FRAM

New insight in accident analysis?

Comparing a multi-linear

(Sequentially Timed Events Plotting method, STEP, Hendrick & Benner, 1986)

and

a systemic

(Functional Resonance Accident Method, FRAM, Hollnagel, 2004)

method for accident analysis

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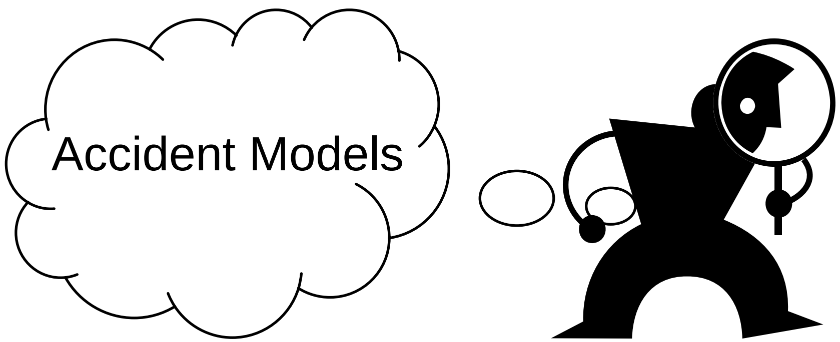

Based on a presentation by Erik Hollnagel, 2004

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Research questions

- Which new insights does FRAM, a new systemic method provide to accident analysis in comparison to STEP, an established multi-linear method?
  - What we can learn from both methods, how, when, and why to apply them, and which aspects of these methods may need improvement?

LN-KKL case

” … *The* ***aircraft came into a significant lower approach than expected …***

…. The approach was cancelled due to the aircraft was still in dense clouds and the aircraft drifted a little bit from the LLZ at OSL…

…The ***crew did not notice*** *that the* ***aircraft movements were not normal****.”*

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Non-linear accident model

Assumption: Accidents result from unexpected combinations (resonance) of variability of normal performance

Conse-quence: Accidents are prevented by monitoring and damping variability
Safety requires constant ability to anticipate future events

Hazards-risks: Emerge from combinations of normal variability (socio-technical system)

The future can be understood by considering the characteristic variability of the present.

Adapted from a presentation by Erik Hollnagel, 2004

FRAM

0 Define the purpose of modelling (accident investigation) and describe the target situation or scenario to be analysed

1 Identify essential system functions; characterise each function by six basic aspects

2 Characterise the (context dependent) potential variability using a checklist. Consider both normal and worst case variability

