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Human Factors in Railway Challenges and solutions

Experiences from putting a Train Management System into service

Stavanger 08 April 2025

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Lørdag 16. november 2024 ble det nye togledningssystemet tatt i bruk på strekningen Gjøvikbanen Nord

TU Ledige stillinger Nyhetsbrev Nyhetsstudio Video Innlogget

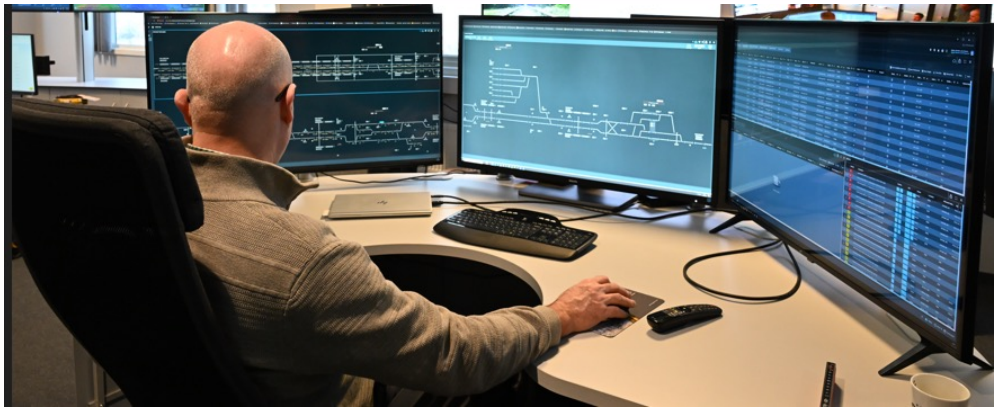
SAMFERDSEL

Digitale signaler har gitt betydelig bedre sikkerhet på Gjøvikbanen

Konserndirektør Sverre Kjenne hadde forventet noen barnesykdommer i det splitter nye signalsystemet, så langt har det meste gått på skinner.

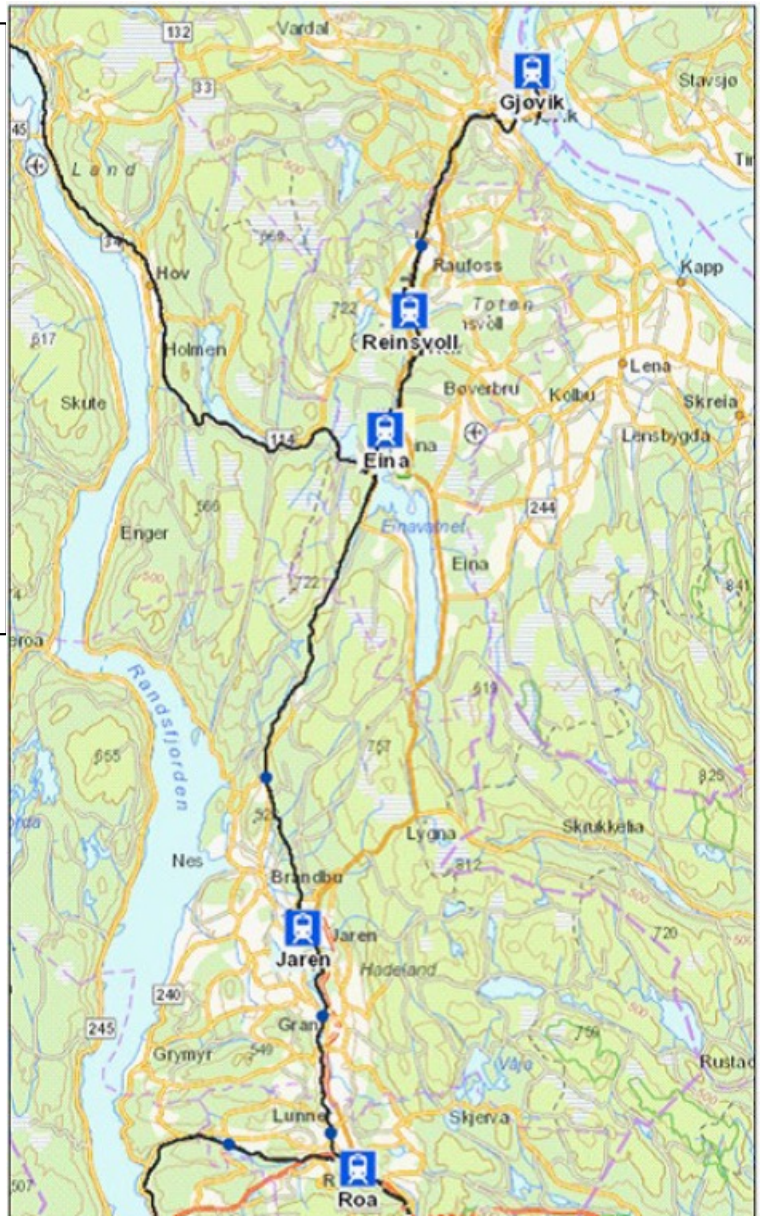
To måneder med nytt togsystem:

– Har gått over all forventning



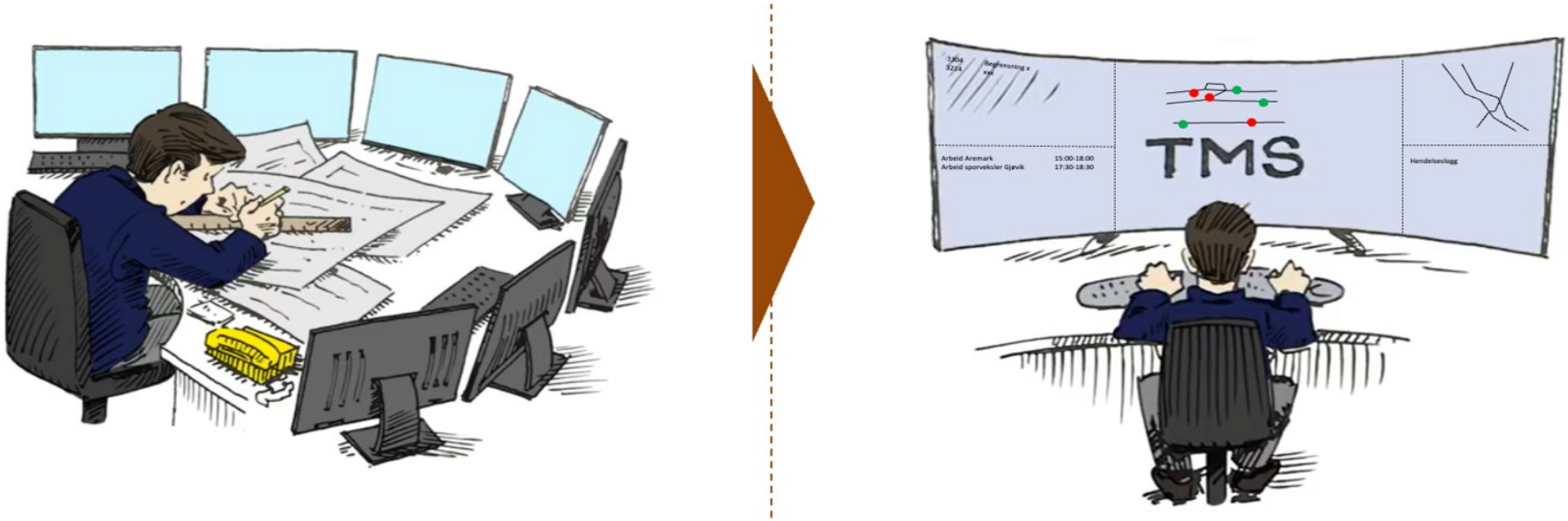
Putting a new Train Management System (TMS) into service:

- What does this mean from a Human factors perspective?
  - What challenges did we meet ?
  - How could these be handled ?
  - How is it possible to ensure Safety and Usability ?



