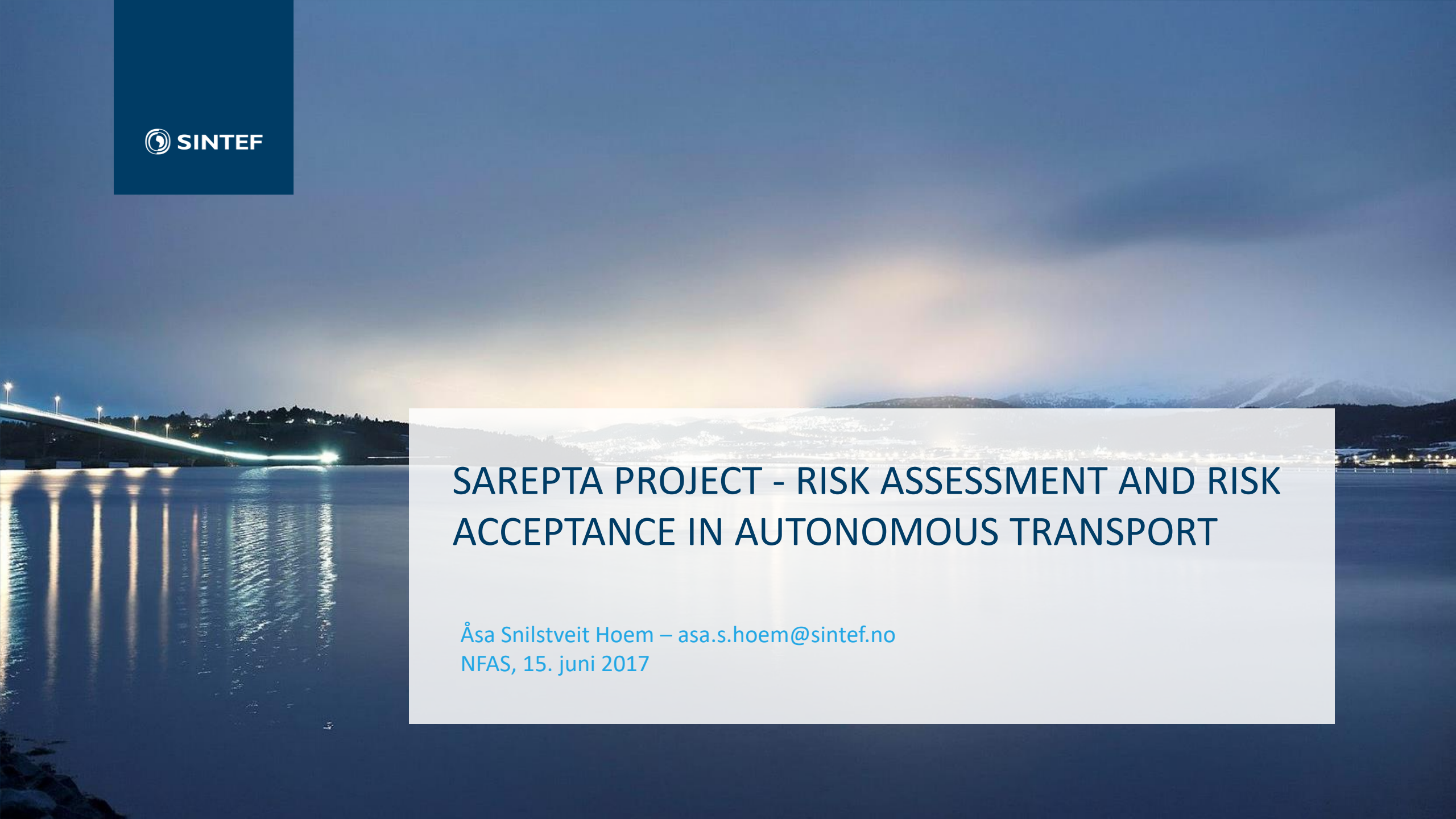

SAREPTA PROJECT - RISK ASSESSMENT AND RISK ACCEPTANCE IN AUTONOMOUS TRANSPORT

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NFAS, 15. juni 2017

Agenda

- Motivation
- The Sarepta project
- Definitions: Risk, Risk acceptance, Risk assessment
- Exploration of cases
- Furher work

