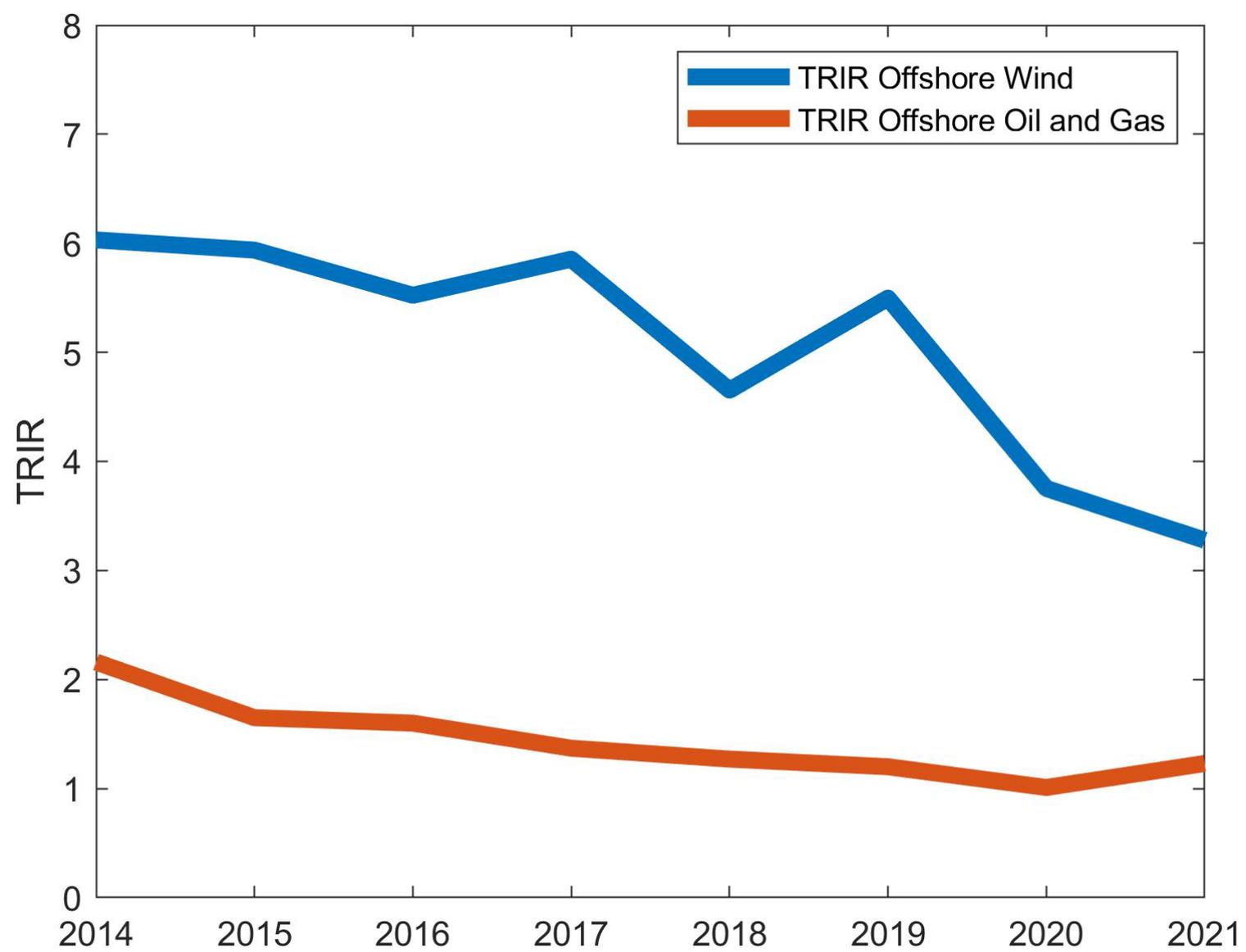
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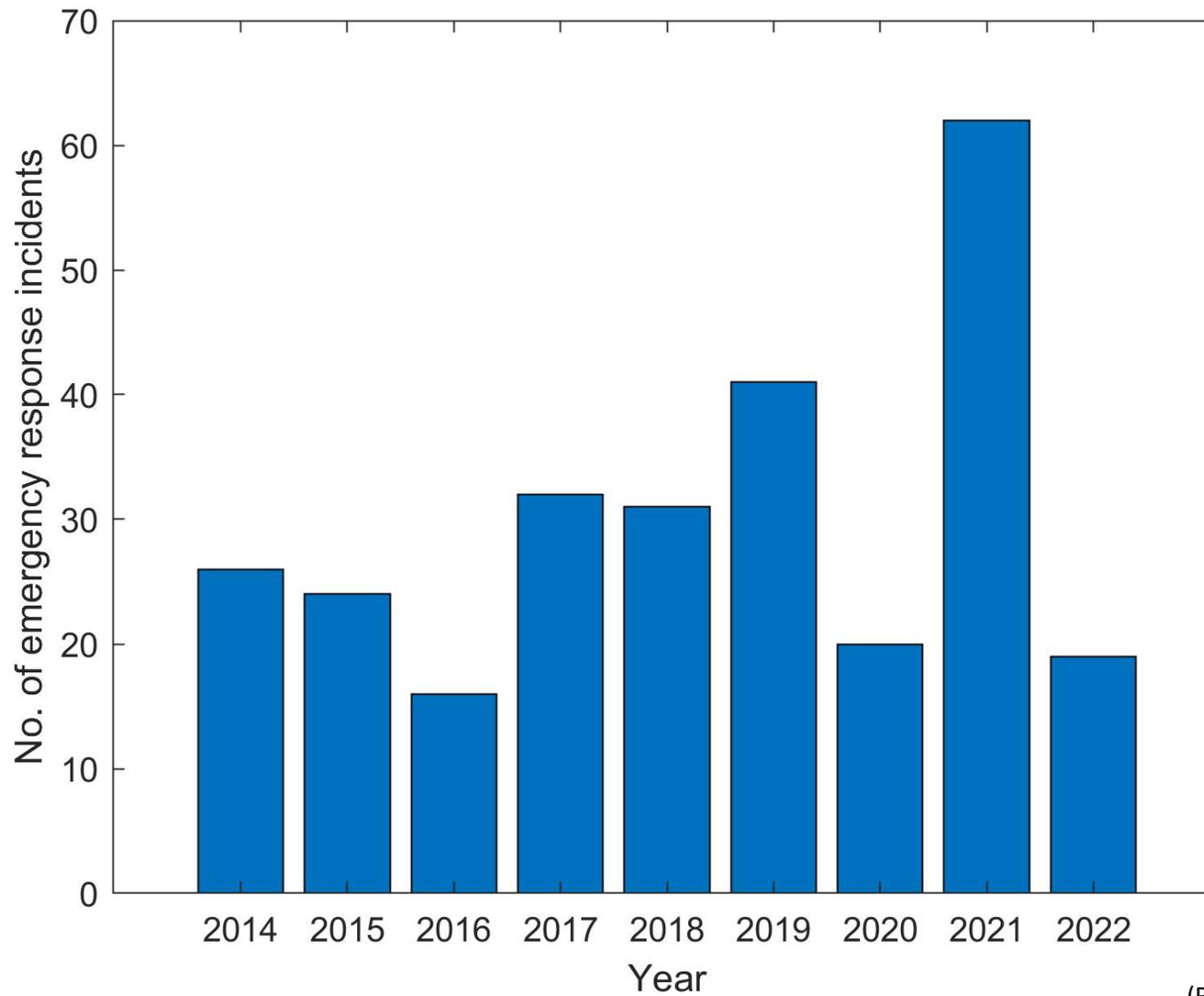
- Safety in offshore wind
- What is systems safety
- Examples
- Applications to FOW

