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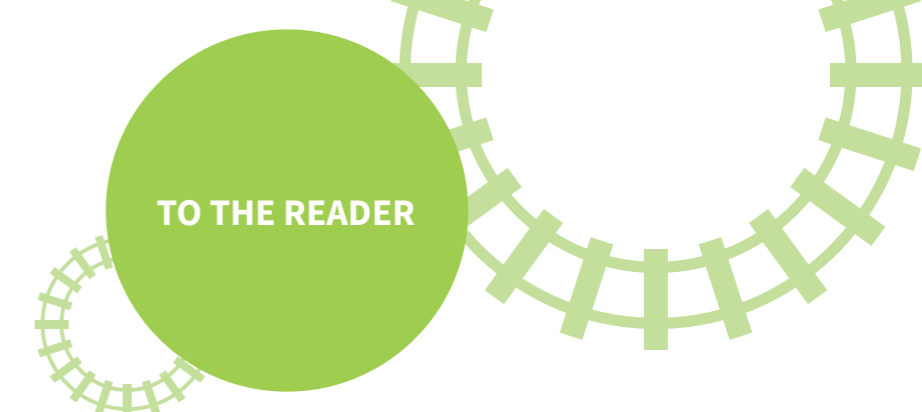
A guide for taking into account human and organizational factors in work

Finnish Institute of Occupational Health

CONTENTS

DEAR READER

This guide details the development of work and the promotion of safety from the perspective of human and organizational factors. We will review what is meant by human and organizational factors, who should understand them and how they can be taken into account in practice.

This guide is intended to provide rail traffic actors with tips for developing their own work and for expanding and renewing their safety thinking. The guide may be useful for rail traffic operators, units in charge of maintenance, railway networks and other actors who develop safety culture. It can be utilized to train employees, supervisors, experts and management; to support work or as a resource for self-study.

Rail traffic has a long tradition of developing safety – the goal of the human and organizational factors perspective is to reframe and extend the work that has already been conducted.

The ProHF research project

This guide contains results, lessons learned and insights from the "Human factors in safety – efficiency and operability" (ProHF) research and development project. The objective of this project was to assess how the mastery of human factor interventions carried out in 2000–2020 in the organizations that participated in the study impacted the organizations' operations, such as their understanding of human factors being part of safety development and their safety management practices. The project data comprised interviews, observations during workplace visits, workshops, indicator data gathered from the companies, and a final assessment.

The project was driven and maintained by the participants' passion to learn, understand and improve their own activities and safety.

Työsuojelurahasto
Arbetarskyddsfonden
The Finnish Work Environment Fund

AIR NAVIGATION SERVICES FINLAND

VR GROUP

FINAVIA

1. WHAT ARE HUMAN FACTORS?

SAFETY IS ABOUT HUMAN ACTIONS, which are successful most of the time. However, in everyday language, the term "human factors" (HF) often has a negative connotation: when something bad happens, it is easy for us to turn to human factors, meaning mistakes made by an individual. Examining human factors from a solely negative and individual perspective is risky: emphasizing human error may, for example, make people afraid to talk about or report defects or near-misses for fear of being blamed.

Narrow, one-sided use of the term human factors does not facilitate development of work; it may actually increase tension in the work atmosphere and, at worst, cause safety-related factors to be hidden.

In this guide, we use the term "human and organizational factors" to describe the creation of a positive safety culture. We base this on the latest safety thinking. Taking human factors into account in a positive and comprehensive manner turns thinking into shared actions, management, organization of work, and group-level activities.

- How can the organization help people succeed in their work?
- How can the conditions for smoothly flowing and safe work be created for different occupational groups?
- In which areas are we already successful and why?
- What, where and how do we learn?
- What maintains and creates safety?
- What impedes safety?

The term human factors has been defined in various ways and the understanding of the part that humans play in creating safety has changed over time. At its simplest, the idea is that we all create safety at our workplaces.

The above definition aims to broaden the concept from focusing on the individual and on errors towards more comprehensive and positive safety thinking.

> **HUMAN FACTORS ARE THE FACTORS IN A GROUP OR INDIVIDUAL, ORGANIZATIONAL OPERATIONS, OR WORK CHARACTERISTICS, WHICH CAN EITHER SUPPORT OR WEAKEN THE SYSTEM'S ACTIVITIES AND THUS THE SAFETY OF SERVICES."**
> (TEPERI, 2012)

It is crucial that human factors are taken into account as an everyday part of normal work, and not as a mere entry in the safety management manual. Human actions and characteristics should be taken into account at the workplace or organization when planning and managing work as well as in personnel development. Ultimately, this should be evident in the conversational culture that management and supervisors create, in the user-friendliness of instructions and procedures, and as healthy and happy operative personnel.

Human factor development programmes (Teperi, 2019) in safety-critical areas aim to:

- emphasize the focus on successes and the things that work well
- enable deviations to be more openly raised
- create a more comprehensive understanding of the background factors of deviations
- focus on constructively processing shortcomings and thus encourage learning, participation and co-operation between different occupational groups
- more openly share understanding and lessons learned.

Using the concept of human factors in a positive and comprehensive way to improve the safety culture enables a broader view of the background factors of events. Development work becomes an instrument of open discussion.

Rail traffic actors, including the VR Group, use the term "HOF" (human and organizational factor) for human factors. This is also the chosen practice of the European Union Agency for Railways.

Human Factors is a scientific discipline with a history that spans several decades. The concepts that explain the scope and methods in the area have evolved over time. The term "HF" or "Human Factors", as used in the related scientific literature, includes organizational factors.

In this guide, we use either the term "human factors" (HF) or "human and organizational factors" (HOF), depending on the context.

2.1 SAFETY THINKING IS EVOLVING – TOWARDS AN ADAPTIVE CAPABILITY

A NEW DEFINITION of safety management and human factors is required in order to eliminate the deep-rooted notion of "humans as the weakest link in the system". Safety research has highlighted a new approach that aims to make safety thinking even more understanding, positive and proactive.