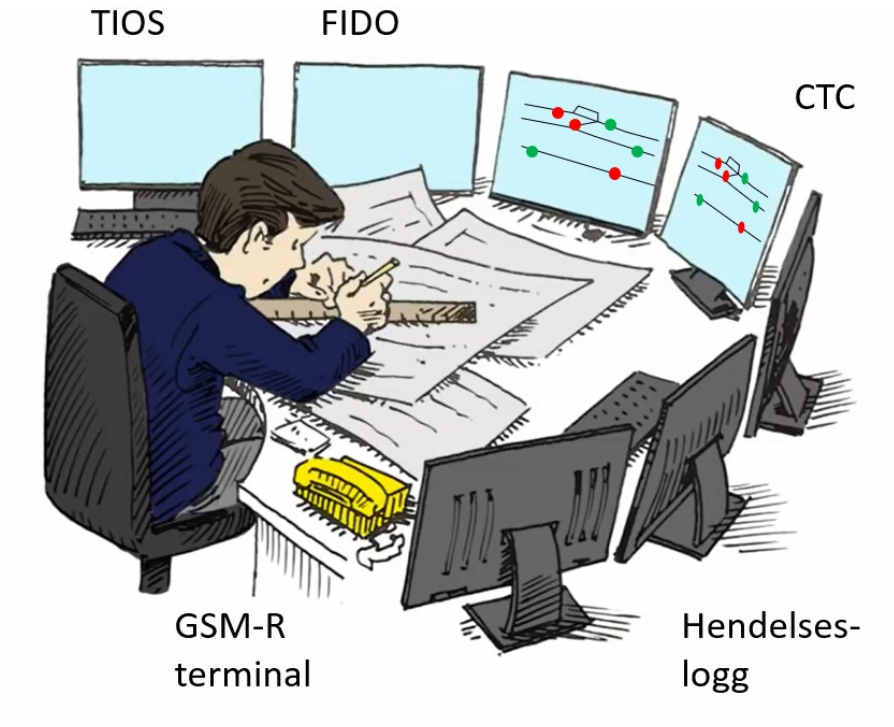
Background and Goals for the new Traffic Management Systems

(Basically the same for Norway and Sweden)

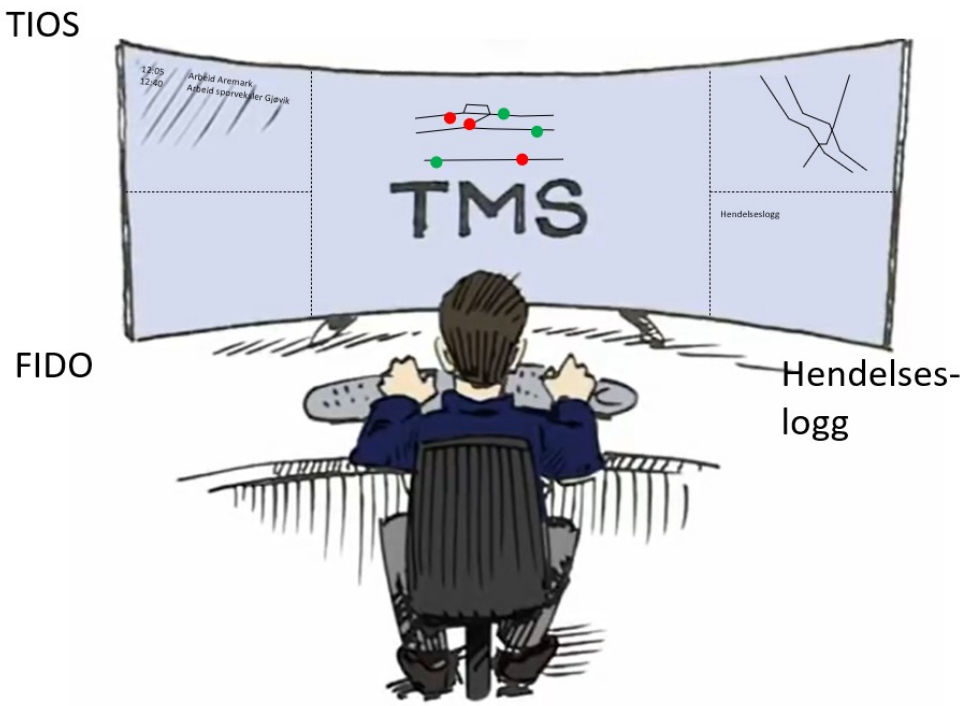


TMS will merge information from several support systems into one integrated GUI

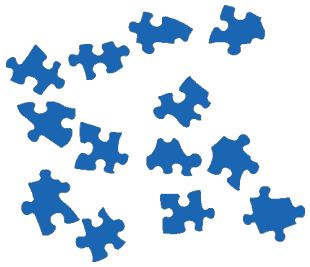
From different screens, keyboards and mouses for each support system…



…to information from different support systems merged into one graphical user interface

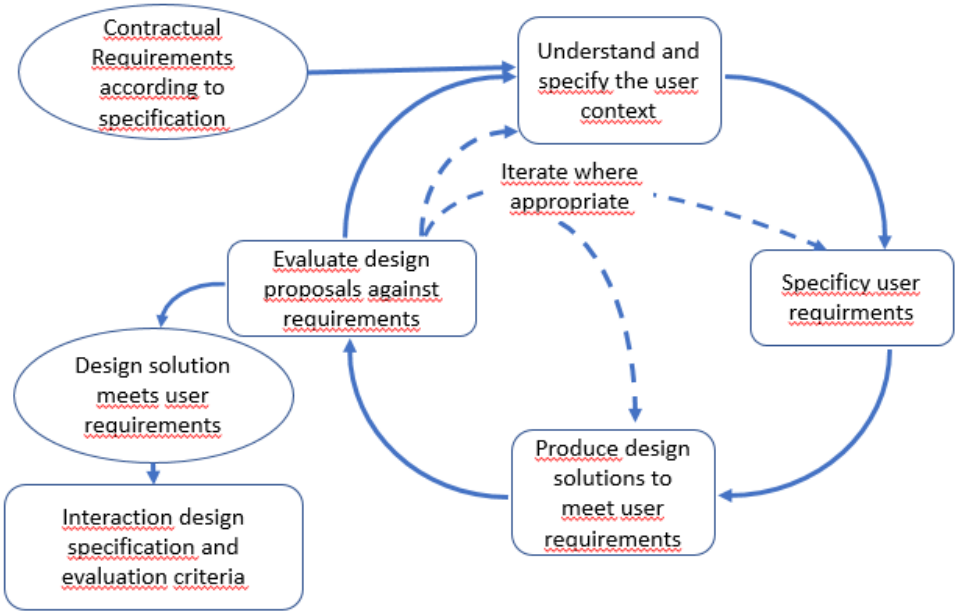


Human Factors in the Norwegian TMS-project – Challenges and needs to fulfil



?

From developing bits and pieces in isolation…



ISO 9241 Part 210 Human Centred design for interactive systems

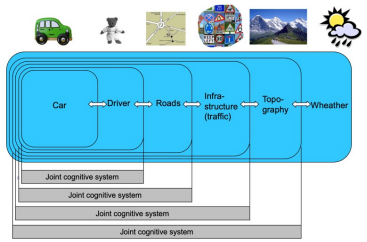
…to an agile, iterative approach where the system is developed incrementally