3 Define functional resonance based on possible dependencies (couplings) among functions

4 Identify barriers for variability (damping factors) and specify required performance monitoring

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1 Function: Manual approach

Time available varies

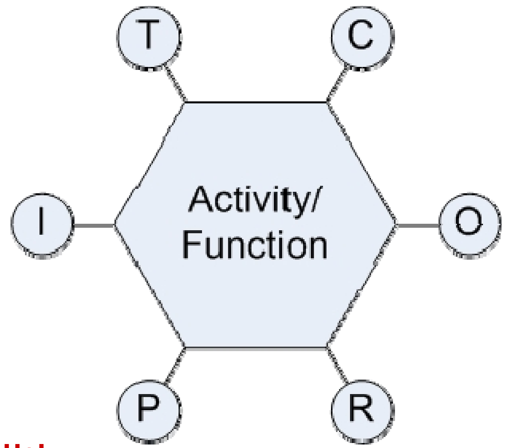
Standard Operation Procedures

Time

Control

Pilot informed of glide slope failure

Input



Output

Altitude lower than approach path

Precondition

Resource

Autopilot disconnected

Pilot flying and pilot non-flying

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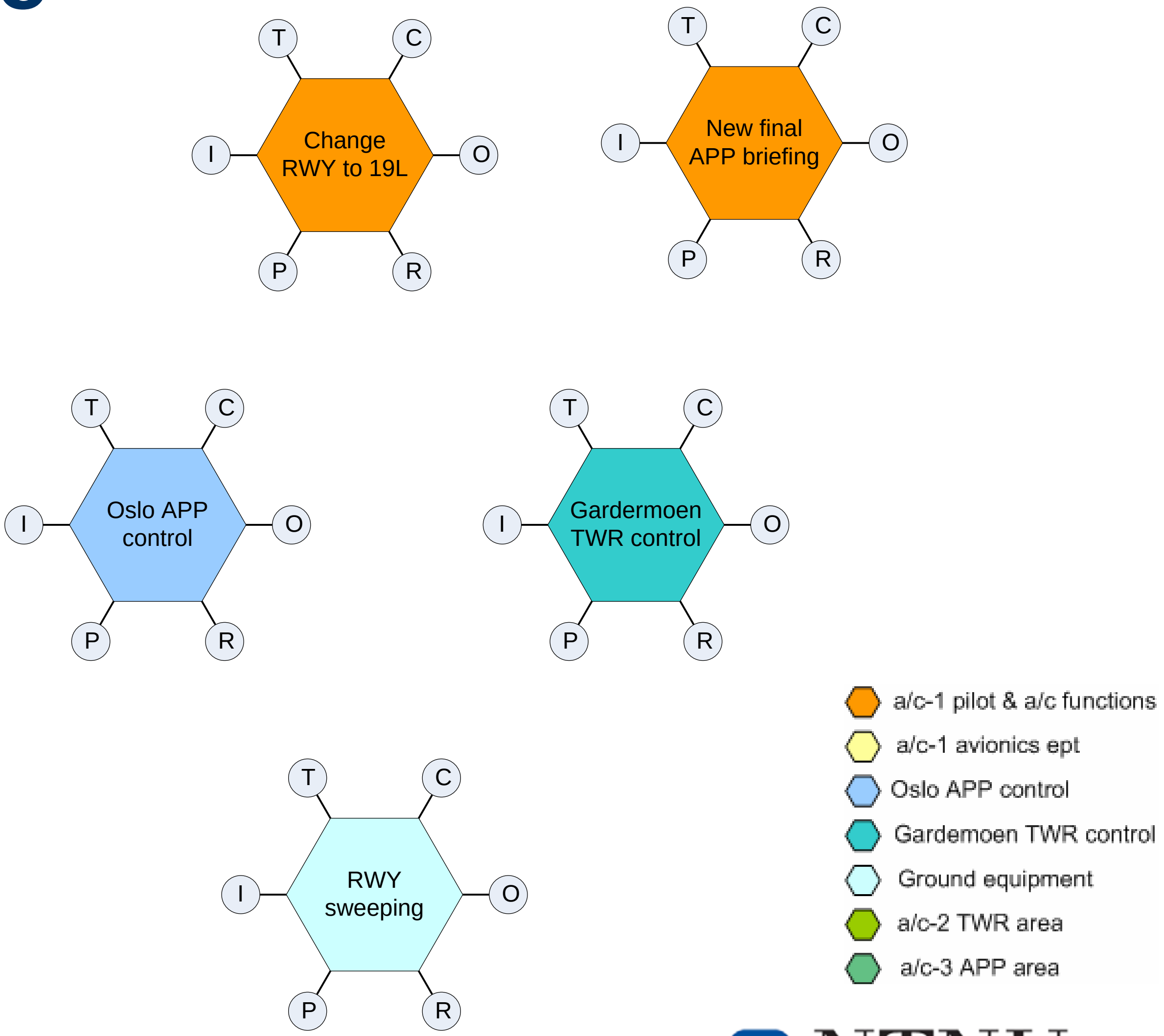
LN-KKL case

Short after clearance to 4000ft, the crew was informed that **runway 19R** was **closed** because of **sweeping** and that landing should take place at **runway 19L**



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LN-KKL case

Under the last part of the flight, at this time the aircraft has established localizer (LLZ) and glidepath (GP) for runway 19L, **the glidepath signal was off.**

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LN-KKL case

The aircraft came into a significant lower approach than expected.