The differences between the traditional approach and the new approach are presented below (Hollnagel 2014) and in Figure 1 on the next page.

SAFETY I
– THE TRADITIONAL APPROACH TO REALIZING AND DEVELOPING SAFETY

- **SAFETY =** the risk of unwanted events is as low as possible
- **REACTIVE APPROACH:** safety is improved by eliminating risks, failures, errors and their underlying reasons
- Focus on factors that impair safety, on "what goes wrong"
- People are perceived as sources of errors, risk factors or risks

SAFETY II
– THE NEW APPROACH TO REALIZING AND DEVELOPING SAFETY

- **SAFETY =** as much as possible goes right and is successful
- **THE PROACTIVE APPROACH:** events are identified and anticipated
- Focus on successes and factors that maintain safety
- Acceptance that human actions always vary and the circumstances for actions are always restricted, and that this requires adaptation
- Resilience is created by developing work processes and new work methods, reducing risks, mitigating consequences, compensating for a lack of resources and ensuring that work is done correctly
- People are perceived as assets ("rescuers") who bring flexibility, elasticity and tolerance to systems in constantly changing work situations

IN A CHANGING OPERATIONAL ENVIRONMENT, ou must be able to ensure not only safety but also that operations are high in quality, flow smoothly and are precise. This requires a resilient organization: Today, rail traffic operations are challenged by international requirements such as regulatory reforms, increased national competition and changes demanded by global pandemics and other crises.

The human and organizational factors viewpoint offers tools for traditional safety work, such as risk assessment and deviation analysis. However, it also offers a more comprehensive view than mere accident prevention. Human factors are, in fact, related not only to safe but also smoothly flowing, meaningful and appropriate work. We learn to ask "how" and "why" instead of being content with only a technical description of "what" happened: How did the deviation happen from the perspective of the people who encountered it? How can we succeed as often as possible in diverse work situations, which keep changing? How can we improve the general conditions for success as well as eradicate individual risks?

Understanding human actions becomes increasingly important as constant change and uncertainty challenge our adaptability.

Resilience refers to the capacity of an individual or organization to flexibly adapt to the changing requirements of the operating environment (Conklin, 2012; Hollnagel et al, 2006). Being able to prevent serious deviations is of central importance; to anticipate abnormal situations and manage them as they occur; to mitigate the consequences of deviations after

the fact, and to learn from them in order to be able to deal with future deviations (Annarelli & Nonino, 2016; Uusitalo & Ala-Laurinaho, 2017; Wahlström et al 2020).

Resilience can be described as agile, rapidly recurring, flexible actions in a new kind of situation with limited, even scarce resources. A resilient work community will continually and preventatively learn and develop its operations.

Even malfunctions can be used as stepping stones when they are viewed as opportunities to analyse operations more closely and as tips on what to develop next.

> **RESILIENCE IS WHEN AN INDIVIDUAL OR ORGANIZATION FUNCTIONS SMOOTHLY AND FLEXIBLY IN A CHANGING OPERATING ENVIRONMENT, EVEN IN UNEXPECTED SITUATIONS. IT REQUIRES ANTICIPATING, LEARNING AND DEVELOPING TOGETHER.**

THE EVOLVING VIEW of safety management and human factors is illustrated in Figure 1. below.

It is important to note that "traditional" safety management measures may still be needed. As such, the Safety-I and Safety-II viewpoints presented in the figure actually complement each other. Risk analyses and deviation investigations, for example, must not be abandoned, because they are central methods for developing safety in many industries. But the way in which they are conducted may be improved and reframed. Safety practices that work should be continued.

SUPPORT SYSTEM AND HUMAN RESILIENCE:
Ability to anticipate, cope, recover and learn
HELP PEOPLE SUCCEED.

SAFETY I

FACTORS WEAKENING SAFETY

• Unsuccessful actions
• Risks
• Errors

PARADIGM SHIFT IN SAFETY THINKING

SAFETY II

FACTORS MAINTAINING SAFETY

• Things working well
• Understanding human variation
• Limited resources

INDIVIDUALS AND ERRORS IN FOCUS

• "Bad Apple Theory"
• "Find the weakest link and throw them away"
• Latent systemic falures remains in system

= OLD THINKING

CHANGE IN HF-THINKING

ORGANISATION, SYSTEM, RESOURCES AND DEVELOPMENT IN FOCUS

• Several contributing factors behind the cases
• Learning is main goal of investigation
• Human error is starting point for improvement
  - not conclusion

=NEW THINKING

Figure 1. Change in safety thinking – an evolving concept of human factors and safety management (Teperi & Kannisto, 2018 based on Dekker, 2002; Hollnagel, 2014.)

THE EVOLVING VIEWPOINT OF SAFETY RESEARCH (SAFETY-II) can only be put into practice through conscious thinking and actions; this challenges all personnel at the workplace, from management to safety experts and operative employees.

The previously described "maturity phases" of safety management are indeed complimentary. Traditional safety thinking, with its risk assessments, is still required but the models and tools offered by "human-centred" thinking should be utilized alongside it and expand it.

The development of an organization's operations has different phases, including the renewal of safety thinking and practices. These should be recognized and identified. Moreover, different development phases may need different tools and measures.

STUDYING HUMAN FACTORS – THE ProHF PROJECT IN VR FLEETCARE

This guide offers examples, views and experiences of the development path of human factors in VR FleetCare. The data is from the ProHF research project (2019–2020), in which VR FleetCare Oy (previously VR Maintenance) participated as one of the study's target organizations. The data were collected through interviews and observations during workplace visits, by compiling indicator data and from two workshops. Approximately 15 people from different levels and functions of the organization participated in the workshops.

2.2 RELATED INTERNATIONAL POLICIES

RAIL TRAFFIC has already long paid attention to supporting and assessing human actions through, for example, occupational health services and human resources management. The newer viewpoint aims to describe and understand human actions as part of safety management.