Motivation - Autonomous transport

I. **Road: Safety -** reduce number of accidents by 50% and support more efficient transport..

II. **Rail:** Safety (Experience high safety), efficiency

III. **Air:** Reduce risk in operation, (but in Drones 50 to 100 more accidents than manned flights due to poor Human Factors)

IV. **Maritime:** Efficiency, safety

Maritime Air Road Rail

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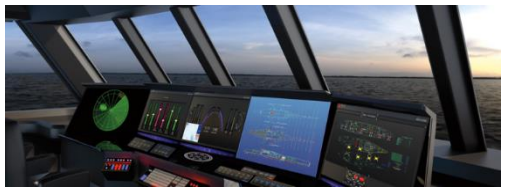
Need for development of new methods

- Most safety analysis tools are all **40-60** years old. Our technology is very different today



1940 1950 1960 1970 1980 1990 2000 2010 2020

FMEA

FTA HAZOP

ETA

Bow Tie (CCA)

FTA+ETA

- Introduction of computer control
- Exponential increase in interaction and complexity
- Lots of new technology
- Age of Complex Systems

Mechanical and electrical components dominate

More instrumentation and software control

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SAREPTA (2017- 2020; 8.9 mill. NOK, incl. PhD; Transport 2025)

Safety, autonomy, remote control and operations of industrial transport systems

A. **Risk identification and risk levels**

B. **Vulnerabilities and threats**

C. **Technical, human and operational barriers**

D. **Organizational and human factors, and regulatory measures for risk mitigation**

Maritime Air Rail Road

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SAREPTA

Key objective:

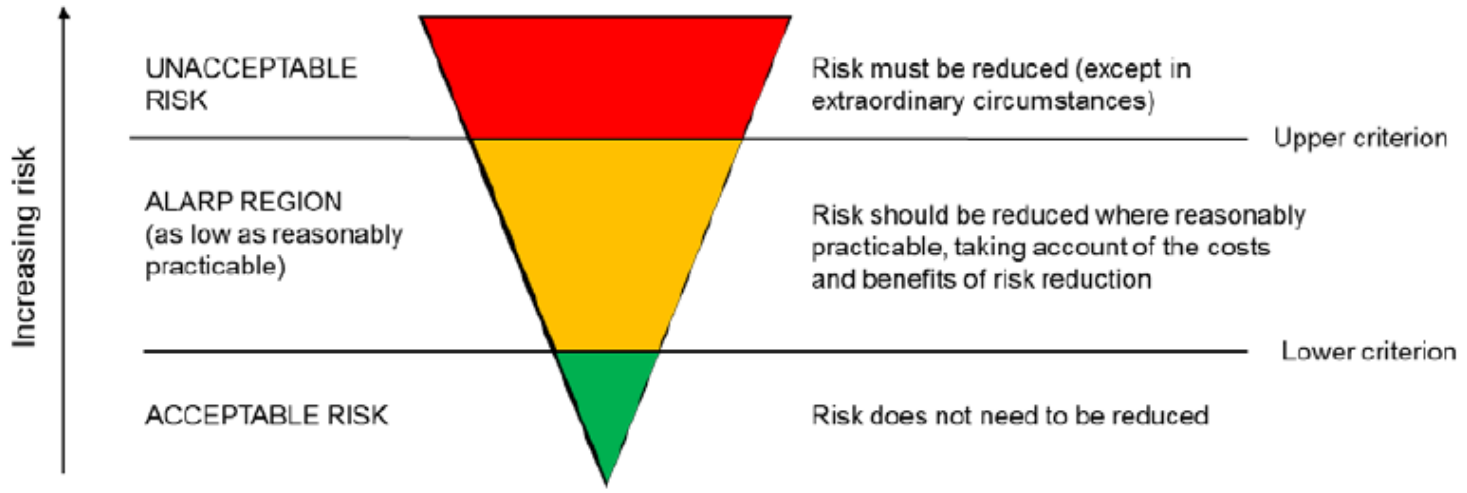
provide necessary knowledge for the development of improved methods for risk assessments and mitigation in transport systems that are autonomous, remotely controlled and/or periodically unmanned.

Goal: contribute to systematizing and expanding the knowledge related to risk level, vulnerabilities, possible barriers and the need for novel, more integrated, regulatory approaches.