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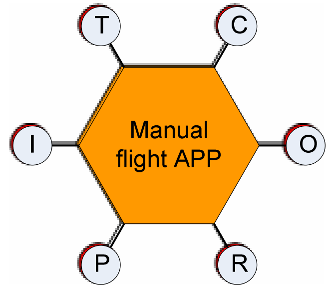
2 Potential for variability



11 Common Performance Conditions (CPCs)	*Rating*
Availability of personnel and equipment	*Adequate*
Training, preparation, competence	*Temporarily inadequate*
Communication quality	*Inefficient*
Human-machine interaction, operational support	*Inadequate*
Availability of procedures	*Adequate*
Work conditions	*Temporarily inadequate?*
Goals, number and conflicts	*More than capacity*
Available time	*Temporarily inadequate*
Circadian rhythm, stress	*Adjusted*
Team collaboration	*Inefficient*
Organizational quality	?

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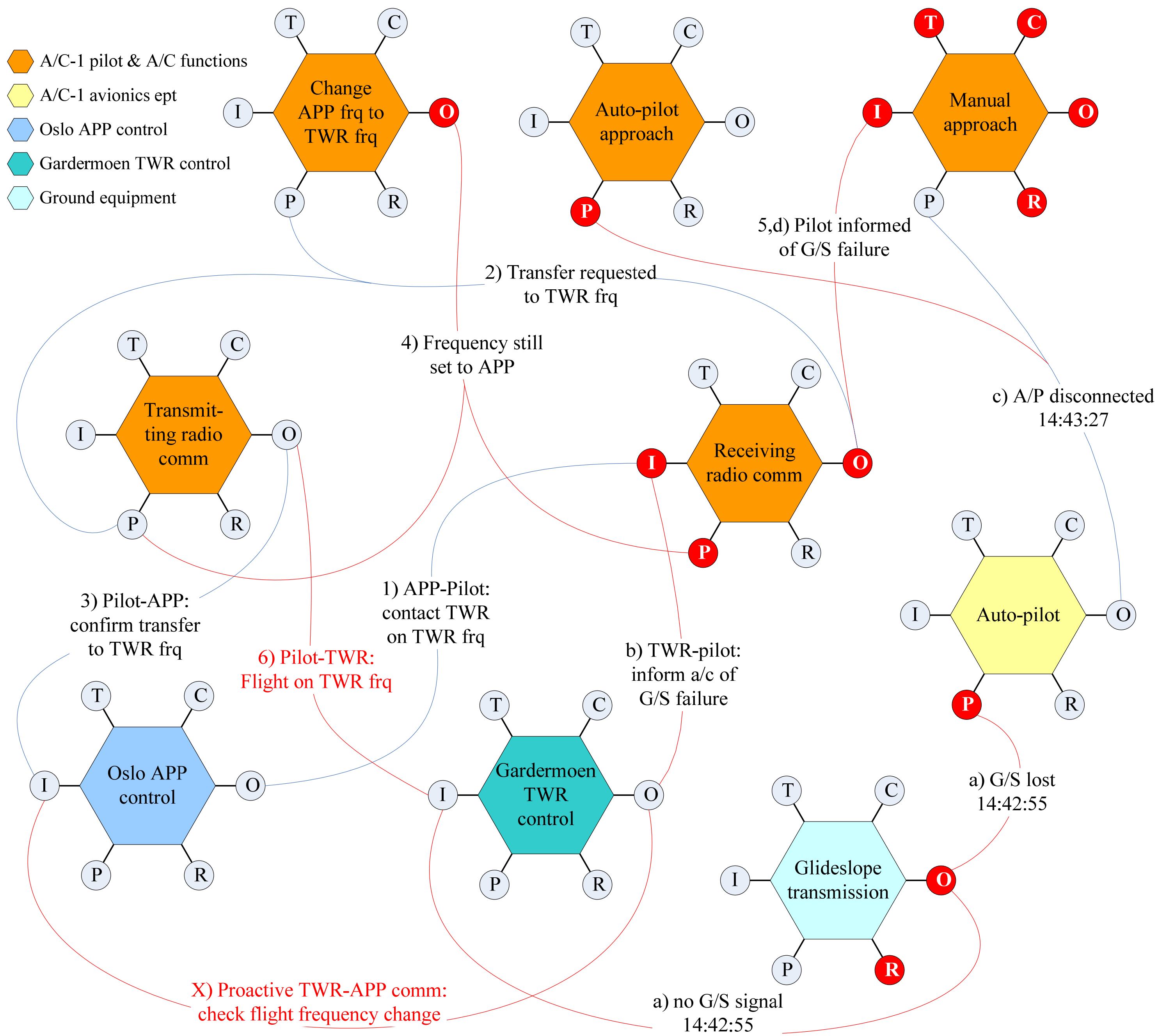
3 Resonance: Instantiation