SAFETY MANAGEMENT SYSTEMS are a current way of systematically improving and maintaining safety over the long term. Normal operations and deviations encountered in everyday work, for example, offer material for developing operations, work and safety – as long as they are openly reported and analysed.

International regulations and policies (EU, 2016, 2018; ERA, 2018) require that rail traffic actors manage and process HOF; proper management of these matters is no longer a recommendation but a prerequisite for continued operations. The Finnish Transport and Communications Agency Traficom oversees that recommendations are met.

The European Union Agency for Railways (ERA) has created a safety management system wheel, a model of the elements that a rail traffic organization must implement in its own safety management. The central parts are planning, realization, assessment, and development of operations. When implementing these, it is important to take into consideration the organization's operating environment and human factors, including organizational factors (Appendix 1). The ERA also outlines the development of safety culture using a safety culture model that describes the different factors as basic requirements and enablers (Appendix 2).

In Finland's rail traffic, the inclusion of human factors in safety management systems and industry training was recommended already in 2015 as part of the Hyvinkää speeding investigation, conducted by the Safety Investigation Authority of Finland (SIA, 2015).

VR FLEETCARE – WHY HUMAN FACTORS?

The reasons why the participants regarded taking human and organizational factors into consideration as being important were compiled in a workshop during the ProHF study (2019). The figure below presents the most salient views.

The participants highlighted the importance of promoting a modern safety culture and safety thinking as well as risk management in the work environment. This development requires functional safety measures and tools. The participants saw incident and deviation investigations as central tools and felt that the HOF viewpoint expanded the technical perspective, helped identify root causes and reduced the culture of blame. In addition to processing deviations, human and organizational factors were recognized as an important preventative part of risk assessment.

Another issue highlighted in addition to the factors related to safety culture was that human and organizational factors should be applied more broadly in the future development of operations, supervisory work and management. By the development of overall operations, the participants specifically meant the intertwining of safety, quality and environmental perspectives.

BROADER DEVELOPEMENT OF OPERATIONS

DEVELOPEMENT OF SAFETY CULTURE

SAFETY THINKING

TOOLS

RISK MANAGEMENT OF WORK ENVIRONMENT

ANTICIPATION, RISK ASSESSMENT

INVESTIGATION OF DEVIATIONS

Figure 2. Why human factors? – Views of workshop participants

3. PROMOTING HOF MANAGEMENT

THE PREVIOUSLY MENTIONED change in safety thinking requires a defined path, process or programme for promoting the issue. The organization can then utilize this to promote a new kind of safety thinking and ensure that human and organizational factors are taken into consideration as part of safety and other management.

First, what is about to be developed should be considered as a whole. What is the organization actually developing under the heading of HOF?

• How is HOF understood? How is management committed?

• What is the current situation?

• What are the goals of HOF?

• How is motivation for development generated?

• Whose responsibility is development?

• What does development mean in practice at the different levels and in the different functions of the organization?

• How is trust in doing things together built?

• What are the measures and opportunities for improving the level of safety and safety culture?

• What does HOF actually mean in my work?

• What does HOF affect and what will developing it change?

3.1 WHAT IS BEING DEVELOPED?

Human factors comprise a wide range of different factors related to an individual's actions, the characteristics of work, and the actions of groups and the organization. These all promote safe and smoothly running operations. So, what are we really developing by promoting the consideration of human factors in practice?

Figure 3 outlines how the object of development expands slowly. First, a base is created: all employees must be provided with training in human factors and how taking it into consideration can affect how safe operations are and how smoothly they flow. Developing competence and awareness via training and discussion promotes a new kind of safety thinking. In joint events, it is important to create a common vision of what human factors specifically means in one's own company and operating environment and the terms that are used to discuss it.

Already during training, participants should begin to apply what they have learned. Often, it is most natural to do this by examining and developing the company's safety measures. For example, do current incident investigations take matters related to human factors sufficiently into account? How are matters related to human factors recorded in deviation reports? If human factors are included in safety measures, instructions and tools (such as incident reporting forms), they are systematically taken into account. Section 4 contains practical tips for this.

The human factor perspective offers a good starting point and ideas for developing work: safe, high-quality, smoothly flowing and productive work are all simultaneously promoted. For example, clear work instructions, clean and safe work, agreed standard work methods, and a common view of the opportunities for flexible operations ensure that basic work flows smoothly, and that even in unexpected situations, workers quickly find a common way to react. The initial push for developing work could be the need to reduce the number of repetitive disturbances and interruptions, or possibly a new device that requires changing work methods. The tips provided in Section 4 also function as guidelines for developing work.

Improving resilience means comprehensively supporting the capacities of individuals, groups, the community, and the organization to anticipate and flexibly adapt to changes in the operating environment. Understanding the systemic connections between people, software, hardware and operations becomes even more important. Examining human factors also helps people identify methods for supporting a common situation awareness and operational procedures, even in unpredictable and new situations. A central feature of a resilient organization is learning together. This happens not only during training but also, first and foremost, during everyday work when confronting challenges together, sharing ideas and lessons learned, and evaluating work practices. This leads to the continual development of a common understanding of human factors and how they impact work.

Figure 3. Human factors – expansion of areas being developed (Teperi ym. 2020)

VR FLEETCARE'S DEVELOPMENT PATH

In 2016, the VR Group launched a project in co-operation with FIOH (the HF programme 2016–2019.) The programme included the training of VR's own instructors and experts, training in the renewed HF investigation model, and tailoring the HF Tool™ for VR Group's different business areas/divisions. The VR Group's safety unit led the project. VR chose raising awareness (training, informing) and improving investigations as the main goals, and safety as the main perspective.

The following covers in more detail how increasing consideration of human factors has progressed in VR FleetCare. The description is based on discussions during the ProHF project workshop (2019).