Definitions

- Risk
  - Traditional analytic context: **Probability ✖ consequences**
  - ISO 3100 (2009): Risk = effect of uncertainty on objectives
  - PSA (2016): Risk = the consequences of an activity with the associated uncertainty
- Risk assement
  - the overall process of risk identification, risk analysis and risk evaluation (ISO31010:2009)

- Risk acceptance
  - Criteria used as a basis for decisions about acceptable risk
  - Individual and Societal



→ How to move to ALARP and ACCEPTABLE RISK?

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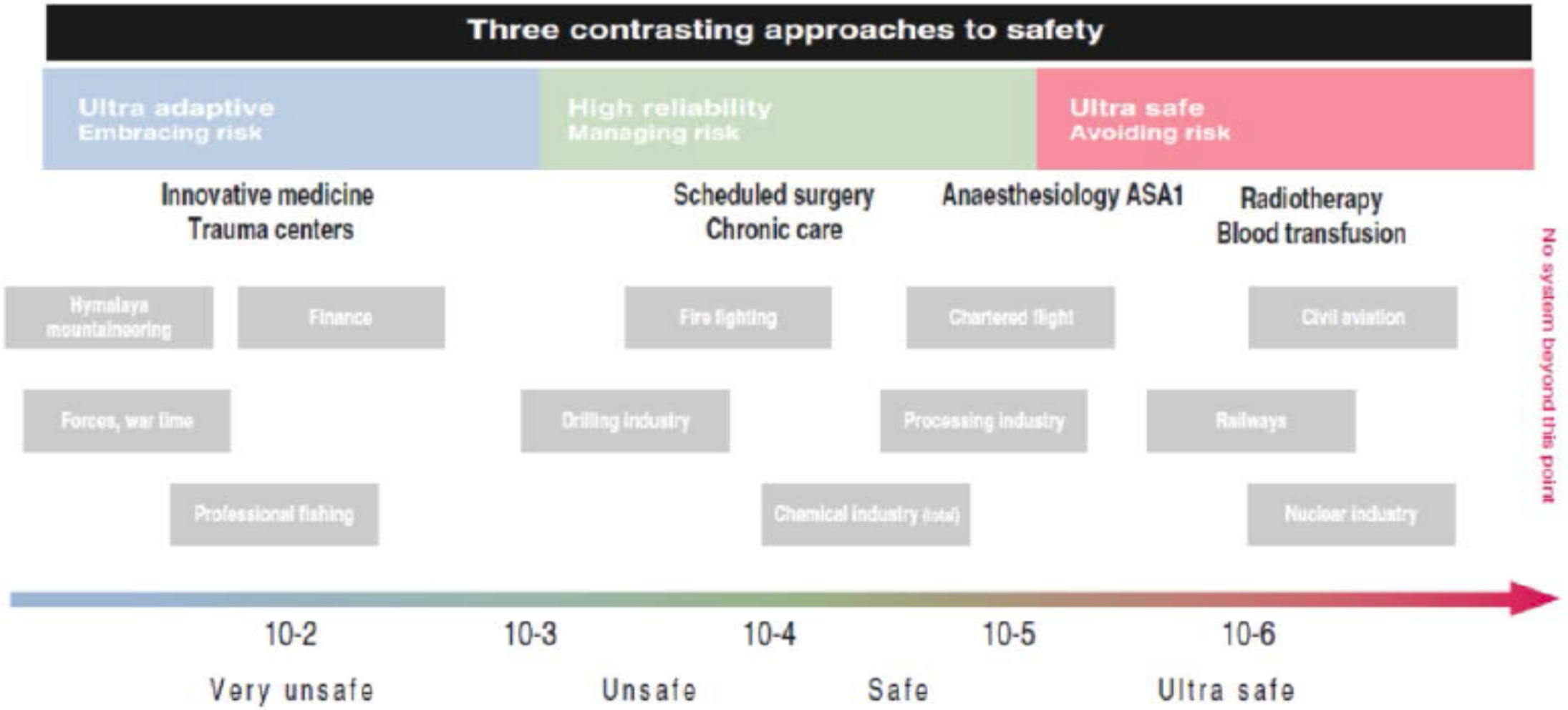
System Safety – high risk/high hazard

Origins – Paradox of Almost Totally Safe Systems (René Amalberti)