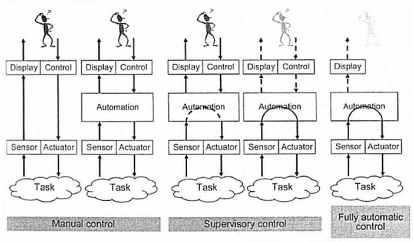
Human Factors vs CSM RA*

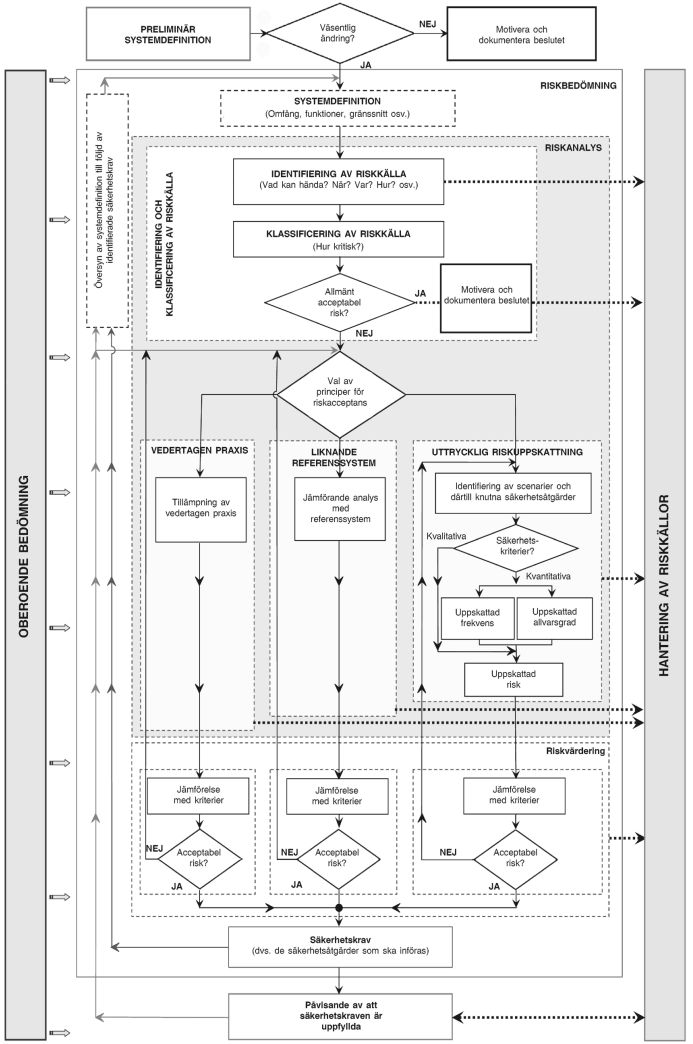
What changes does the implementation of a new TMS System imply from an operators perspective?

And how to handle?

System definition







Traceability

* Common Safety Method for Risk Evaluation & Assessment

Human Factors in the RAMS* Standard (EN 50126-1:2017)

Multi-level systems approach

- Nested systems concept
- Boundaries towards a ”bigger” environment
- System consists of Inter-related subsystems

Fundamental to understand:

- The boundaries between the system and the environment
- Interactions with the inter-related subsystems

A correctly implemented Systems Approach is a powerful aid in understanding:

- Failures of the system
- Contributions to accidents/near-accidents
- Potential Hazards

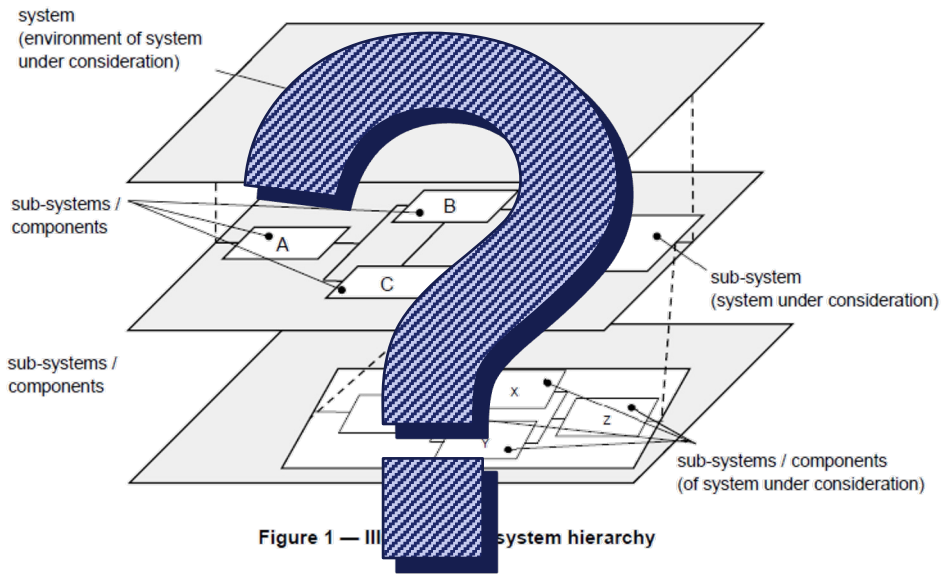
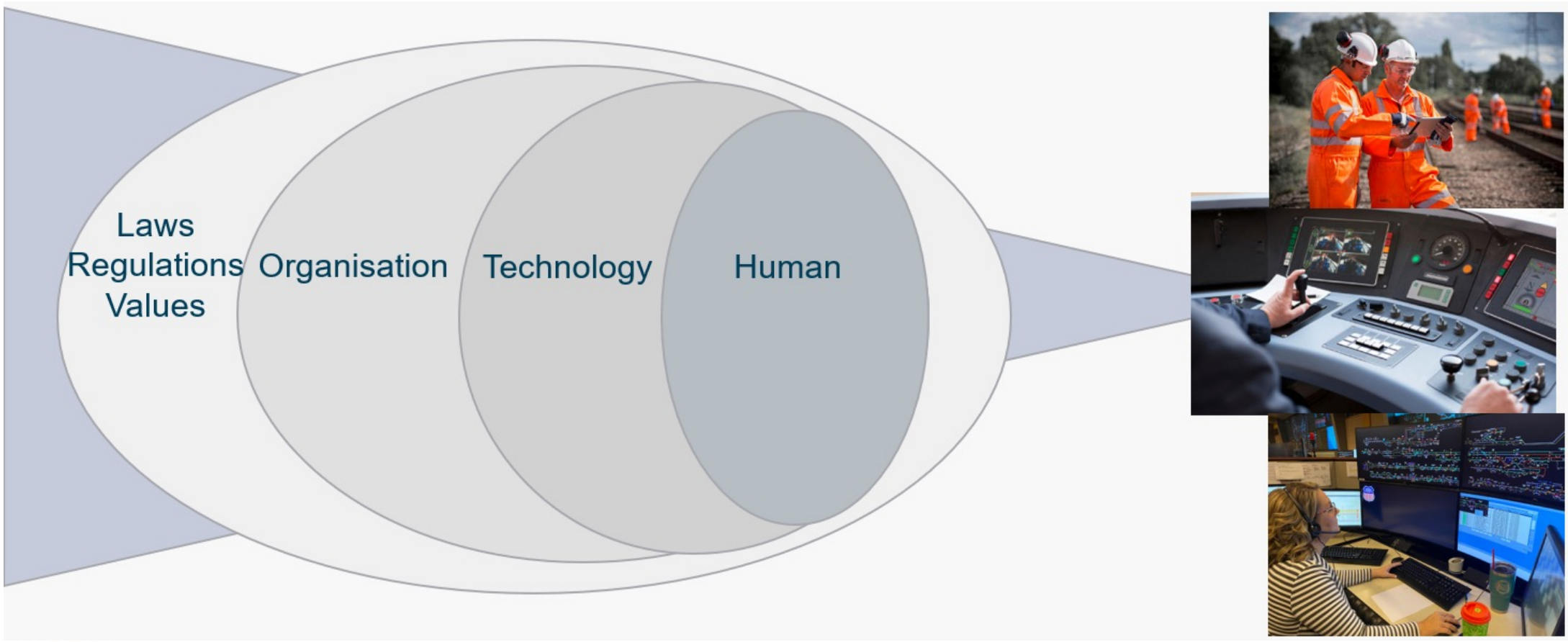


Figure 1 — III … system hierarchy

EN 50126-1:2017, Chapter 5.2, Figure 1.