" **TAKING HUMAN FACTORS INTO ACCOUNT HAS BEEN A JOURNEY OF SHARING INFORMATION, LEARNING TOGETHER AND INCREASING THE VISIBILITY OF SAFETY.**

ANTICIPATION, CHANGE MANAGEMENT

HF Tool™ AND SAFETY MEASURES

IMPROVEMENT OF WORK AND WORK ENVIROMENT

HF DEVELOPMENT PROGRAMME

TRAININGS AND KNOW-HOW

TAKING HUMAN FACTORS INTO ACCOUNT IN INVESTIGATIONS
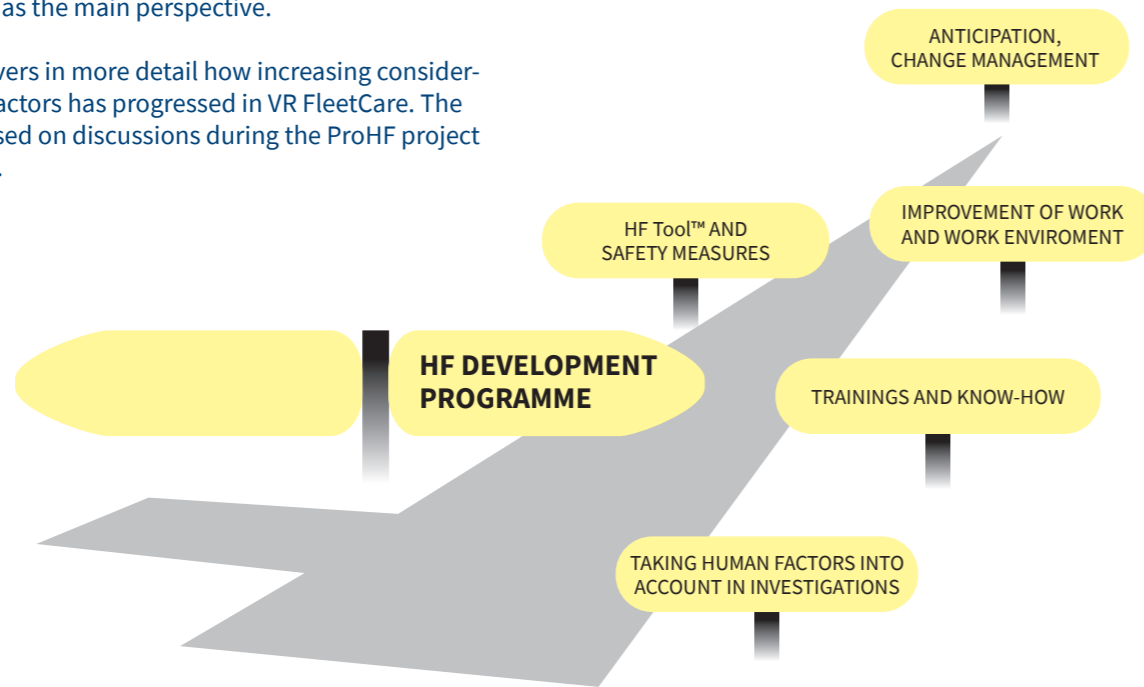
Figure 4. VR FleetCare's development path

Perspectives of investigations and processing of deviations

The human factor perspective was utilized in one specific accident investigation and its use in a few other deviation and accident investigations gave encouraging results.

The many ways to develop competence

In 2016–2019, a HF programme for training instructors and experts within the organization was conducted in co-operation with FIOH, by using FIOH's framework and tools. Improved competence could be seen as an increased discussion on safety and human factors. The improvement of employees' knowledge and awareness continues through induction refresher courses and online training.

Improved consideration of human and organizational factors in safety measures

For example, utilizing the HF Tool to develop deviation description templates, investigation reports and safety management practices. The perceived reduction in blaming and better opportunities for employees to participate in deviation processing were considered important improvements.

The application of the HOF perspective in updating work instructions and **other development of work and the work environment.**

The wish to integrate HOF more widely into anticipation, change management, the management of production risks, and the **overall development of operations.**

3.2 IMPROVING AND IMPLEMENTING HUMAN FACTOR MASTERY THROUGH CO-OPERATION

Mastering human factors (including organizational factors) requires conscious actions and activeness from all levels and parties of an organization.

The management must record this issue in the guiding principles of the organization, such as the strategy, safety policy, safety management system, and occupational safety and health action plan.

However, merely recording it is not enough. The perspective must be one of the decision-making criteria, such as when deciding on investing in new equipment, implementing changes in the organization, planning the reorganization of work, or implementing changes in systems. The top executives are also responsible for ensuring a long-term, systematic plan for implementing and developing this issue, as well as the resources required.

Supervisors need their own role to implement clear procedures and tools for promoting the mastery of human and organizational factors in their own work community. For example, they must take HOF into account in deviation investigations and take previous successes into consideration in addition to identifying what went wrong. They must know how to process matters in an open and systematic way, without blaming, and by building trust between employees. By their own example and approach to work, supervisors promote the success of their operative employees. Their work needs to be

supported by the top management, especially under exceptional circumstances.
The supervisor's role in the line organization must be clear.

The operative personnel are primarily responsible for managing their own competence and functional capacity to ensure that they can cope with their work and constantly adapt their situation awareness during everyday tasks. They must have an independent approach to work and be interested in personal professional development, while openly highlighting any shortcomings they encounter in their work. Operative employees must be able to trust that their perspectives of practical work are taken into account when planning and managing work.

It is essential that personnel are involved in the development of work. The company should create operational models and structures that enable discussions on work and its areas that need development.

THE PERSPECTIVE OF HUMAN AND ORGANIZATIONAL FACTORS must be considered in overall production, production management, procedures, and the information systems that support them. In other words, these perspectives should already be considered proactively, and not only during and after deviations. This means that those who plan work, the management and supervisors, must already have this perspective "on their agenda" before the operative personnel do their everyday work "in the field".

Essential questions:

• Can the work environment be designed so that any disturbances, such as noise, heat and cold can be controlled?

• Has work been organized so that it is evenly distributed between different employees and parties?

• Are work-related roles and responsibilities clear? Do people understand how their own actions impact the work environment?