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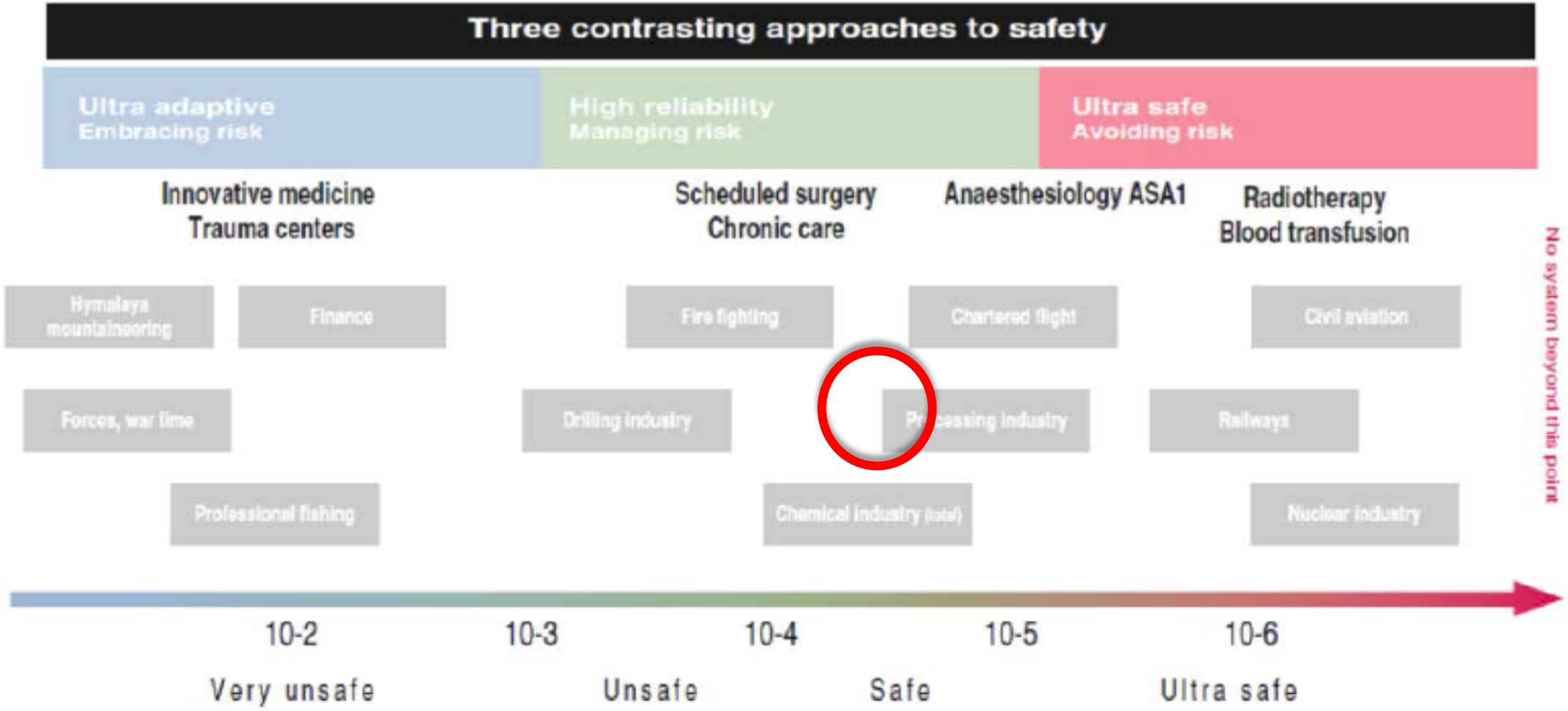