4. Recommendations

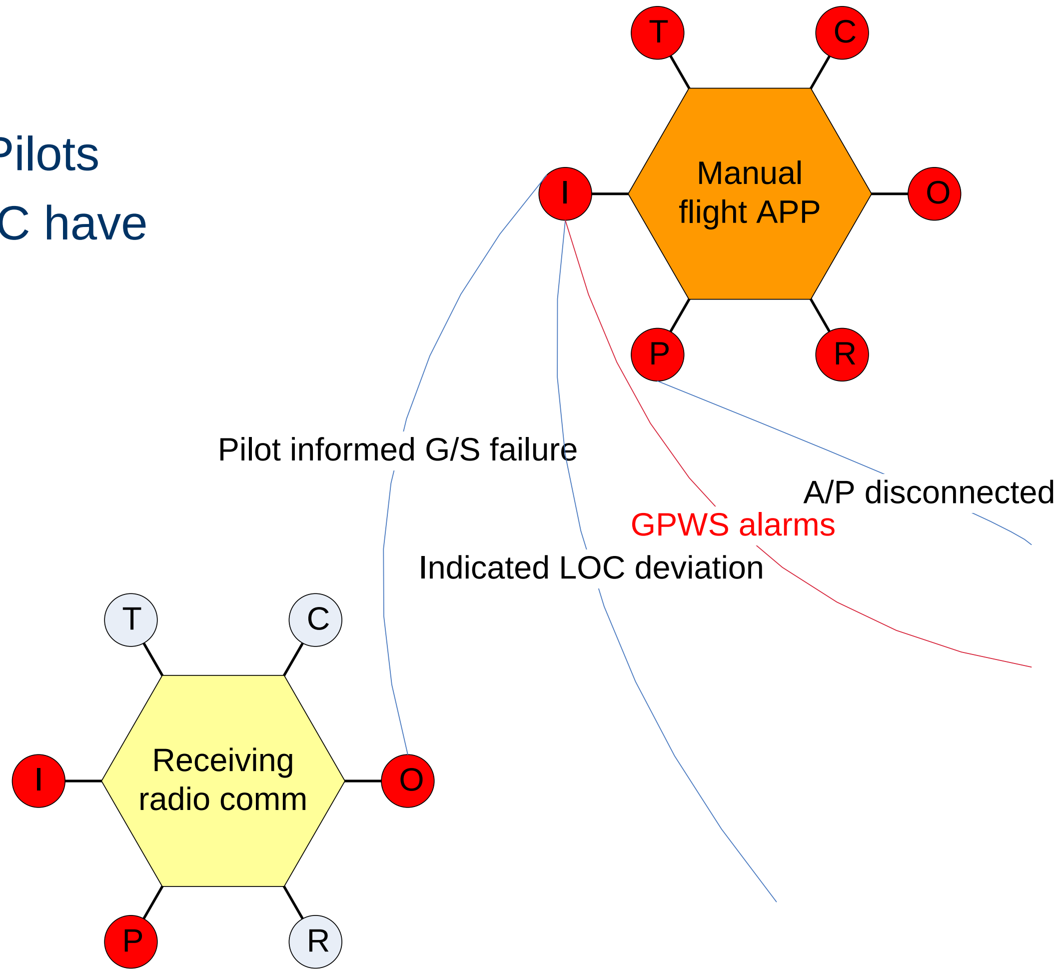
Training including for ATC & Pilots

- Situations where pilots/ATC have different experience
- Changing conditions
- Communication analysis