• Is work managed in a way that enables participation? Can employees participate in planning changes related to their work?

• Are perceived shortcomings processed openly? What forums exist for these discussions?

• How well are ideas development related to deficiencies in safety or quality or arising from third party investigations put into practice? Are they used as a starting point for improving operations? Does the organization learn from or repeat its previous mistakes?

A good rule of thumb for assessing whether the human factors perspective has been adopted is to ask:

Are the basic aspects of work in order, such as the tools and the work environment? Or will they improve if the process of mastering the human factors at the workplace progresses? How well this thinking has been accepted cannot be assessed on the basis of a "new jargon". Rather, what must be assessed is how well the basic idea, its "philosophy", has permeated into everyday activities.

A good way to progress is to first see how the organization works and how, for example, the management supports operative work. This can be followed by assessing how functional the working conditions (such as working hours, equipment, instructions) are. Only after this should an organization check whether work groups, teams and individuals have adopted the desired practices.

The following presents the tools that FIOH applied in the VR Group's HF programme.

4.1 GETTING TO KNOW THE HF Tool™

The HF Tool™ was originally created for air traffic management in 2003 to promote competence in and the analysis of human factors. The objectives of the tool were:

• To provide a comprehensive outline of human factors as actions among individuals, work characteristics and group and organizational factors, as well as among organizations themselves
• To verbalize human actions in a diverse way
• To highlight the functional and positive aspects of human actions and human variability
• To improve employees' skills in this area (Teperi, 2012)

The purpose of the tool is to illustrate how systemic and comprehensive human actions are and how different factors interact. The success of activities is decided by many factors; factors that also influence each other – no individual factor can be emphasized. Whether we can achieve the goals of smoothly flowing work, safety and well-being depends on many issues.

HUMAN FACTORS OVERALL
An analysis tool based on the HF Tool was tailored to enable the VR Group to analyse human factors and create awareness. Thus far, the VR Group has used the HF Tool for creating awareness, developing competence, training and research. (Figure 5.)

However, the HF Tool is not only used in investigations, even though this is a good way to learn to use the tool. It is also valuable in risk assessment, everyday operations and for developing work. It can, for example, help supervisors, those who plan work and all personnel identify which factors enable success at work and ensure safety, e.g. organizing work and recognizing human factors related to working hours may be in focus.

Since 2008, the HF Tool has been systematically utilized for reporting incidents in Finnish air traffic management. Air traffic controllers have used the tool to improve their understanding of how their own actions create safety and how different background factors cause or mitigate deviations (Teperi et al. 2015). Safety experts in the nuclear energy industry use the HF Tool to more deeply and comprehensively understand the human factors behind operational events as well as to better acknowledge successes (Teperi et al. 2017.)

In aviation maintenance, the HF Tool has helped develop the comprehensive recognition of safety critical work phases in co-operation between different levels of the organization and together with co-operative partners. The tool was used for forming dozens of ideas regarding, for example, the areas of work processes that needed development, and improving the recruitment processes and co-operation practices of the company and the occupational health service centre. The workplace investigation process was also improved and now takes the safety critical nature of aviation maintenance better into account (Teperi et al. 2019.)

1. Competence, mastery of work
2. Situation awareness (perception, memory, decision-making, response/execution)
3. Working along instruction and agreed procedures
4. Understanding the bigger picture/overall situation
5. Proacting, preconceptions and assuring assumptions
6. Workload (overload/unload) and means for managing it
7. Vigilance, alertness, fatigue symptoms
8. Life situation, anxiety, level of (long-term) stress
9. Age; quality and quantity of work experience
10. Health, work ability
11. Motivation, attitudes
12. Emotional state and reactions, mood
13. Information systems
14. Physiological factors, experience

40. management and leadership; structure, styles
41. organization culture
42. co-operation and trust between different organization levels and units
43. understanding railway safety as a whole throughout the railway company's management
44. decisions made (incl. resources, personnel, equipment)
45. change management (personnel, systems)
46. co-operation with partners
47. The company's support for rail operations

20. Quality and contents of work; work demands
21. Quantity of work; time pressure, having to rush
22. Work organization, work distribution, job descriptions; clarity
23. Usability and functionality of devices, software, technology
24. Procedures and instructions; functionality, clarity and being up-to-date
25. Opportunities to influence one's work and working conditions
26. Feedback on work, professional appreciation
27. Opportunity/ability to evaluate and develop one's work processes
28. Assuring competence (training, exercises, other ways of learning)
29. Work hygiene factors, physical work environment, working conditions, occupational hygiene factors (noise, ventilation, lighting, temperature; layout)
30. Shared understanding of the situation among all group members
31. Knowledge of all group members is used
32. Communication within group (e.g. are misunderstandings, misinterpretations and mishearing corrected)
33. Structure and cohesion of group, group dynamics (social relations, atmosphere, mutual support)
34. Communication between different groups
35. Information flow, communication practices
36. Decision-making in group
37. Safety culture
38. Manager supports the concretisation of safety at work

ACTIONS AND CHARACTERISTICS OF THE INDIVIDUAL

WORK OPERATIONS AND CHARACTERISTIC

RECOGNIZE THE HUMAN FACTORS THAT CONTRIBUTED POSITIVELY OR NEGATIVELY TO THE EVENT

ORGANIZATIONAL-LEVEL FACTORS

GROUP-LEVEL FACTORS

Figure 5. VR Group's "Human Factors" analysis tool (based on HF Tool™ by the Finnish Institute of Occupational Health)

THE ACTIONS AND CHARACTERISTICS OF THE INDIVIDU-AL are an important area to note because human factors are always connected to human actions in some way. The essential issue is the perspective from which an individual's actions are considered. The actions and characteristics of an individual must not be seen as a list of reasons for an unfavourable event but rather a description of matters that a well-functioning work community and organization can take into account. (Figure 6.)