<https://www.grupocobra.com/en/proyecto/kincardine-offshore-floating-wind-farm/>

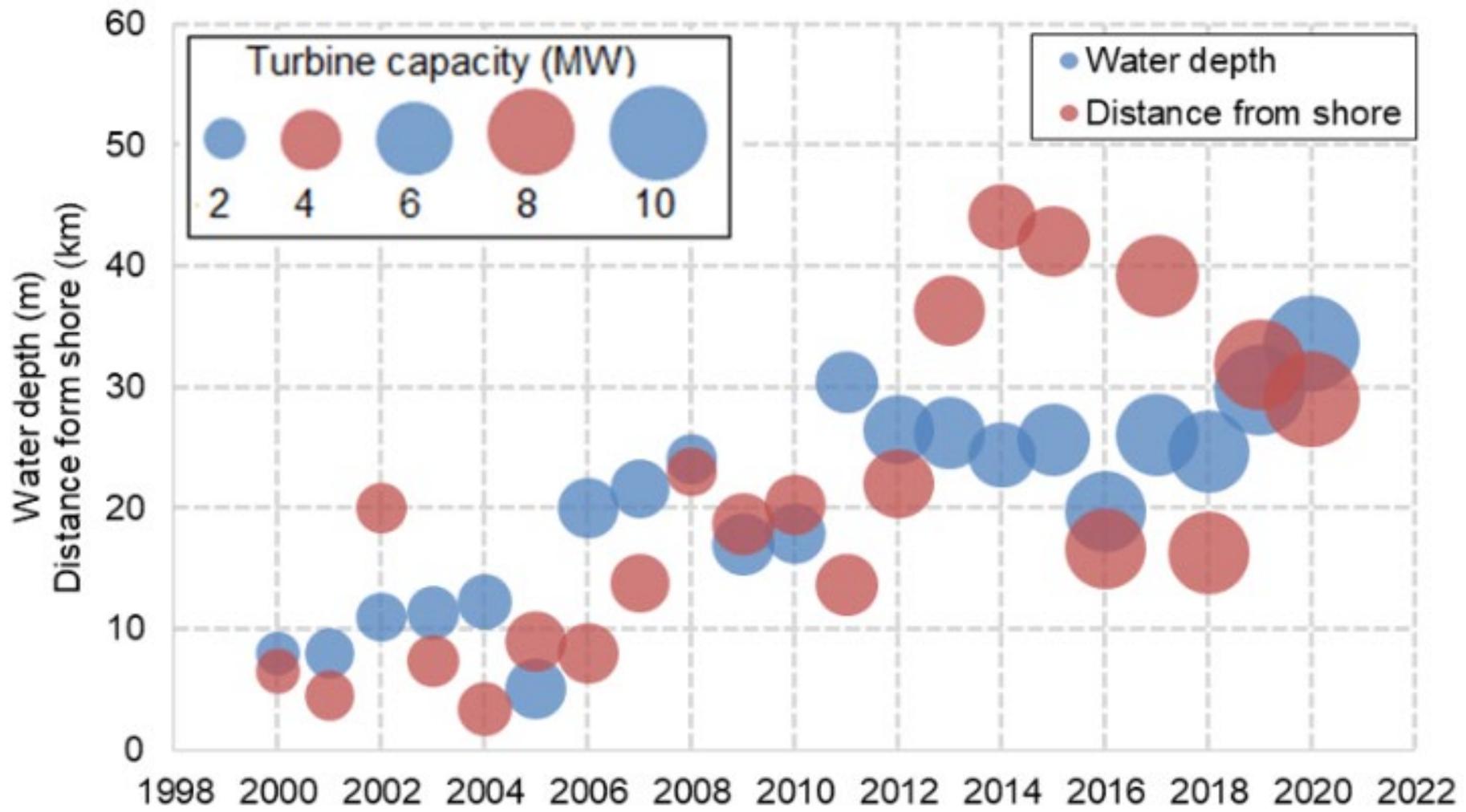




(Rowell et al., 2024)