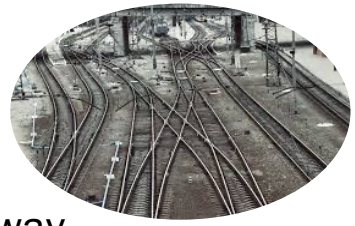
* RAMS Reliability, Availability, Maintainability & Safety – Lifecycle analysis framework

Modelling the Human Factors Context – In general



Modelling Human Factors in Railway – Train drivers perspective

Human/Systems Interface



Railway Infrastructure

Railway Topography

Railway maintenance

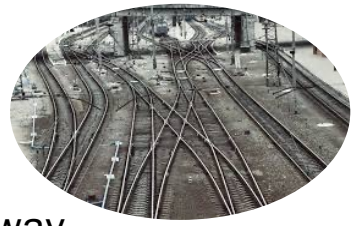
Train technology

Train traffic and scheduling

Train driver behaviour & Driveability

Modelling Human Factors in Railway – Train Dispatchers perspective

Human/Systems Interface



Railway Infrastructure

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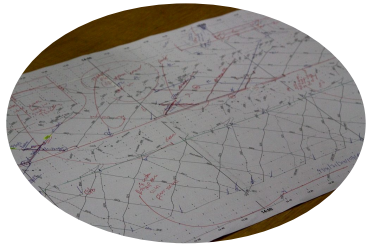


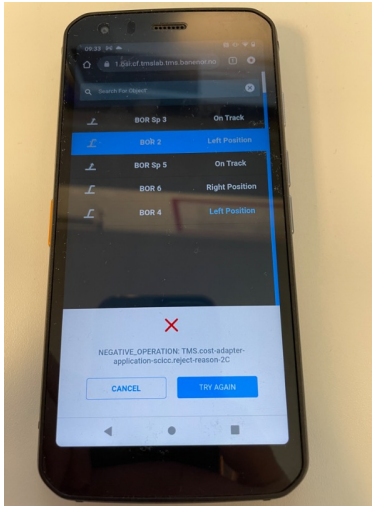
Train Graph & Conflict solving

Train Dispatchers behaviour & Usability

Handling of work in field operations

From Key Cabinets to Handheld Terminal (HHT)

VS



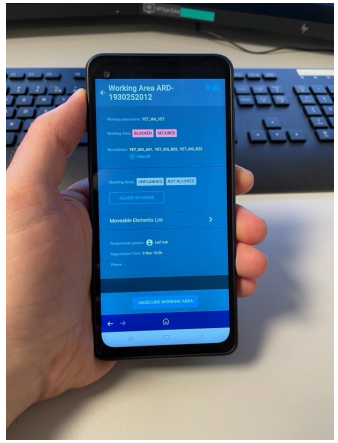
Changed technology to secure work in tracks

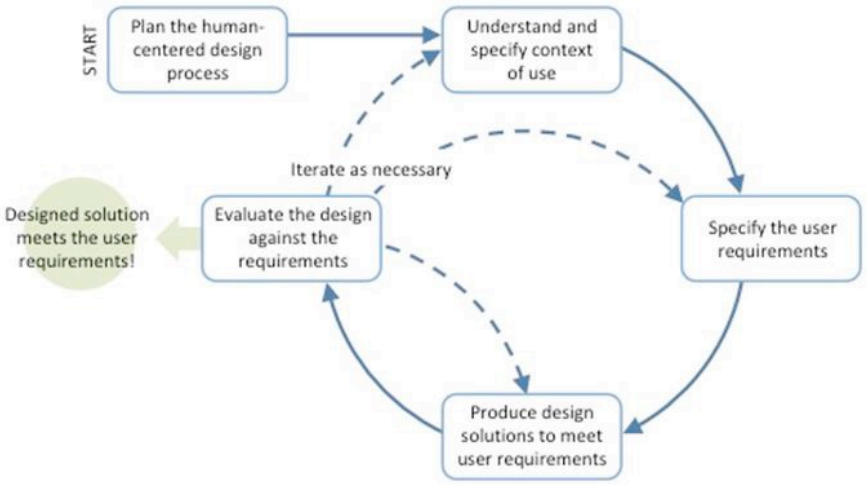
- In part a new way of working
- Need for new processes/updated procedures
- Potentially new risks

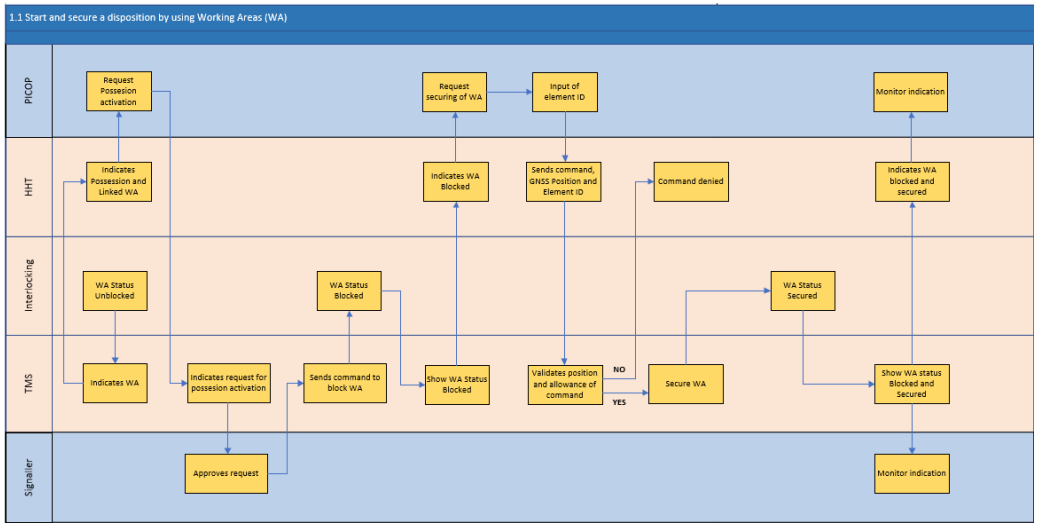
How to handle from a Safety and Usability Perspective?

How to develop, adressing the needs and handle the changes that the HHT imply?

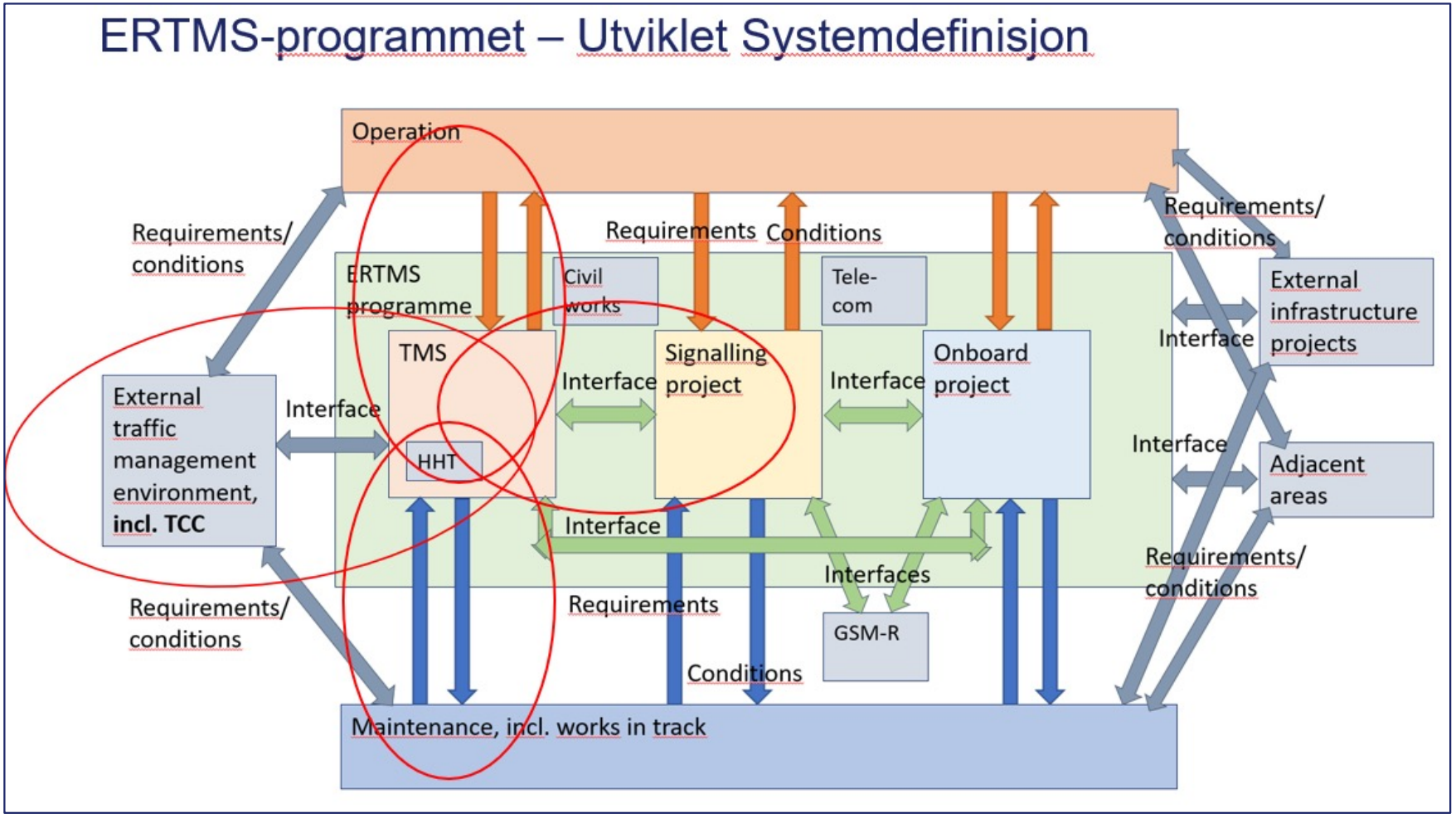
- Understand how the work is performed today
- Understand how the work will be performed using HHT
- Analyse the difference with focus on safety and usability
- Suggest improvements (if needed)