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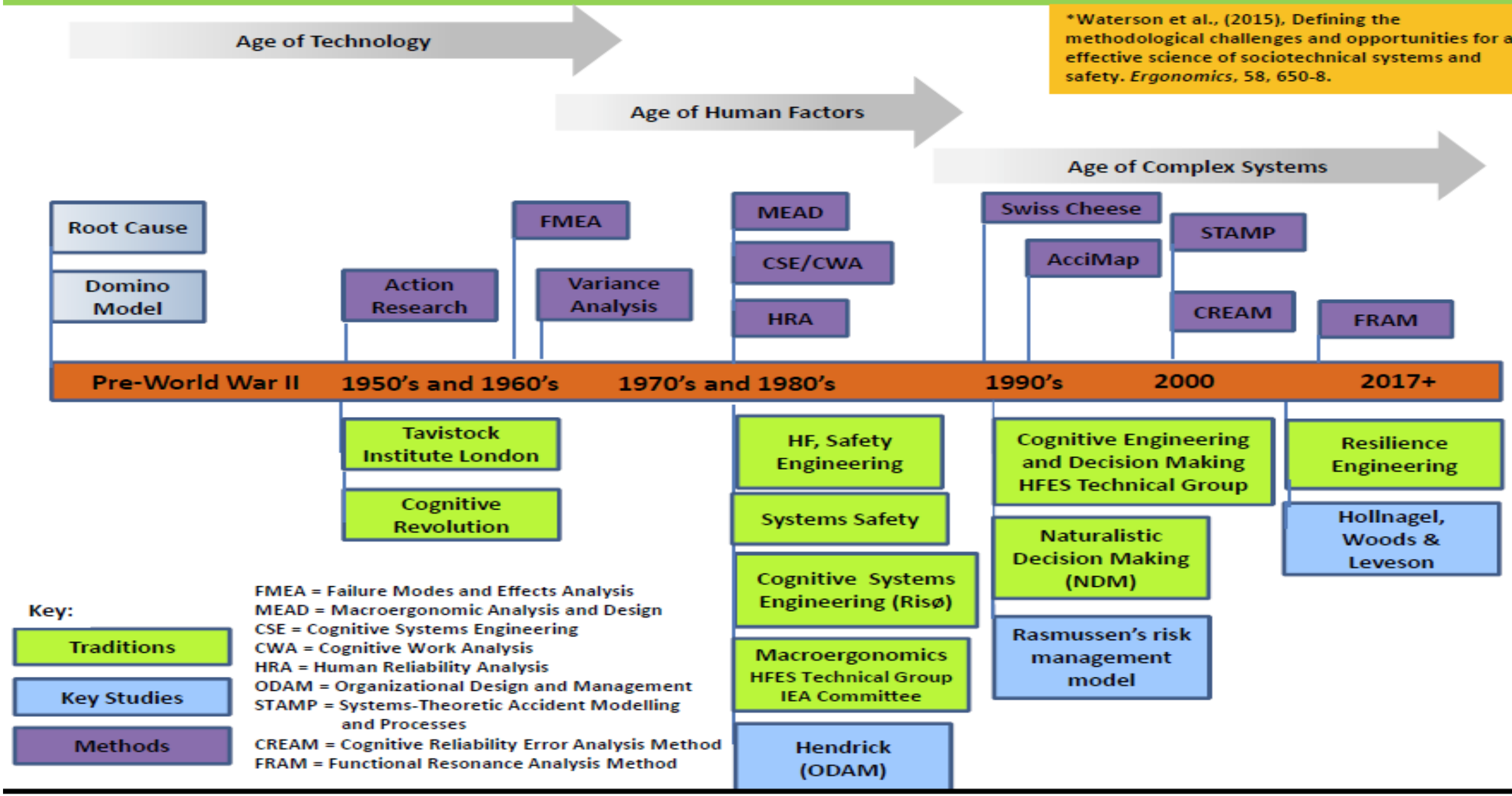