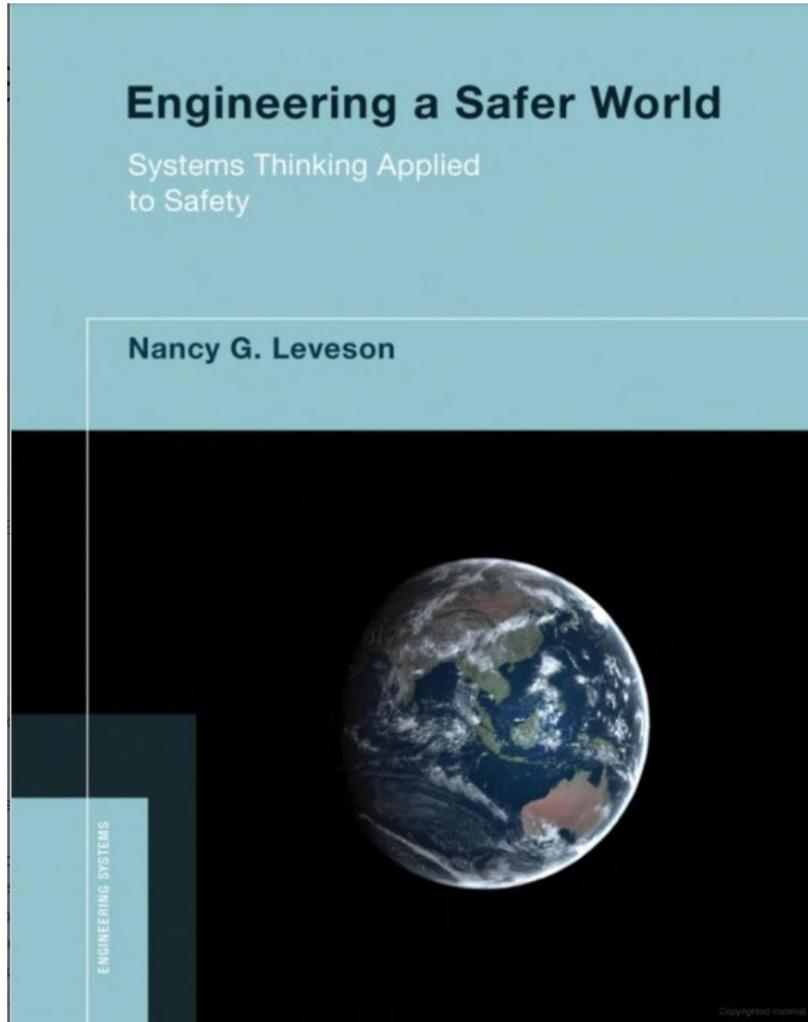
(Rowell et al., 2024) (G+ Global Offshore Wind, 2022)



(Bilgili and Alphan, 2021)



Complexity



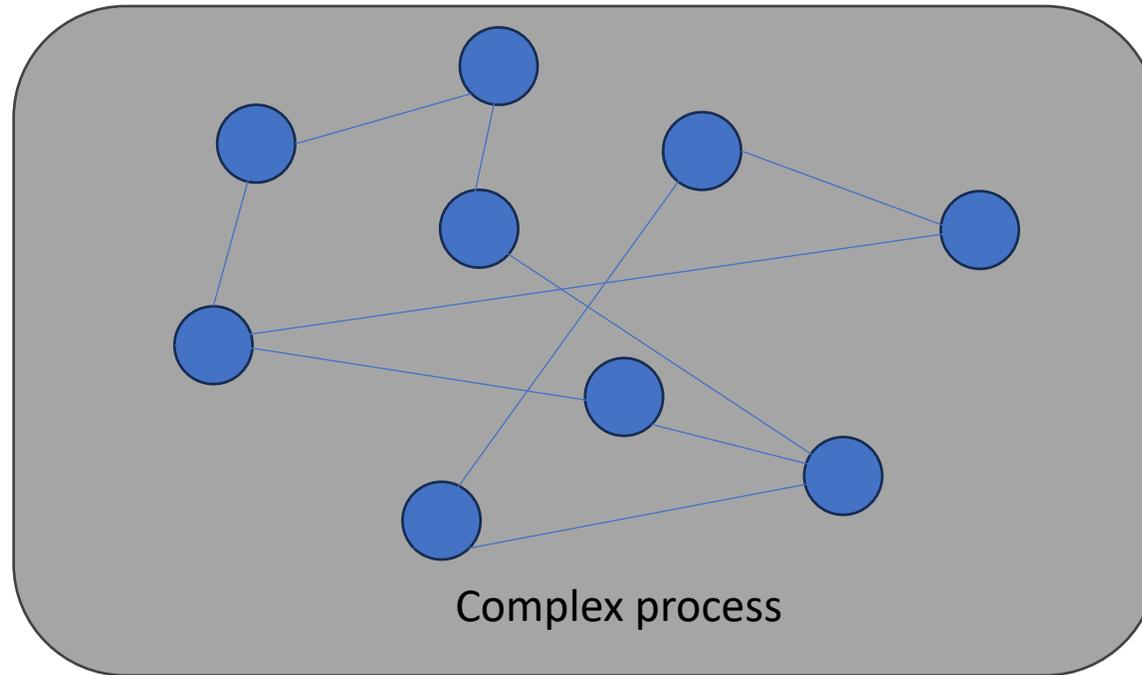
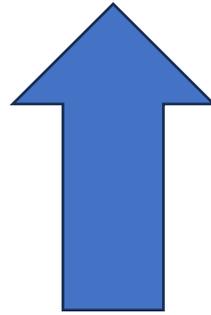
“Safety is an emergent property of a complex system”
Leveson 2012

Linear Causality

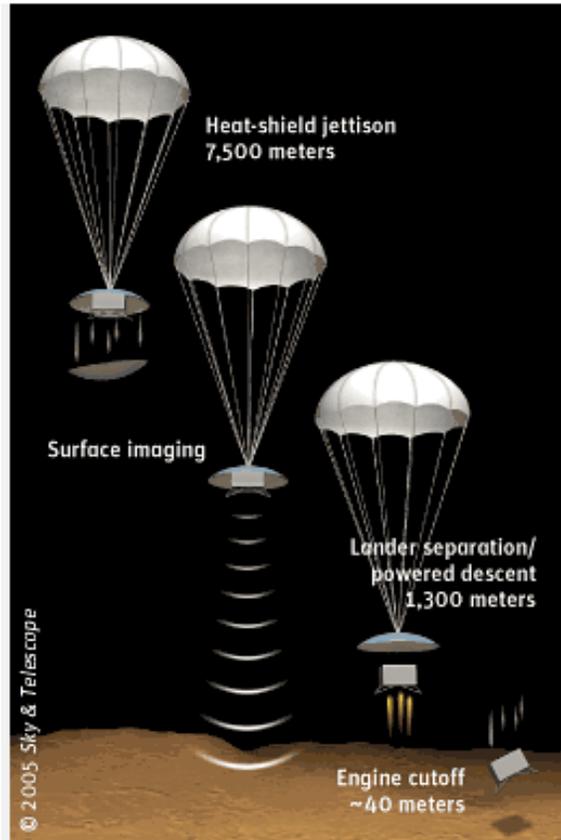


Where is the root cause?