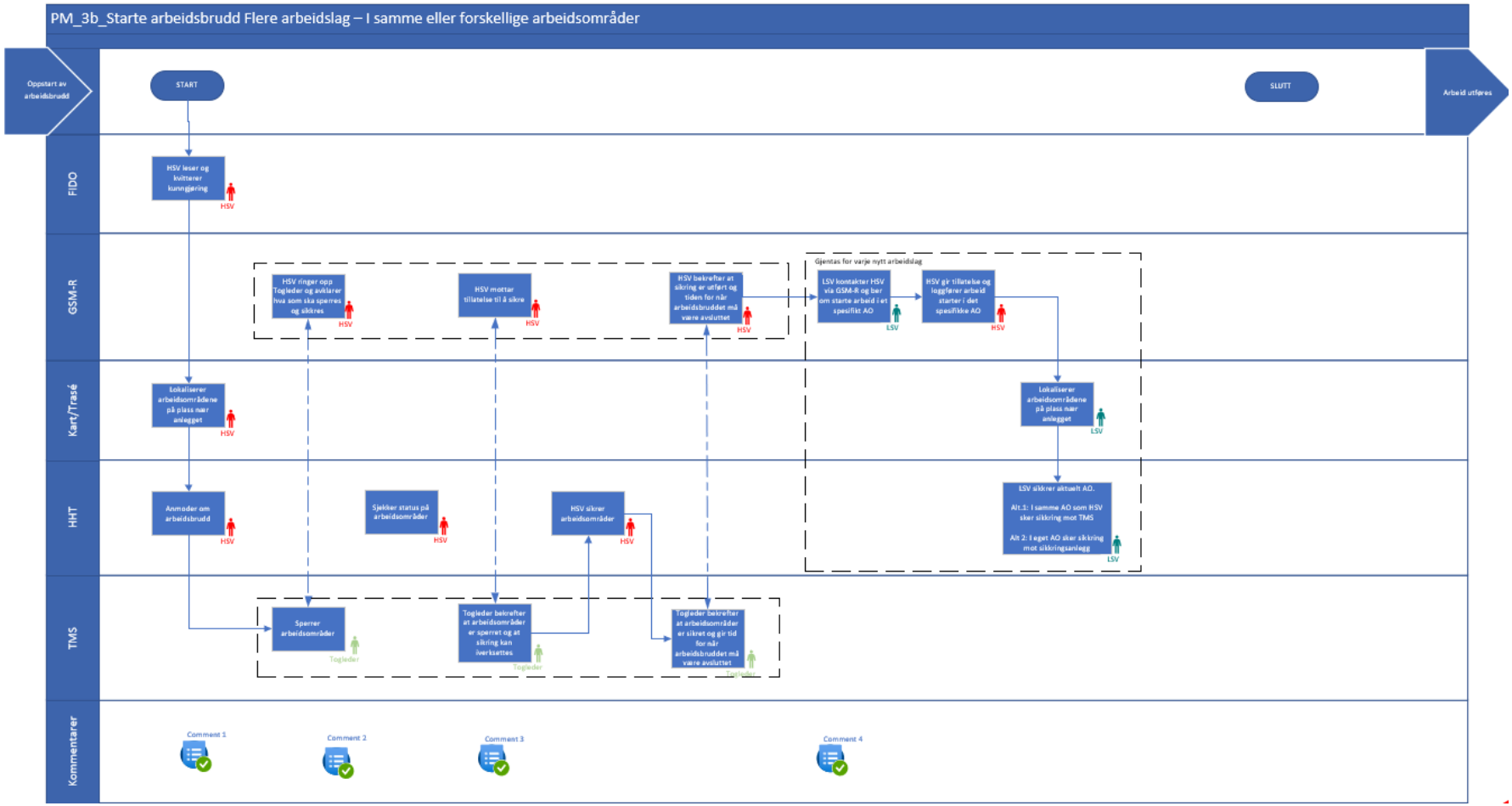


Understand the context – How? => Modelling, modelling and more modelling



Understand the context – How? => Modelling, modelling and more modelling

Understanding of the process vs different roles



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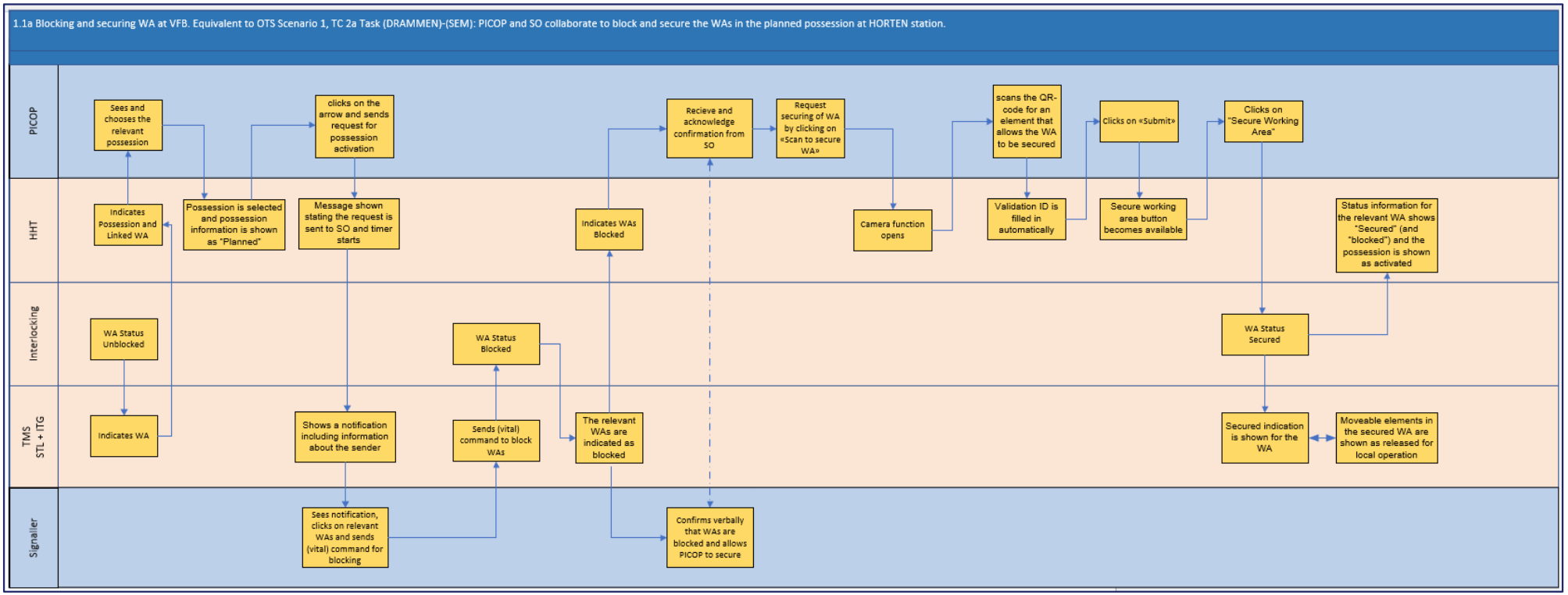