The section on the individual examines the competencies that each employee requires in order to succeed in their work. Simplifications of an individual's actions, such as "carelessness" or "forgetfulness", are often over-emphasized when determining that factors that impact these actions. Only one of the four sections of the HF Tool describes the actions of the individual. Good human factor mastery also involves comprehensively considering factors not related to the individual. It also makes discussing more sensitive issues such as personal problems or emotional reactions easier when the tool lists all the issues.

Actions on the individual level can be best supported when their connection to work and to the different levels of the organization are understood. Situation awareness and motivation, for example, do not improve if employees are merely told to "be more precise" or "mend their ways". A more essential question is: How can work and the work community be improved so that the employee's situation awareness and motivation improve?

Some factors that impact individual actions and characteristics are more closely connected to work (such as workload and instructions), whereas others (health and life situation) are more strongly connected to the employee as an individual. To master human factors, it is important to first consider, in both cases, which work and workplace factors we can affect. It is also easier to address any possible issues related to an employee's personal life when everything is in order at the workplace.
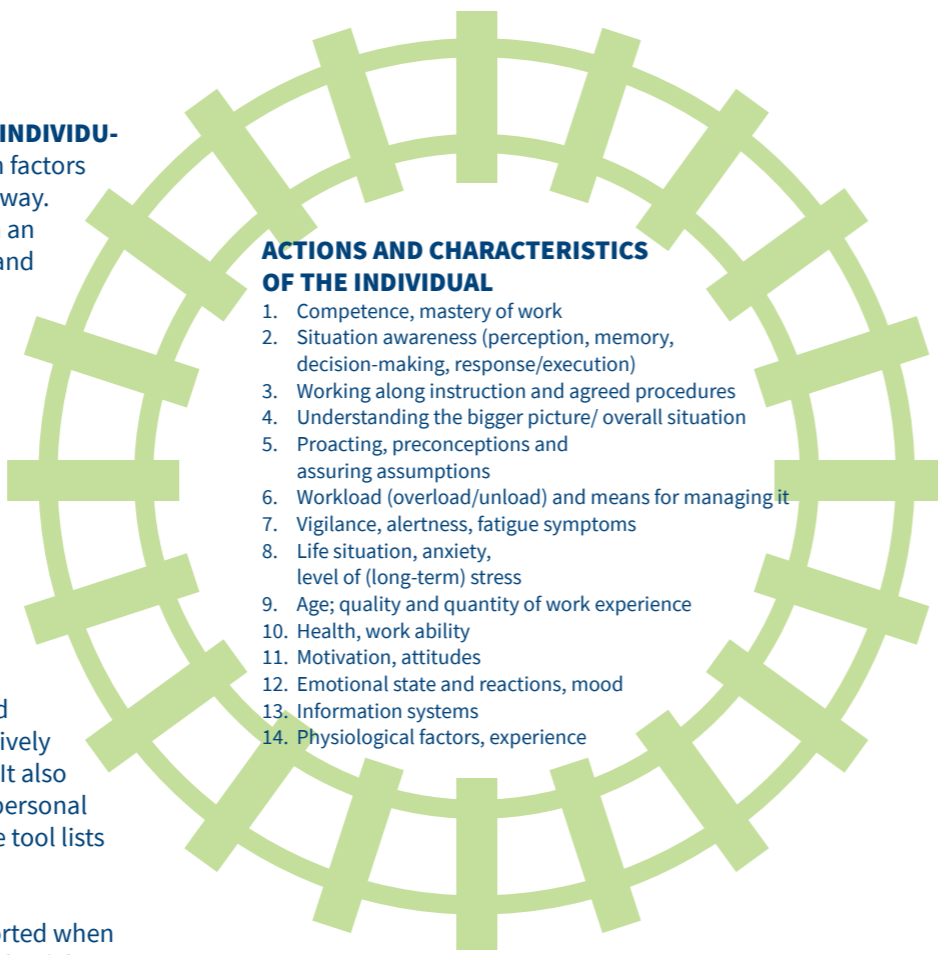
ACTIONS AND CHARACTERISTICS OF THE INDIVIDUAL
1. Competence, mastery of work
2. Situation awareness (perception, memory, decision-making, response/execution)
3. Working along instruction and agreed procedures
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10. Health, work ability
11. Motivation, attitudes
12. Emotional state and reactions, mood
13. Information systems
14. Physiological factors, experience

Figure 6. VR Group's HF Tool™: Actions and characteristics of the individual

In the interviews and work observations of the ProHF project, the employees of VR FleetCare specifically identified professional skills and work experience as individual-level strengths. The areas identified as needing development included the management of alertness and fatigue and support in motivation and attitude-related matters.

WORK OPERATIONS AND CHARACTERISTICS are closely connected to human factors. Work demands can be conceptualized as a counterpart of human factors. Workload and the impact of individual factors can be managed by altering the characteristics of work and paying attention to physical and psychological ergonomics. The different characteristics and demands of work create psychosocial stress in addition to physical stress. These can be related to either the content of work, the organization of work, or the social interaction of the work community. Excessive or unmanaged psychosocial stress increases the risk of human error (Figure 7.).

The sections of the HF Tool that focus most on psychosocial stress are Work characteristics and Group-level factors. The Work characteristics section focuses on working conditions in addition to the content and organization of work. Working conditions are often neglected when examining human factors, even though, together with appropriately assigned tasks, they provide the basis for smoothly flowing and safe work.

Processing the Work characteristics section clarifies the practical work situations and local circumstances in which work is carried out. Changes in the characteristics of work and related arrangements affect how employees cope in their work and enjoy it.