Emergent Properties

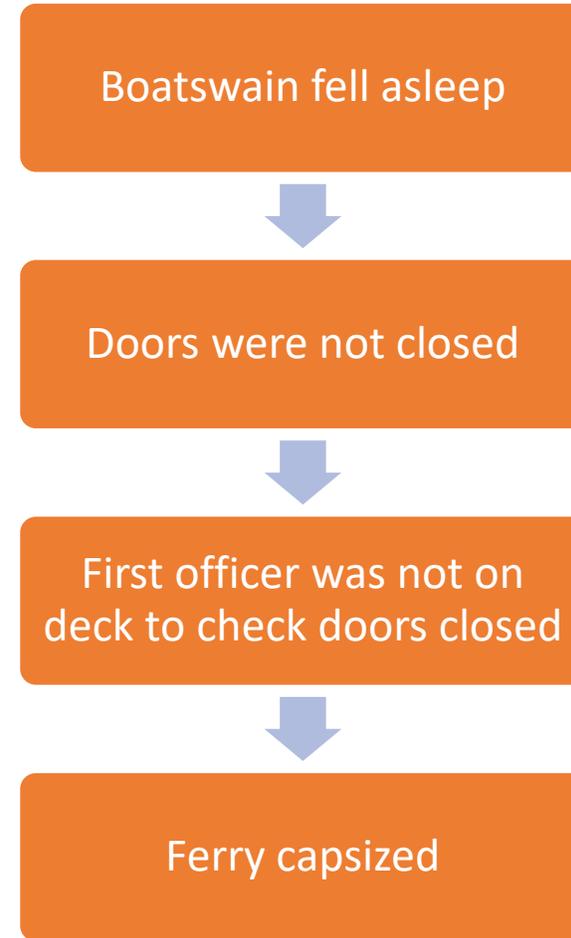


Software error 'caused Mars lander crash'



Lander crashed after engine shutdown prematurely.

(Leveson, 2012) (Reichhardt, 2000)



(Rasmussen, 1997) (Leveson, 2012)

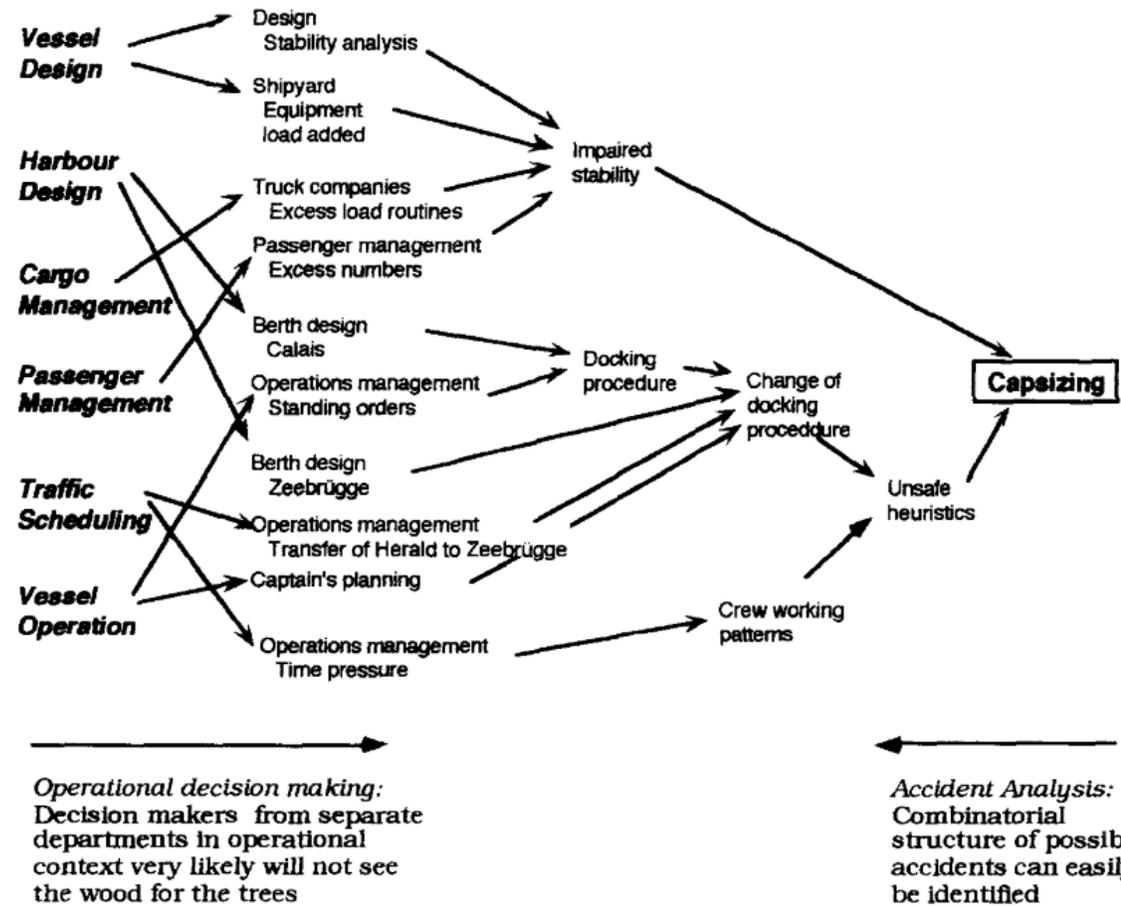


Fig. 2. The complex pattern of the Zeebrugge accident.

(Rasmussen, 1997) (Leveson, 2012)

Engineer who lost arm while working on North Sea wind turbine wins compensation

Darren Hoadley wins compensation from employer Siemens Gamesa after losing his arm in a 2018 accident installing a wind turbine in the Belgian North Sea