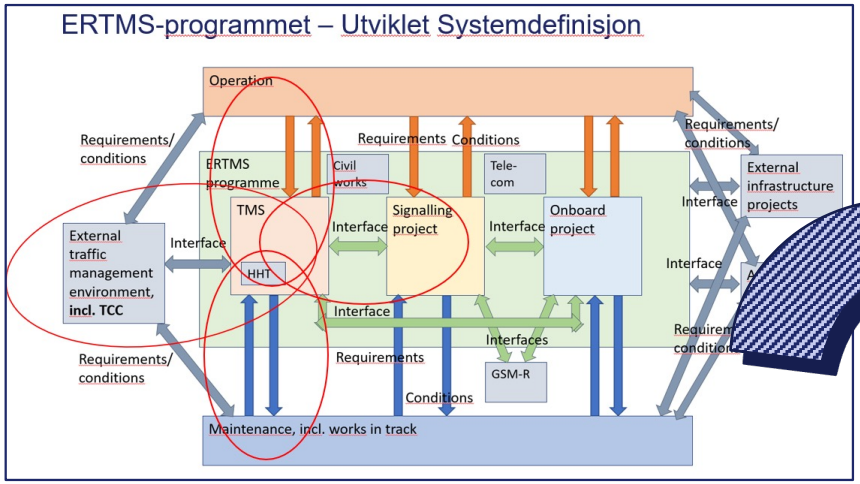
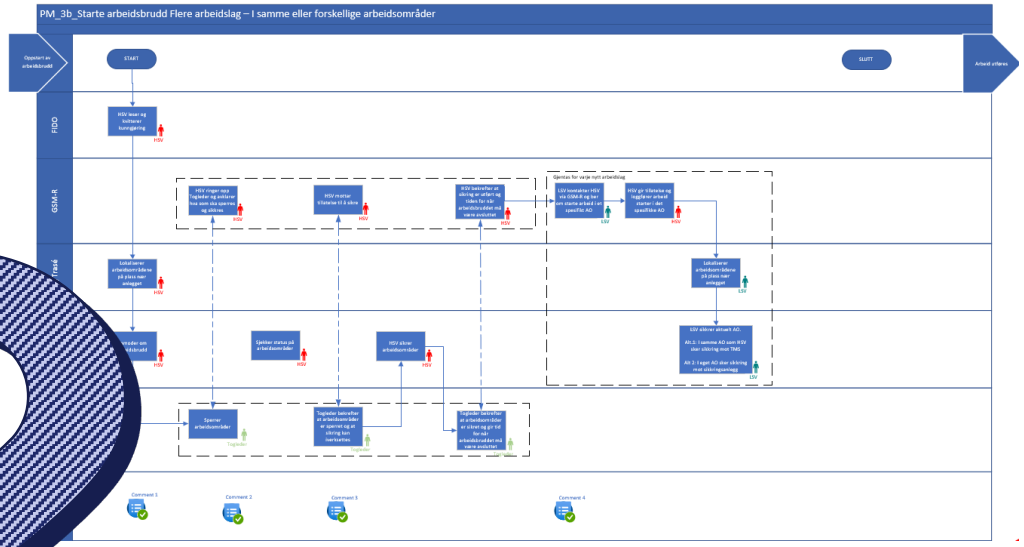
Understand the context – How? => Modelling, modelling and more modelling

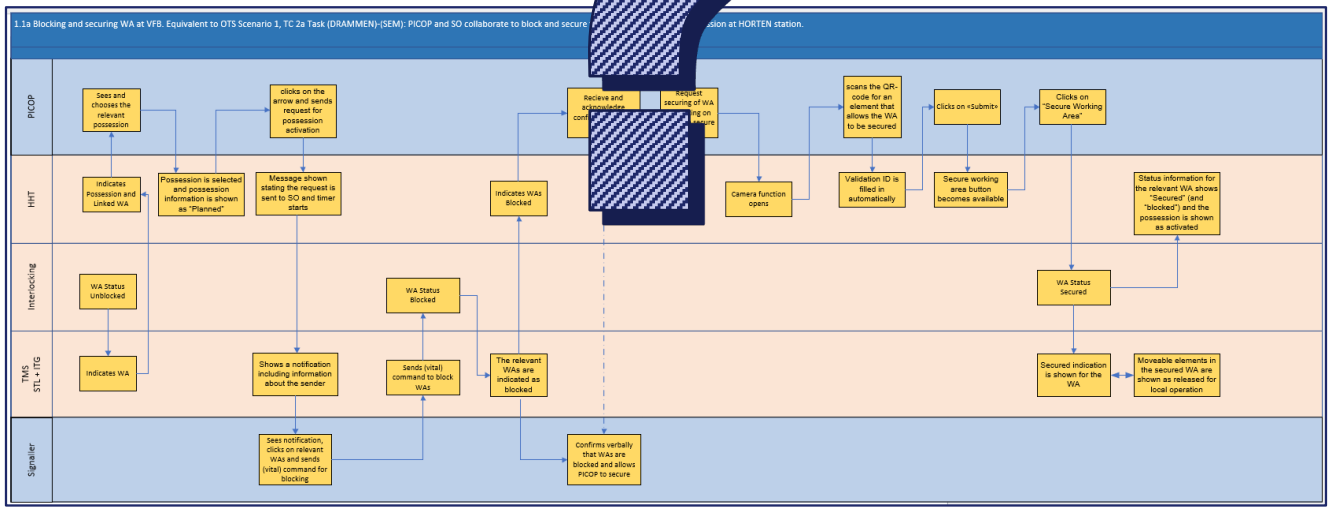
Understanding of the process vs the systems involved