WORK OPERATIONS AND CHARACTERISTIC
20. Quality and contents of work; work demands
21. Quantity of work; time pressure, having to rush
22. Work organization, work distribution, job descriptions; clarity
23. Usability and functionality of devices, software, technology
24. Procedures and instructions; functionality, clarity and being up-to-date
25. Opportunities to influence one's work and working conditions
26. Feedback on work, professional appreciation
27. Opportunity/ability to evaluate and develop one's work processes
28. Assuring competence (training, exercises, other ways of learning)
29. Work hygiene factors, physical work environment, working conditions, occupational hygiene factors (noise, ventilation, lighting, temperature; layout)

Figure 7. VR Group's HF Tool™: Work operations and characteristics

In the ProHF project, the employees of VR FleetCare regarded training at work and opportunities to influence their own work as positive factors on the work level. The functionality of devices and systems, workload and time pressure, as well as matters related to the work environment were considered challenging. Perceptions of work methods and instructions were divided. Some considered work instructions and procedures to be strengths of the work. However, others felt these matters clearly required further development.

GROUP-LEVEL FACTORS describe matters that make the group's co-operation successful. As work is always conducted as part of a group, group-level factors impact every situation in one way or another. As such, the impact of group-level factors should also be considered from the perspective of groups other than official and established teams. Groups may be short term, such as project teams that work closely together even though the group is disbanded after the project is completed. In addition, organizational or unit boundaries may exist even within tight-knit groups. The HF Tool's group-level perspective can also be used for assessing pair work, in relation to issues such as communication, decision-making and situation awareness. (Figure 8.)

Based on their everyday experiences, many may feel reluctant to discuss their group's internal matters outside the group. Examining a group's actions is not neutral in the way reviewing technical details is, which is why it is often not done at all. Discussing the group's internal atmosphere can be very sensitive and it can be challenging to adopt a groupwork perspective when examining routine activities. Group-level phenomena are not necessarily considered part of the safety "vocabulary".

Thus, the perspective of group action is not necessarily taken into account in incident investigations or other safety-related work. This is why this perspective should be promoted. As part of normal work, assessment of group actions provides many opportunities to develop the team's operations. You could, for example, agree on communication practices and methods to create a common understanding of the situation. In order to develop work, it is also important to remain as neutral as possible when raising factors related to the interaction between members of the group. Processing group-level factors encourages teams to consider together how to improve members' interactions.
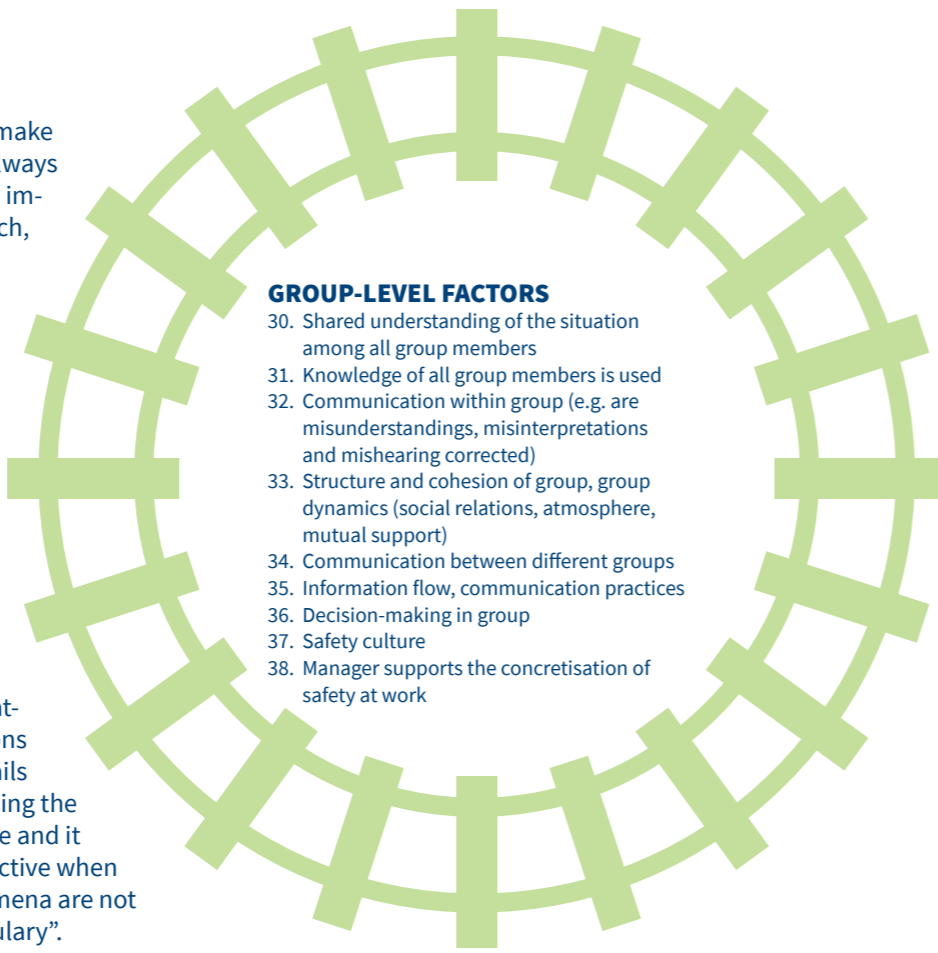
GROUP-LEVEL FACTORS
30. Shared understanding of the situation among all group members
31. Knowledge of all group members is used
32. Communication within group (e.g. are misunderstandings, misinterpretations and mishearing corrected)
33. Structure and cohesion of group, group dynamics (social relations, atmosphere, mutual support)
34. Communication between different groups
35. Information flow, communication practices
36. Decision-making in group
37. Safety culture
38. Manager supports the concretisation of safety at work

*Figure 8. VR Group's HF Tool™: Group-level factors*

In the ProHF project interviews, group cohesion and supervisor support were identified as the most obvious group-level resources. Safety culture was also highlighted as positive. Difficulties in communication and misunderstandings related to work were listed as challenges that require further development.

ORGANIZATIONAL-LEVEL FACTORS contain the structures that form the basis of a company's operations. However, specific work situations are seldom examined in relation to organizational level factors. Examining organizational factors produces a common understanding between different levels of the organization of the connections between the wider organizational context and operational work situations.

Taking the items of the HF Tool into account in everyday work situations makes management visible to the operative personnel and confirms the impact of management among those in management positions (Figure 9.)