04/11/2022, 1:57 pm

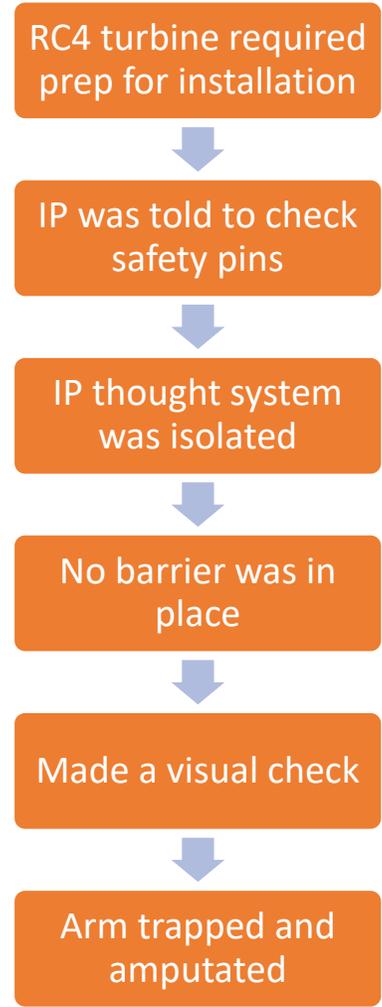
By Matthew Perry



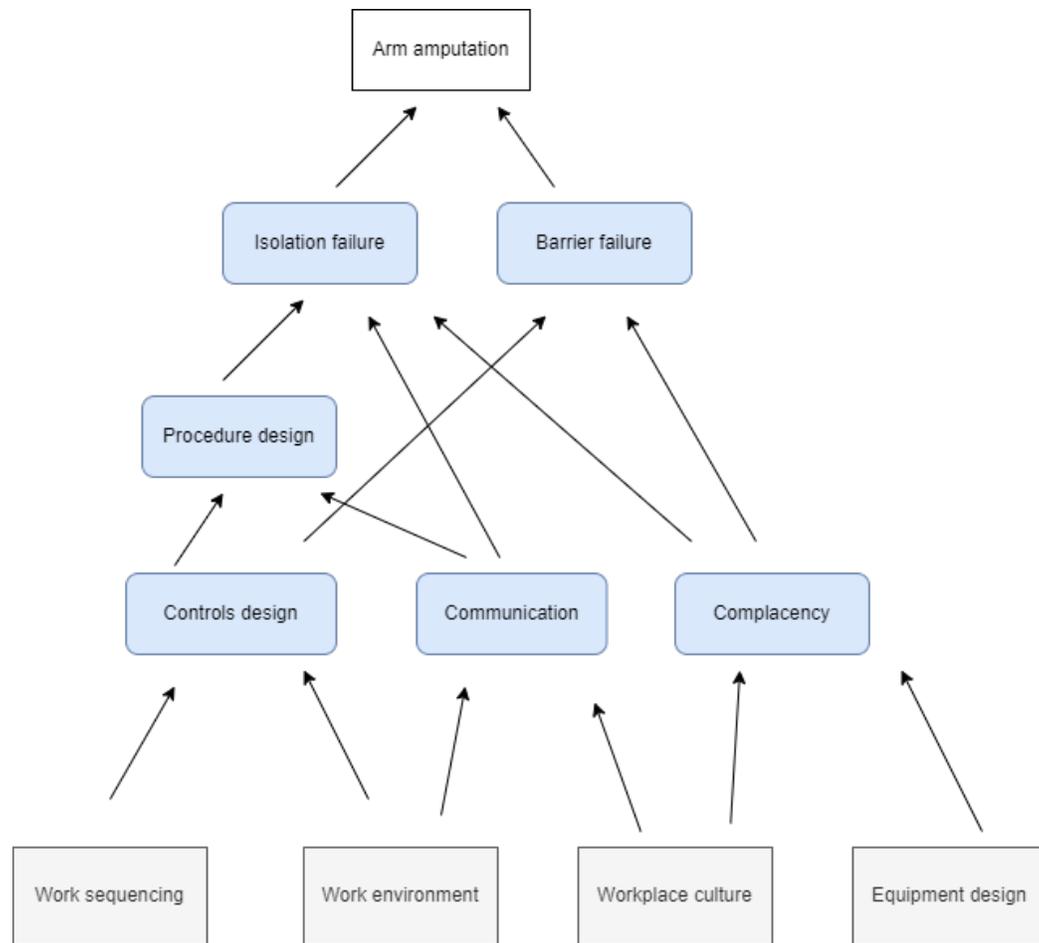
Offshore wind turbine engineer Darren Hoadley

© Getty Images for iStock

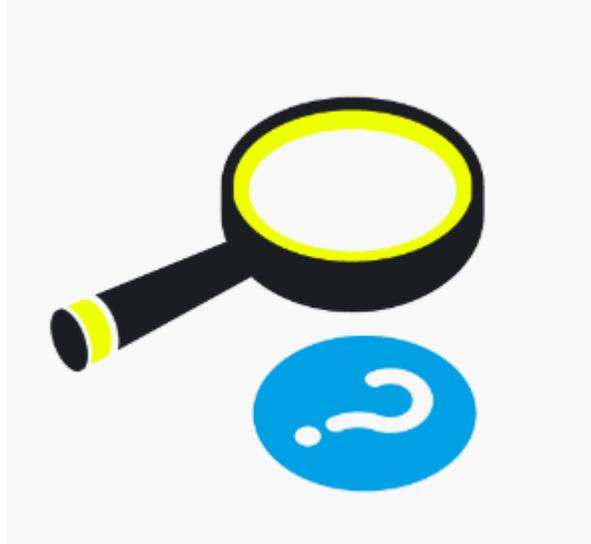
<https://www.energyvoice.com/health-safety-environment/542984/engineer-who-lost-arm-while-working-on-north-sea-wind-turbine-wins-compensation/>



Darren Hoadley v Siemens Gamesa Renewable Energy Ltd (2022)