Understand the context – How? => Modelling, modelling and more modelling







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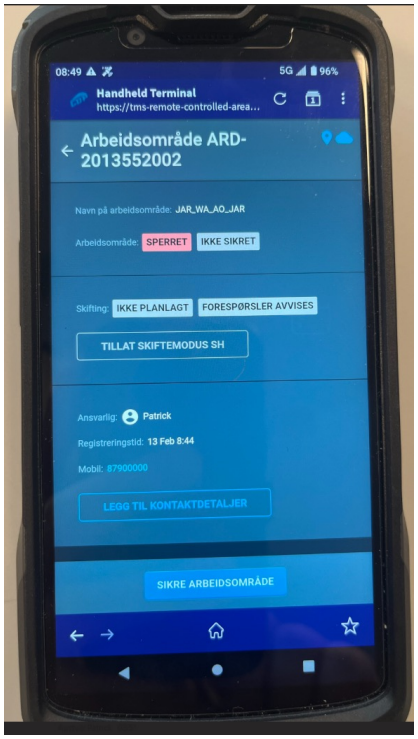
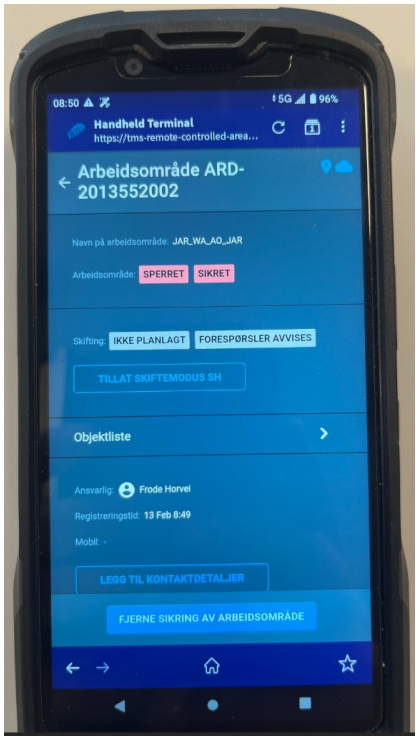
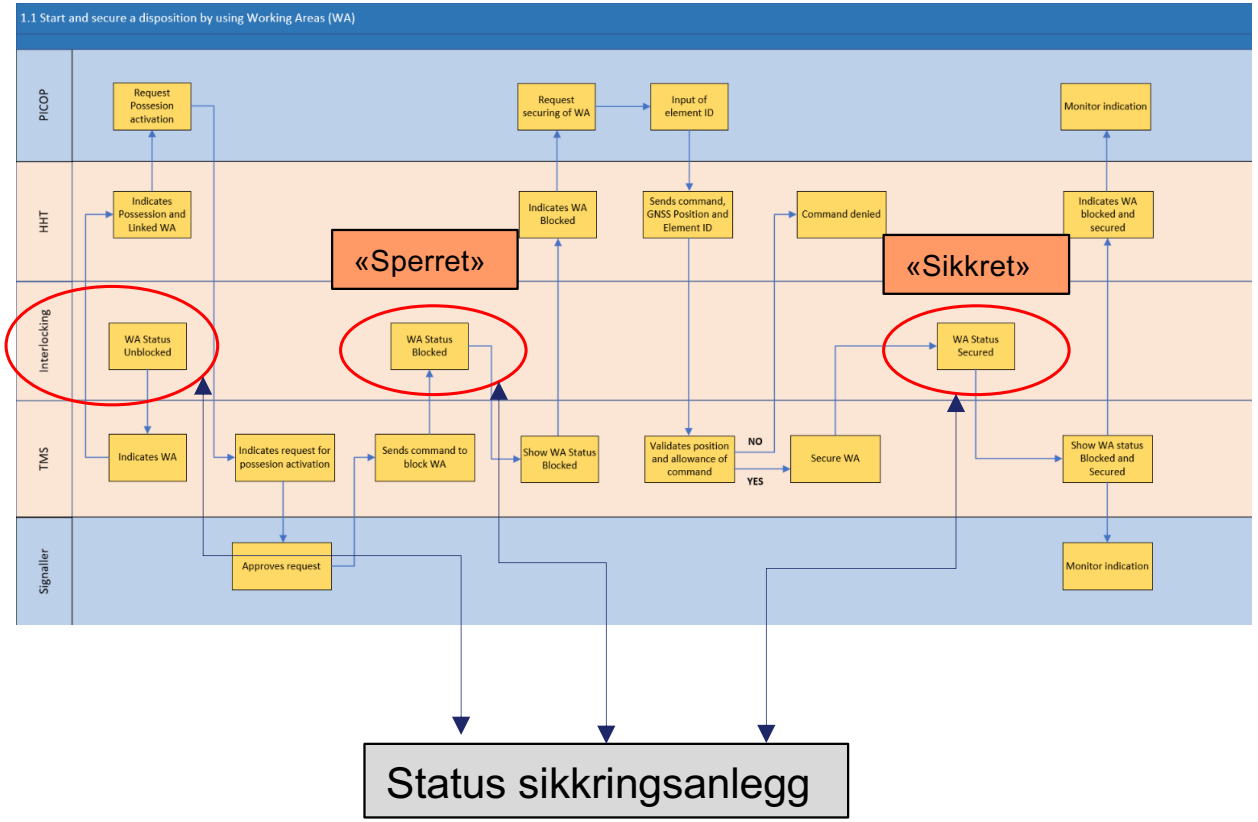
Understand the context – How? => Be there or be square

=> Full understanding of how to use in field operations





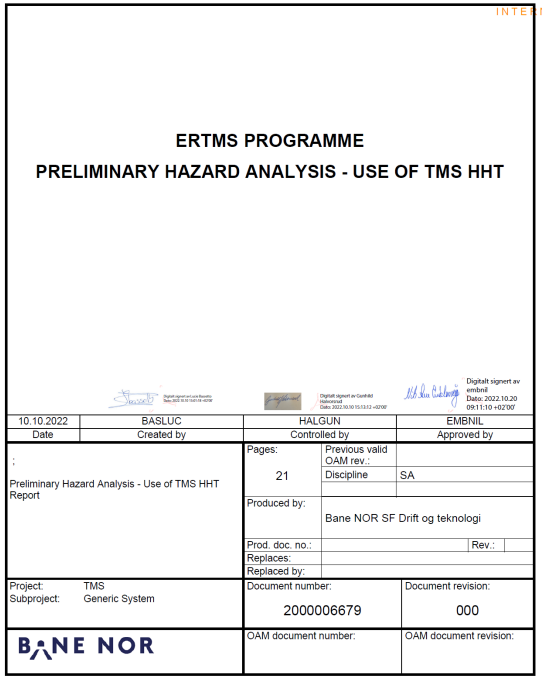


Status sikkringsanlegg

Status sikkringsanlegg
– Indikering på HHT

How to integrate into the context where the HHT will be used
(with focus on Safety, Usability and operational aspects)

Hazard analysis – Use of HHT in field based on operational scenarios



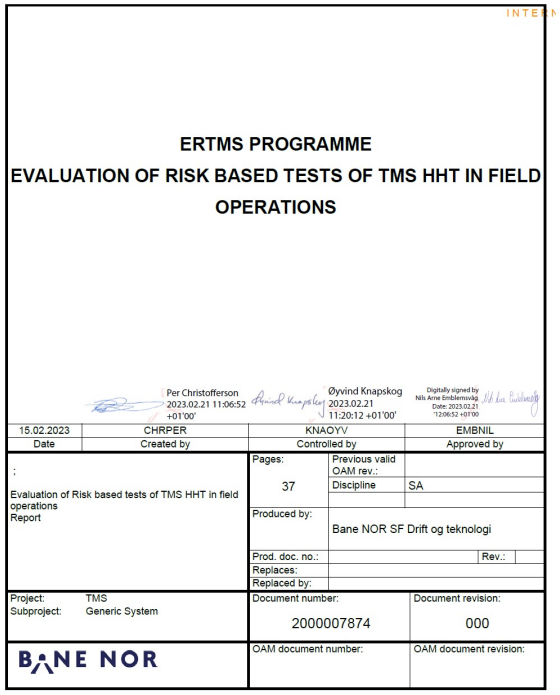
ERTMS PROGRAMME

PRELIMINARY HAZARD ANALYSIS - USE OF TMS HHT

10.10.2022	BASLUC	HALGUN	EMBNIL
Date	Created by	Controlled by	Approved by

Preliminary Hazard Analysis - Use of TMS HHT Report	Pages: 21	Previous valid OAM rev.:	
		Discipline: SA	
	Produced by: Bane NOR SF Drift og teknologi		
	Prod. doc. no.:	Rev.:	
	Replaces:		
	Replaced by:		
Project: TMS Subproject: Generic System	Document number: 2000006679	Document revision: 000	
BANE NOR	OAM document number:	OAM document revision:	

Evaluation of risk based tests in field operations – Performed on Gjøvik Station



ERTMS PROGRAMME

EVALUATION OF RISK BASED TESTS OF TMS HHT IN FIELD OPERATIONS

15.02.2023	CHRPER	KNAOYV	EMBNIL
Date	Created by	Controlled by	Approved by

Evaluation of Risk based tests of TMS HHT in field operations Report	Pages: 37	Previous valid OAM rev.:	
		Discipline: SA	
	Produced by: Bane NOR SF Drift og teknologi		
	Prod. doc. no.:	Rev.:	
	Replaces:		
	Replaced by:		
Project: TMS Subproject: Generic System	Document number: 2000007874	Document revision: 000	
BANE NOR	OAM document number:	OAM document revision:	

Establishment and evaluation of risk reducing measures
(5 Focus areas)

1) Working Areas
2) Position validation
3) Maps
4) Instructions and procedures
5) The device

How to prove the solution was Usable and Safe to use ?