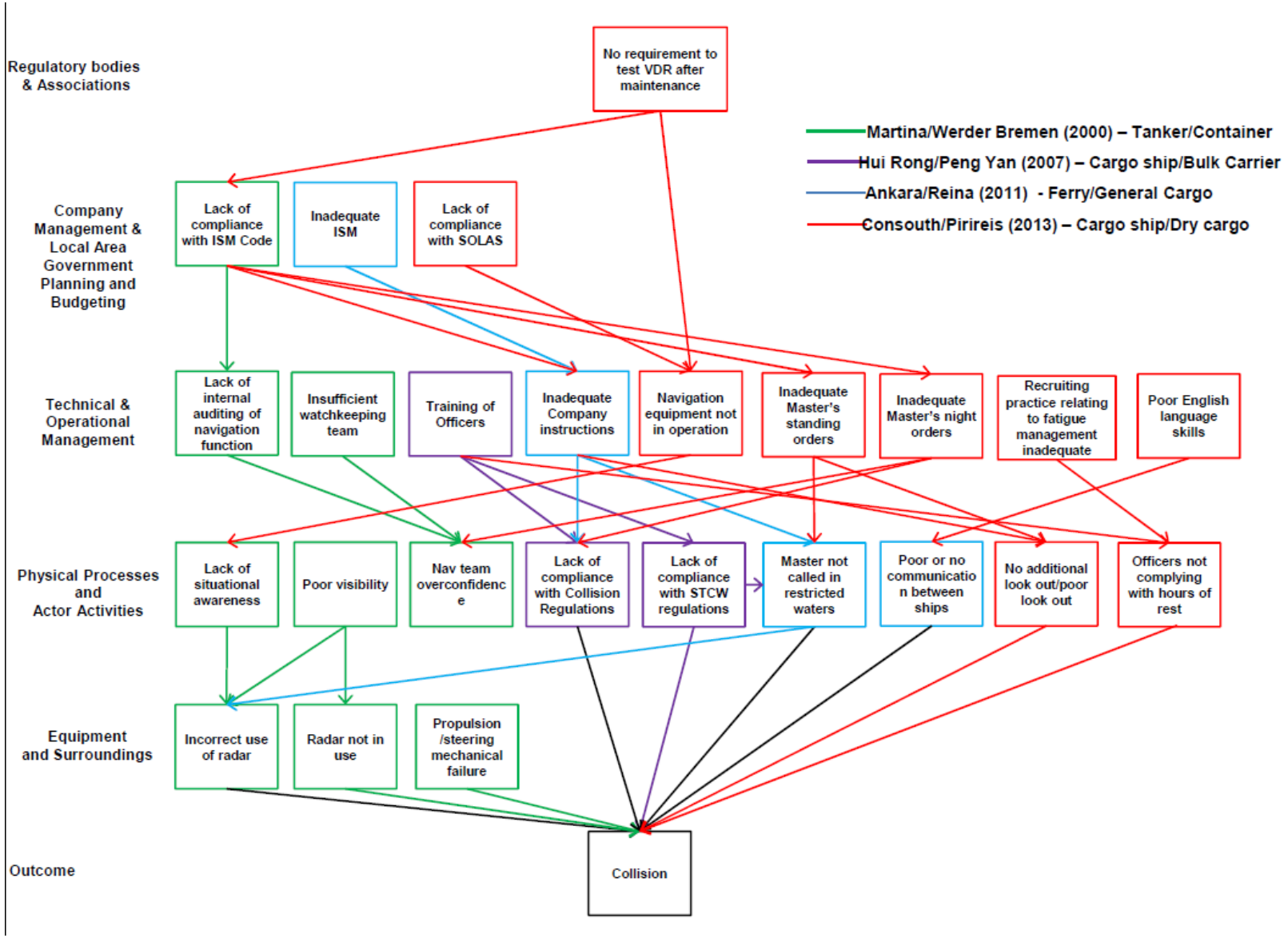
A Timeline of the Development of Methods for Complex Systems and Safety*