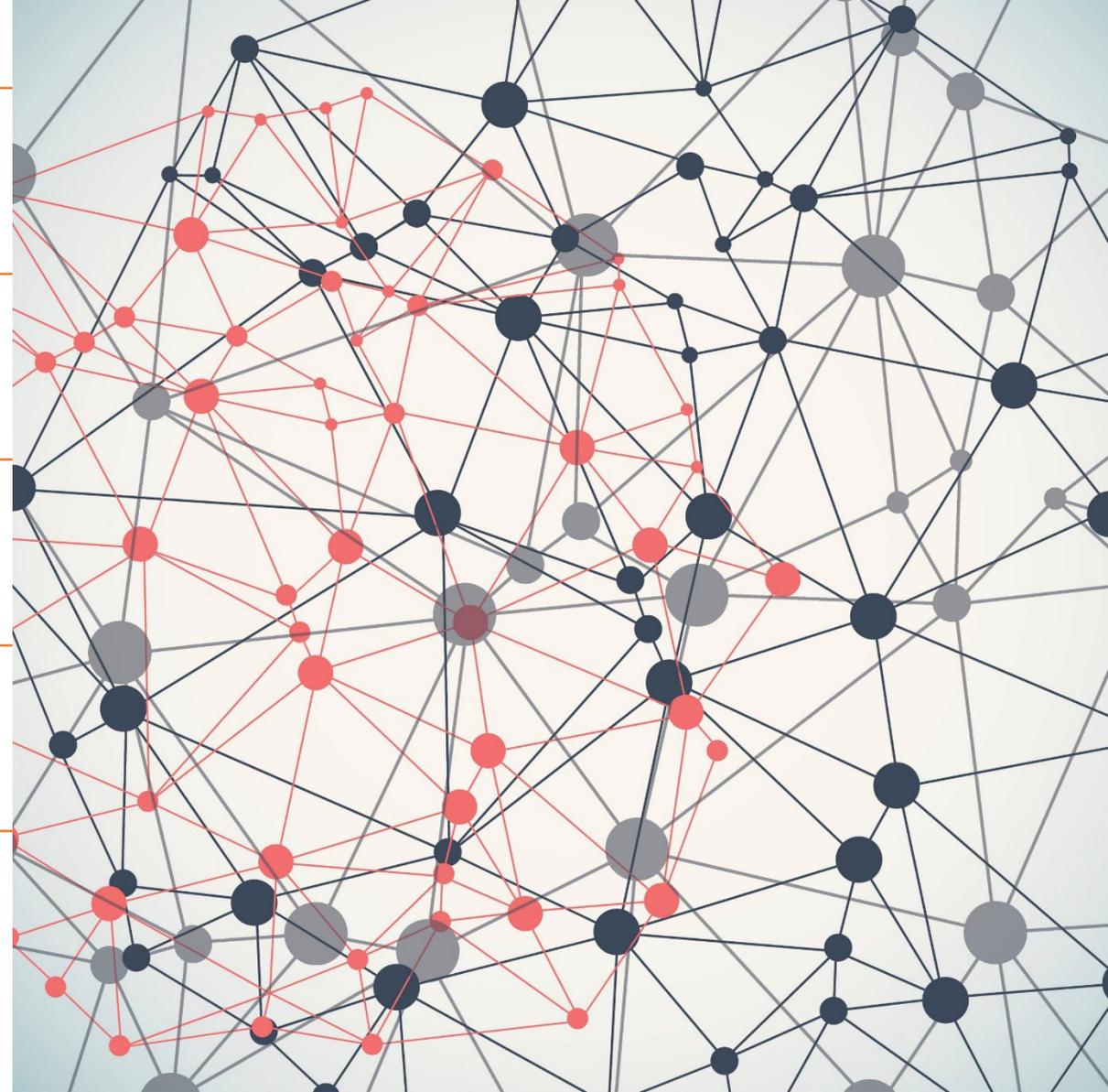
Collision between crew transfer vessel and wind turbine generator



<https://toolbox.energyinst.org/c/presentations/collision-between-crew-transfer-vessel-and-wind-turbine-generator>

Systems Theoretic Accident Model & Processes

(Leveson, 2012)

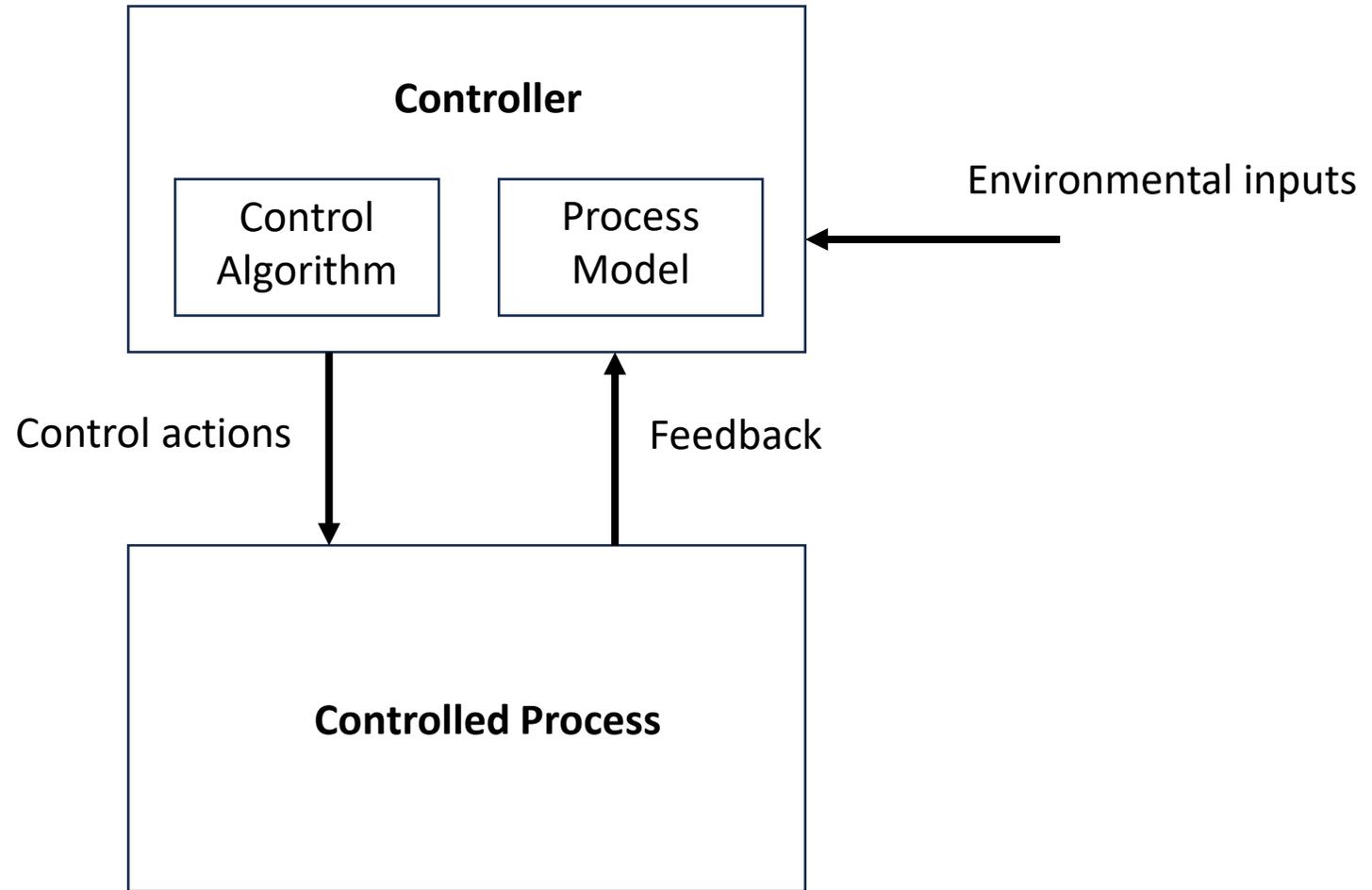


Safety: absence of losses

Loss: could be human life or injury, property damage, loss of generation

Accident: any undesired and unplanned event that results in a loss

(Leveson, 2012)