- Follow up on HF Governings processes
- Collaboration throughout the program
- Establishment of key documentation
- Participation in development activities
- V & V Activities

Human Factors Report

"Safety Case style"

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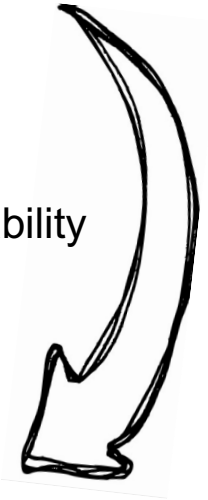
Handling changes in the TCC

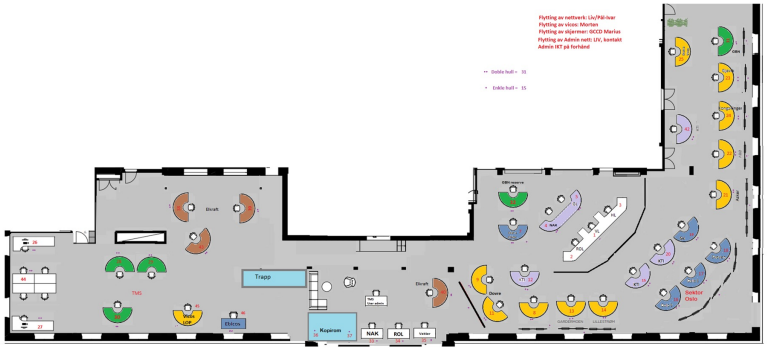
- Modelling the environment based on:
  - System definition
  - Operational Scenarios
  - CRIOP STEP Diagrams

- Performing workshops to catch operative needs and potential hazards
  - Using e.g.
    - Tailored CRIOP Checklists
    - CRIOP STEP Methodology
    - HAZOP & other (Risk) analyses for certain processes

Traceability



- Follow up findings
  - Use of Human Factors Checklists
  - Updating Hazard Logs
  - Updating Documentation



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Tools to achieve a usable system

- End users (correctly) involved in the project
  - Iterative design work involvning end users (as part of the design teams)
  - Continuous tests (formative) with end users during the design work
  - Formal tests (Summative) involvning end users

- Safety Management in line with relevant standards and regulations:
  - Tight cooperation between Safety and Human Factors/Usability Teams
  - Hazard Log as a tool to achieve valid closing arguments of risks

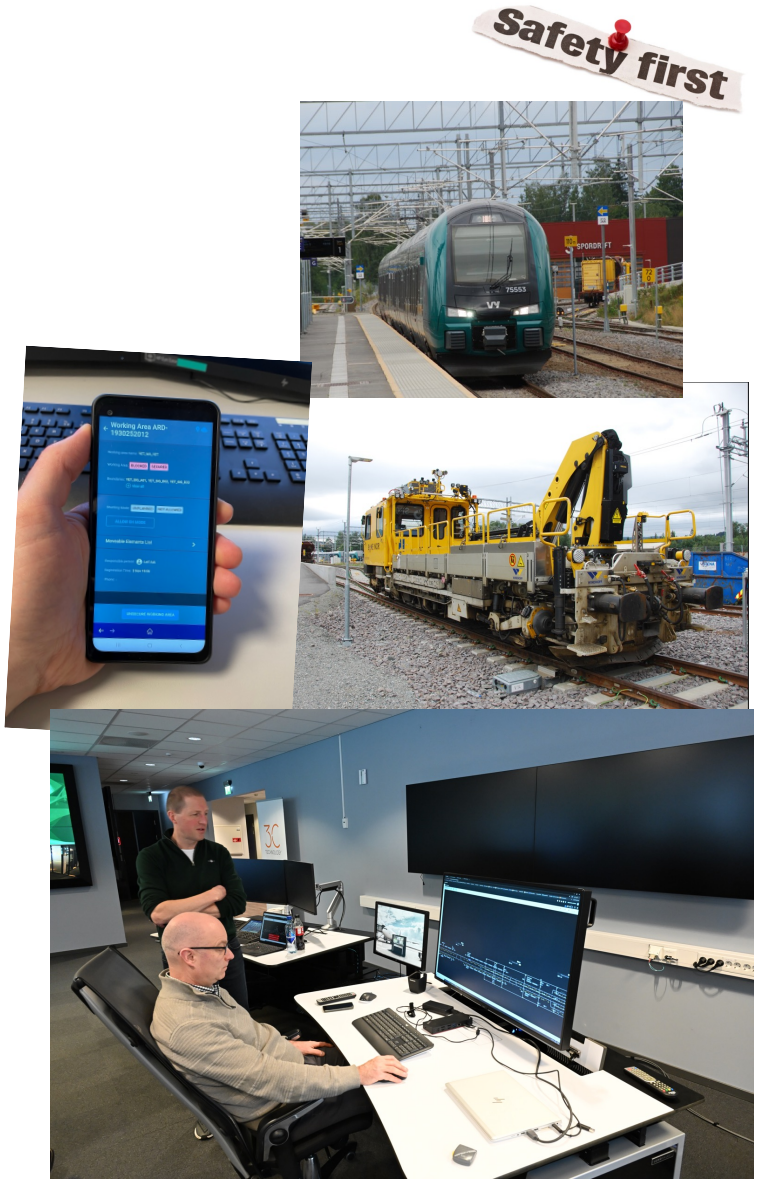
- Requirements/Specific plan to adress Usability & Human Factors
- Continuously performed Usability Assessments
- Interaction design specification and design guidelines

Why the Human Factors & Usability Focus?

Safety & Usability

- If the solution isn´t usable it will not be safe to use (safety builds on that the GUI & Work Processes are satisfactory from a usability point of view*)
- The project needs evidence of that adequate safety is inherent in the System as a whole before commissioning

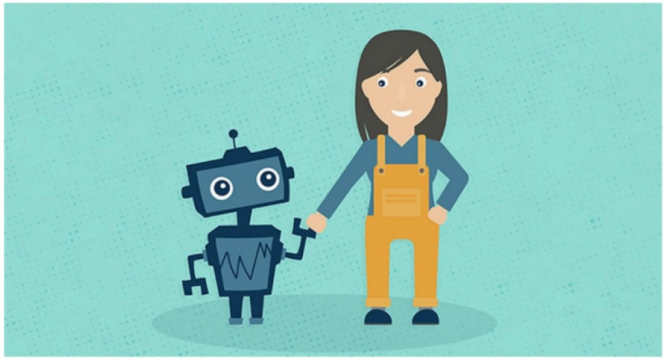
* This is especially important in a Non-SIL/Basic Integrity system where the dispatchers are ultimately responsible for the safety



Especially important Usability aspects

- The concept Operative Planning
  - Support the dispatchers to work and plan proactively
- Automation
  - A well designed automation philosophy should be implemented
- Decision support
  - The System support should be at its best in the most tricky situations
- Situation awareness
  - The system as a whole should maximize situation awareness of the operator

User in the loop



Lessons learned

- Project setup
  - Process (context) driven development
  - Agreed processes to handle changes
  - Human Factors a core value
  - Proactive involvement of authorities
- The Team
  - Include end users (and other relevant roles) early
  - Safety and Human Factors must walk hand in hand
  - Don´t forget RAM-people
- Tech stuff
  - Flexible architecture
  - Make it simple (MVP)
  - Don´t forget Maintenance

- Railway (and common) concerns
  - Security a core necessity
  - Availability needed 24/7
  - Controlled configuration possibilities
- Railway specific stuff
  - Laws, rules and processes govern everything
  - Railway is an extremely conservative branch
  - Railway has highly skilled personnel with high expectations and demands
  - Authorities watch over you, always
- The process
  - Know and model the context – Old & New
  - Processes should govern the design, not the other way around
  - Transparency and traceability is everything

Thanks for paying attention

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