(symbolic barrier)

- *Need to monitor overload, feedback and quality of communication*

(monitoring performance)



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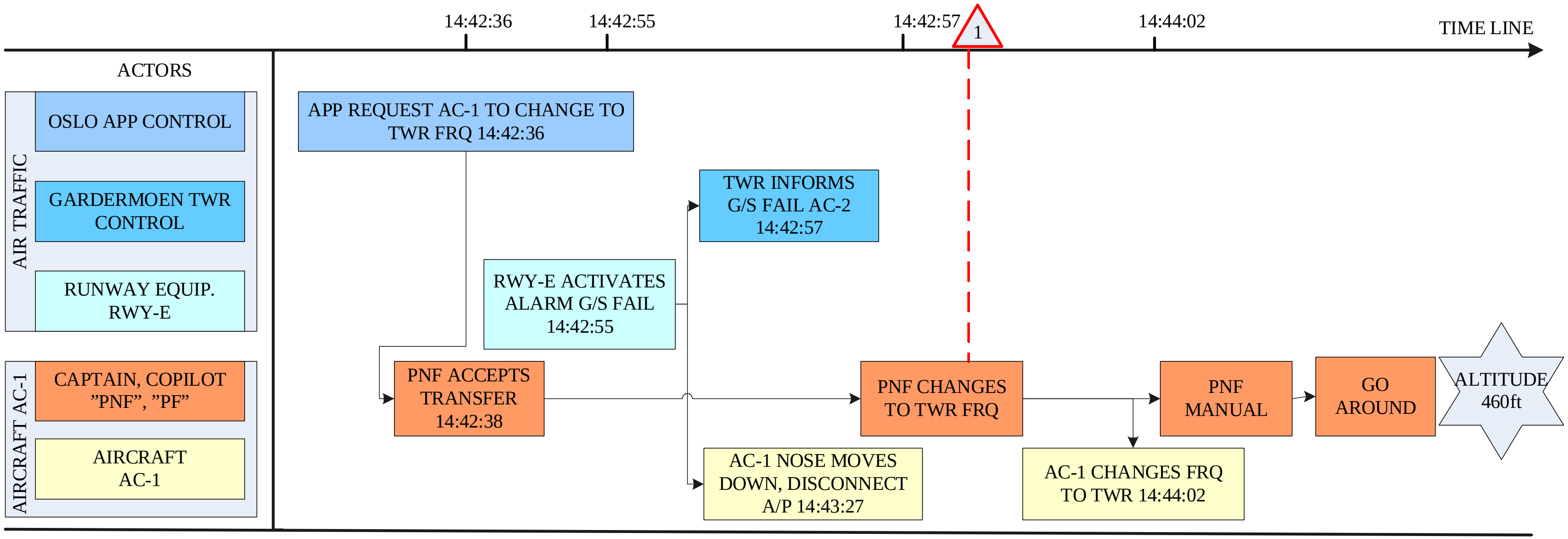
Multi-sequential accident model

Assumption: An accident is a special class of process where a perturbation transforms a dynamically stable activity into unintended interacting changes of states with a harmful outcome.

Conse-quence: Accidents are prevented by identifying, classifying and eliminating safety hazards/problems.
Safety requires constant ability to detect uncontrolled changes and counteract their effects.

Hazards-risks: Are disruptive changes (perturbations) that persons or things introduce, which trigger undesired interactions

STEP worksheet



STEP applied to NAX541 incident (simplified example).