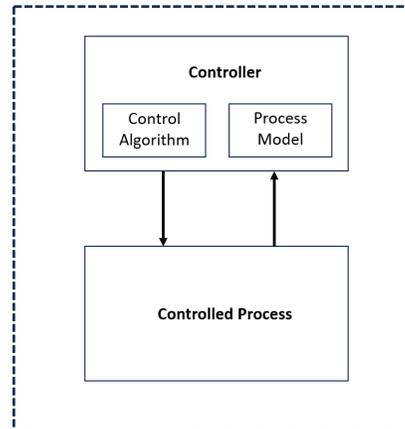
(Leveson and Thomas, 2018)

Organisational analysis

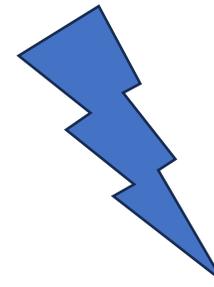
1) Define purpose

- Goals
- Requirements
- Hazards
- Constraints

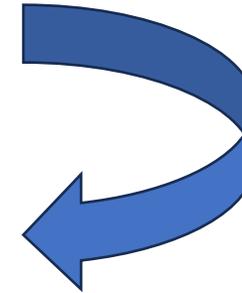
2) Model control structure



3) Gap analysis on control structure



4) Re-design controls



(Leveson and Thomas, 2018)



System Goal SG-1:

Floating wind turbines and infrastructure are designed to provide a safe workplace for persons involved in installing, operating and maintaining them.



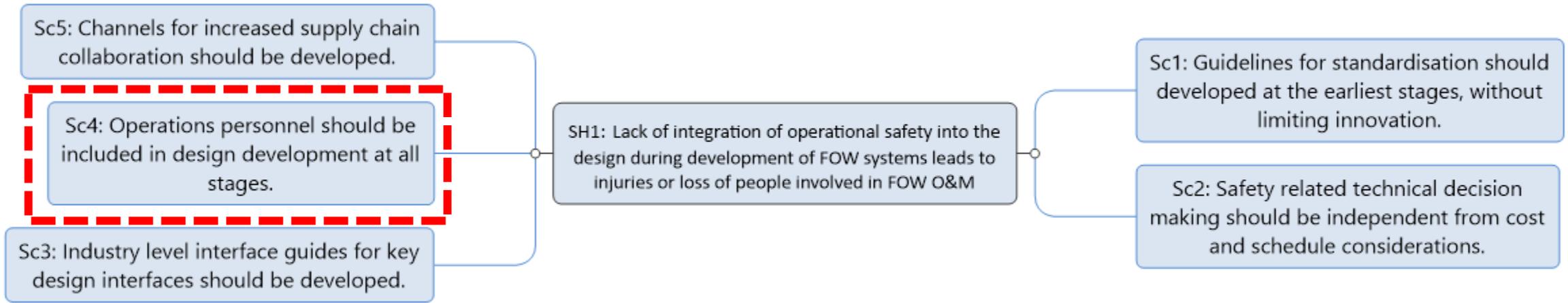
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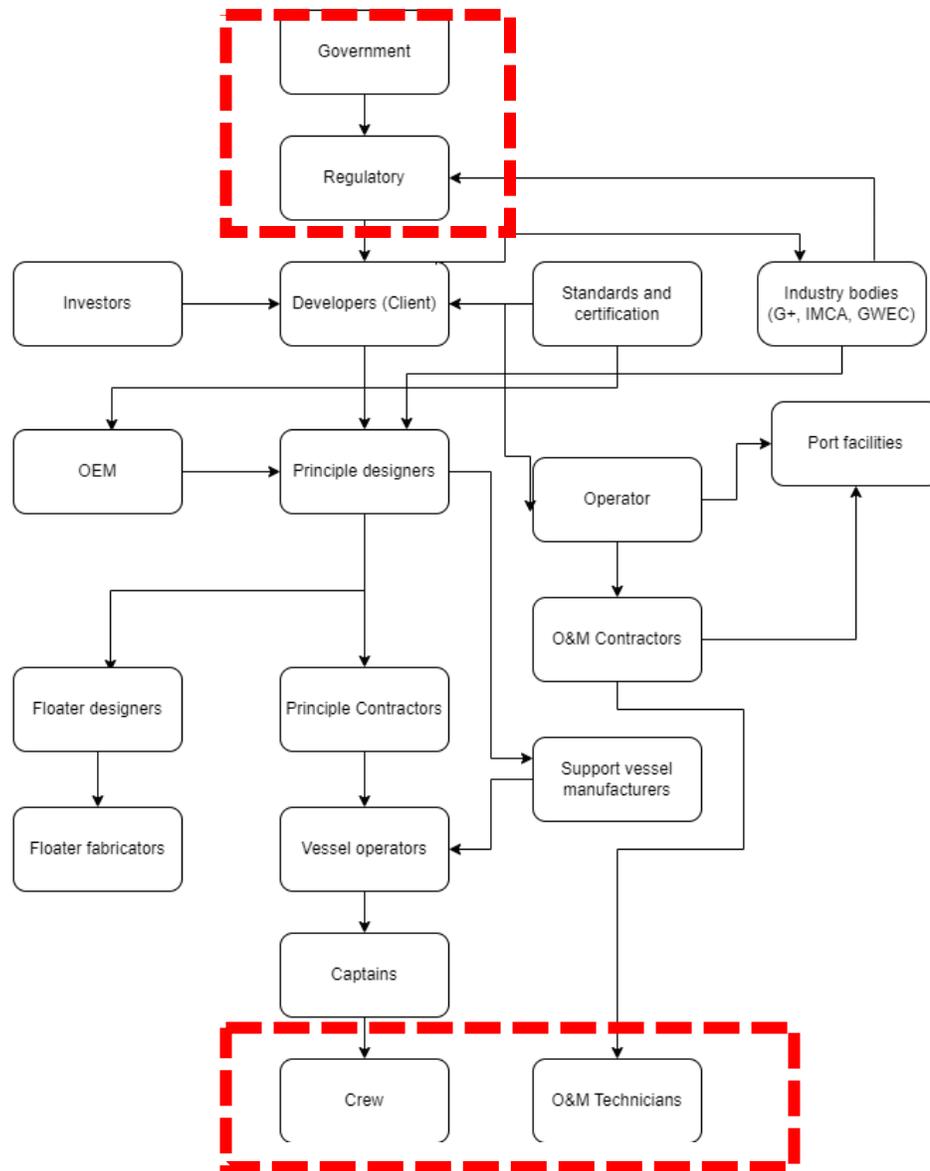
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System Hazard OH-1:

Lack of integration of safety into the design development of FOW systems leads to losses.