*Waterson et al., (2015), Defining the methodological challenges and opportunities for an effective science of sociotechnical systems and safety. *Ergonomics*, 58, 650-8.



Learning from accidents – complex

Can autonomy help?



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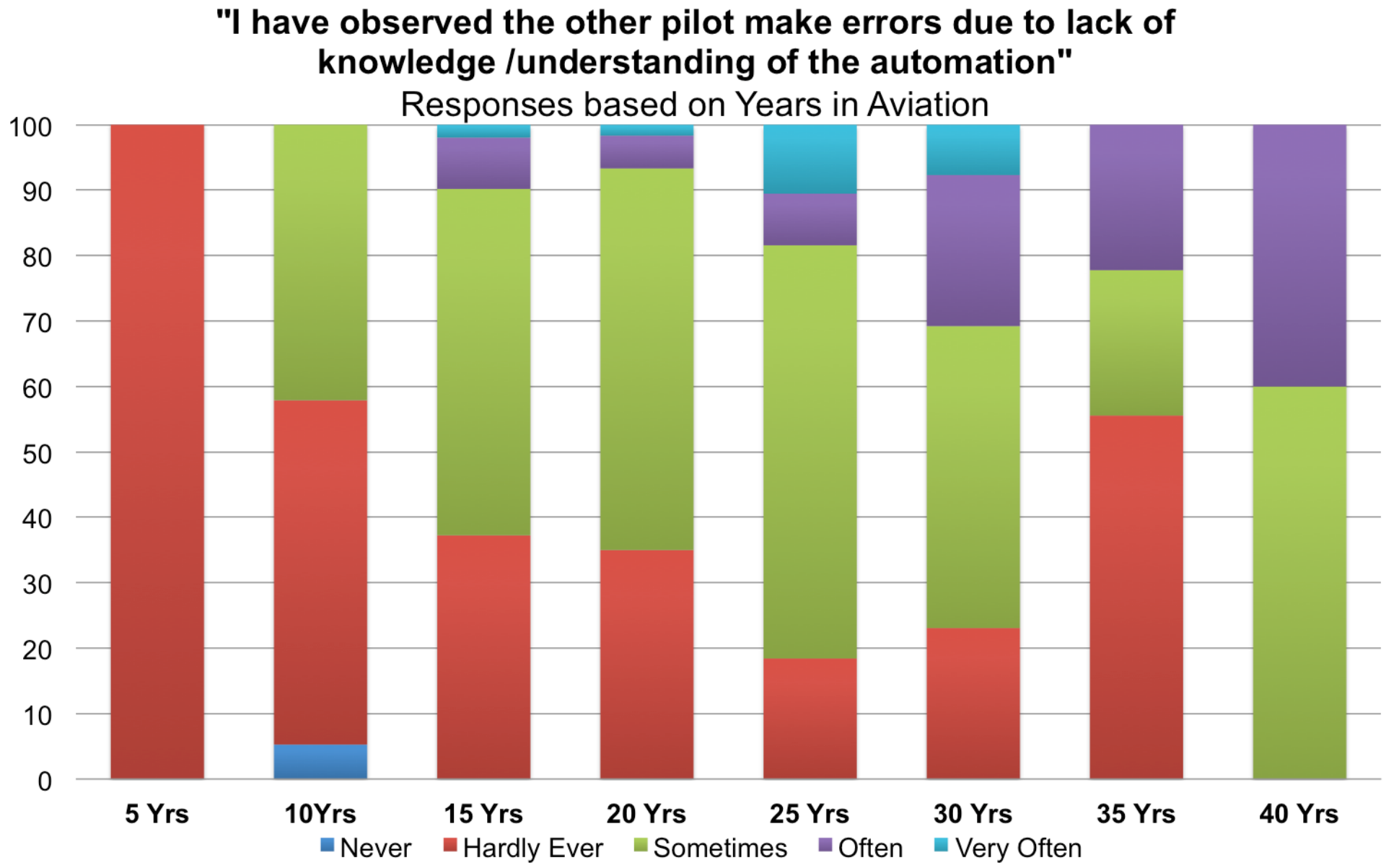

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Source: EK Monitoring & Automation Questionnaire (326 Pilots : 145 Captains & 161 FO's)

Learning from incidents and recoveries

Road:

- Waymo's human drivers had to take control from the automated system (called "disengagement") once for every 5,000 miles its cars in 2016. (– are you awake then?)
- Backup human drivers in Uber's self-driving cars had to take over about once every mile

Challenges:

- Human in control – ensure autonomy supports "Human in the loop" based on human capabilities?
- Autonomy – based on human intervention when needed – sensemaking in crisis? (99% boredom and 1% panic)
- Full autonomy – how to test and ensure resilience (i.e. go to safe and secure condition)

Steps to identify risks and mitigate?

- Learn between different areas –Maritime, Air, Road, Rail
  - Gather empirical data
- Prototype and Test, test, test…in restricted, small and large areas
- Develop methods and new approaches
  - Handling of emergence and the unanticipated

SAREPTA – we need cases

Initial cases:

- **Sea:** MilliAmpere (Plaske) Astat – data collection (with Maritime Robotics)
- **Air:** Transportation by drones
- **Railway/Subway:** Oslo T-bane; Metro København
- **Road:**
  - St. Olav – automated in-house logistics systems (> 10 years experience)
  - Acondo: Bus Trondheim harbor to city center, Snow plowing at Gardemoen
  - SmartFeeder
- Activities:

  - Litterature study
  - Data collection
  - Interviews
  - Cooperation with Human Automation Lab at Duke University

Questions – comments – Cases

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Teknologi for et bedre samfunn