Conclusions

- FRAM provides a different explanation on how events are the result of the variability of normal performance and functional resonance
- STEP supports identifying and showing what happened and when
- FRAM, besides what and when, illustrates how: the dynamic interactions within the socio-technical system
- By taking into account context and dynamic interactions it was possible to identify new factors in the analysis of the incident

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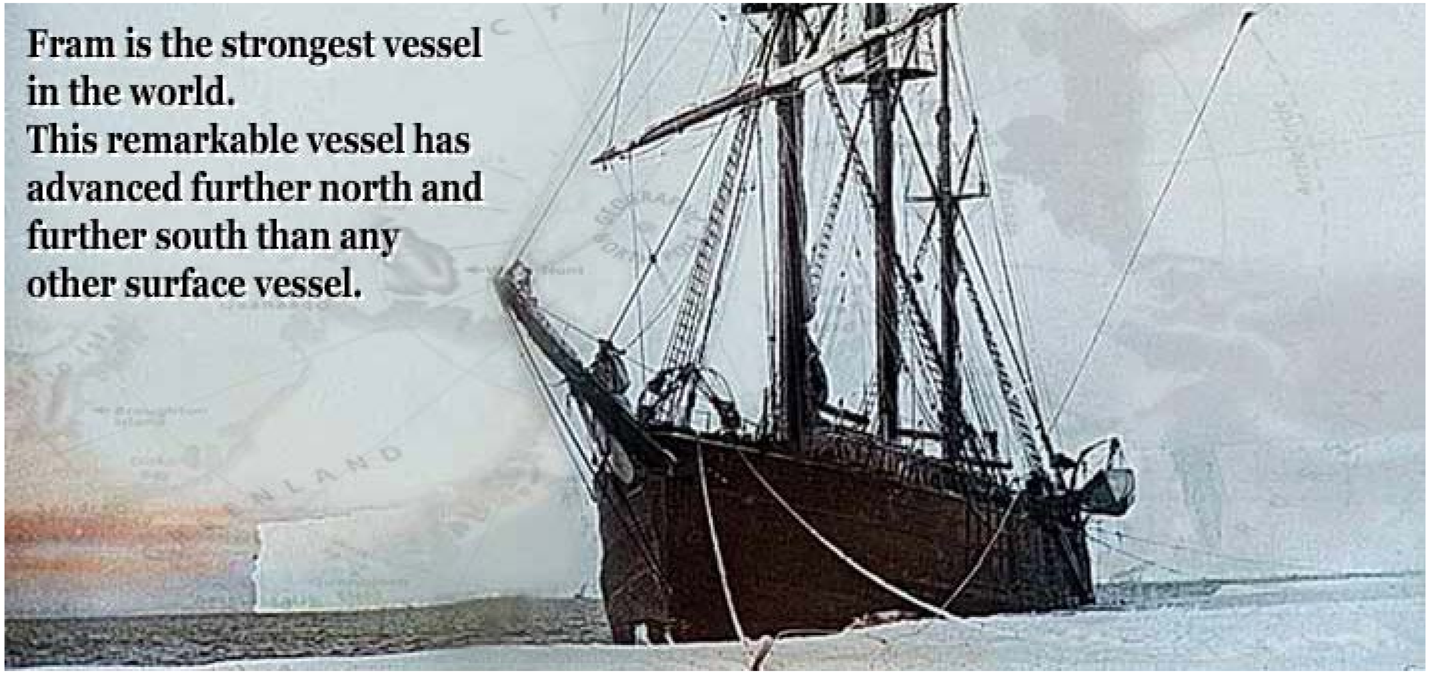
Remaining challenges

- A more structured approach to generating recommendations in terms of barriers and indicators
- Evaluating how well FRAM is suited as a method to collect and organize data during early stages of accident investigation



Thanks to: the investigators and managers of the Norwegian Accident Investigation Board, Ranveig K. Tinmannsvik, Erik Jersin, Erik Hollnagel, Jørn Vatn, Karl Rollenhagen, Kip Smith, Jan Hovden, several aviation experts and the participants in the 2nd FRAM workshop for helpful comments

Any questions?

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