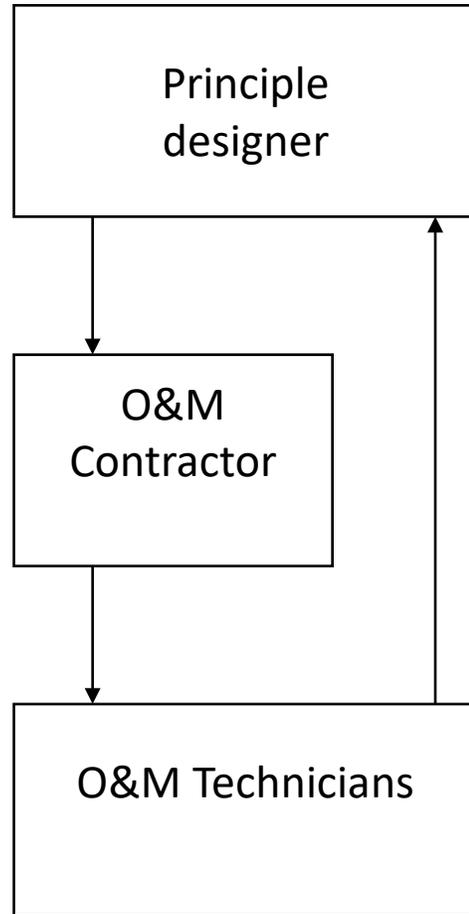
(G+ Global offshore wind, 2022)



Control actions:
Legislation
Regulations
Policies

Feedback:
Accident reports
Near miss reports
Worker engagement

What controls are in place?
Are constraints enforced?



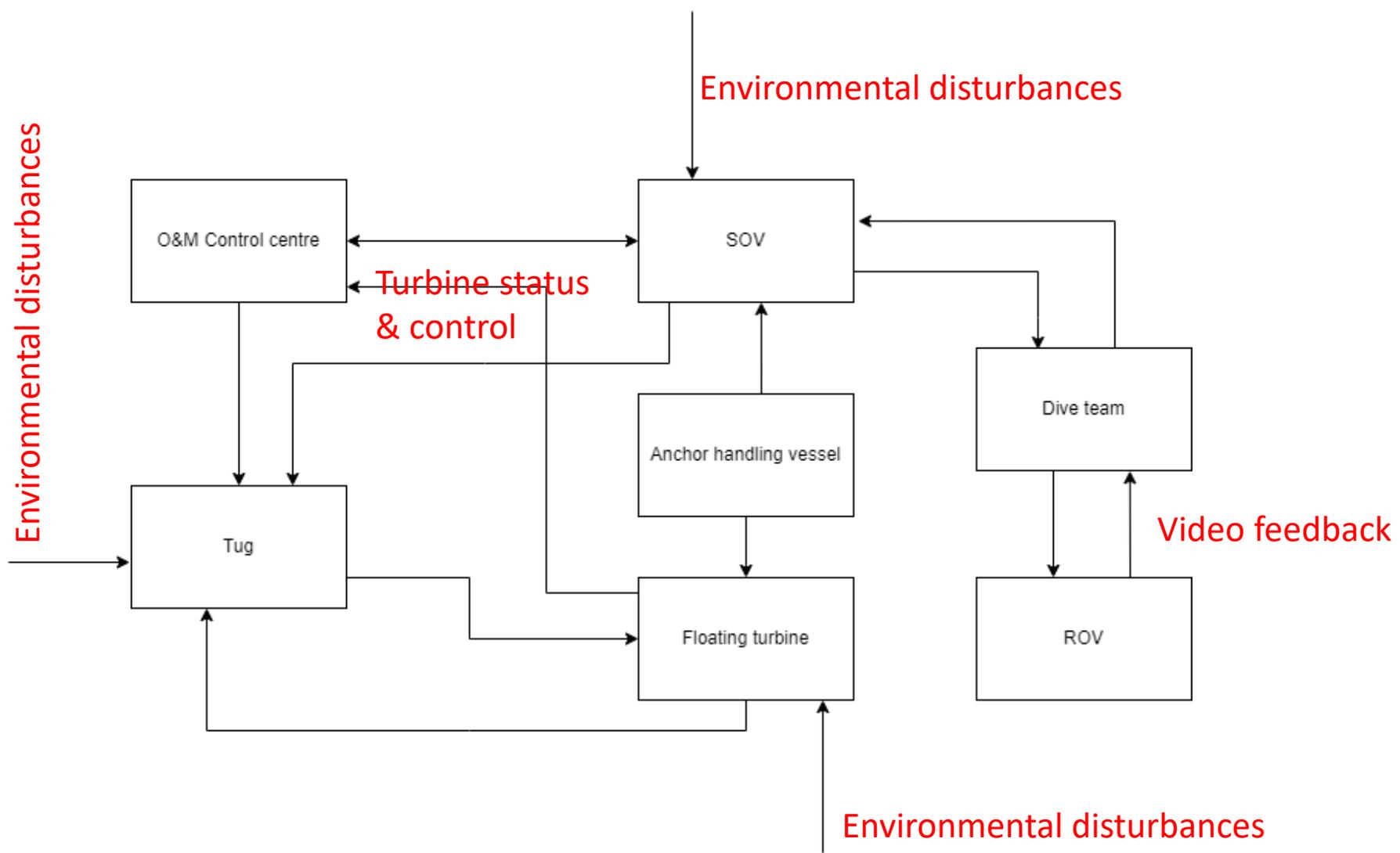
What feedback mechanisms are in place?

Example gap analysis:

Requirement – Operations personnel involved in all stages of design development.

Control structure element – Designer, O&M Contractor.

Weakness identified – No formal mechanism for involvement at all stages.



Applications for FOW

Organisational analysis

Design technical analysis

Operational hazard analysis

SOV operations hazard analysis(Puisa et al., 2021)



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