The items also encourage assessment of the organizational culture: customary practices, approaches, values, and priorities. The organization's own understanding of culture is very important because in order to change culture one must first understand what is being changed.

Organizational factors express not only the organization's internal factors but also those related to inter-organization operations, such as co-operation with the authorities.
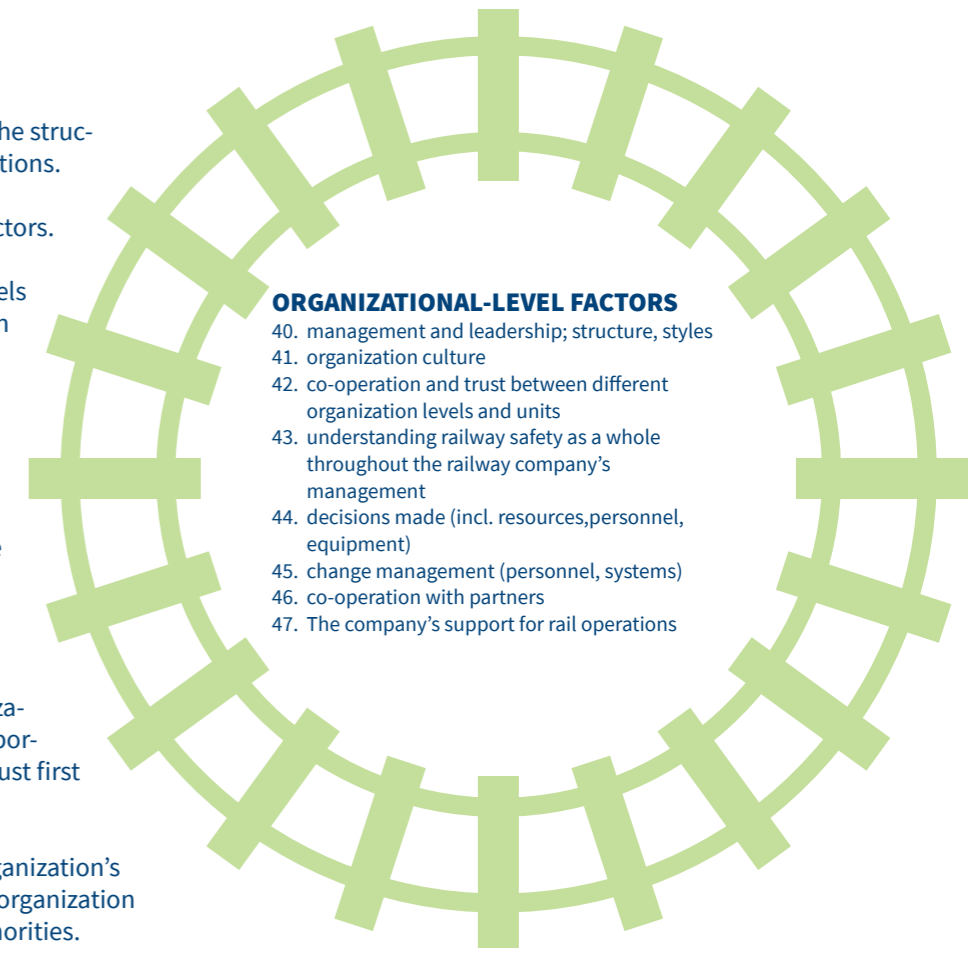
ORGANIZATIONAL-LEVEL FACTORS
40. management and leadership; structure, styles
41. organization culture
42. co-operation and trust between different organization levels and units
43. understanding railway safety as a whole throughout the railway company's management
44. decisions made (incl. resources,personnel, equipment)
45. change management (personnel, systems)
46. co-operation with partners
47. The company's support for rail operations

Figure 9. VR Group's HF Tool™: Organization-level factors

In the ProHF project interviews, the employees highlighted organizational factors less frequently than other levels related to the mastery of human factors. Change management and organizational culture were described as obvious strengths. On the other hand, areas that needed development were identified in both, in particular those related to the organization's decision-making.

4.2 LEARNING FROM DEVIATIONS

THE VR GROUP WANTED to analyse the background factors related to deviations more deeply and precisely as well as to ensure that the human factor perspective is part of analysing deviations.

An HF analysis tool, tailored for the VR Group (Figure 5), was introduced in 2016. Below, the VR Group's investigations are explained in more detail: why the analysis tool was adopted, who uses it and how it is used.

WHY INVOLVE HUMAN FACTORS IN INVESTIGATIONS? DOES IT MEAN THAT PEOPLE ARE ASSESSED MORE CLOSELY?

Involving the human factor perspective in investigations does not signify a more detailed assessment or control of human actions or characteristics. Nor does involving the human factor perspective in investigations mean technically listing or using the points of the HF analysis tool. The basic goal of using the tool is to enable openly raising issues, to gain a comprehensive understanding of background factors, to direct attention to what works well, to enable processing drawbacks in order to learn, and to enable sharing of the lessons and insights learned. The ultimate goal is an improved understanding of one's own actions in a safety critical work environment. Another purpose is to understand the impact that the background factors of the work environment and the organization have on successful work. The idea is to create a work atmosphere that allows constructive self-reflection in a constructive, positive and safe atmosphere.

WHO CONDUCTS THE INVESTIGATION AND HOW IS IT CONDUCTED?

In the VR Group, investigations are led by the local supervisor. After a deviation occurs, a local team is assembled to conduct the deviation investigation. In rolling stock maintenance in VR FleetCare, the rolling stock engineers or supervisors provide their expertise. In VR's Train operations and commuter traffic, similar expertise in operative work is provided by the traction services specialists who have work experience and knowledge of operative specifics.

The HF analysis tool and its related timeline model are employed as investigative tools. The VR Group's HF trainers and experts have been trained in their use (Figure 5, HF analysis tool and Figure 10, timelines). The tools are based on models originally developed by the investigation team of Finavia's safety unit in the 2000s. Prior to railways, they were applied in projects related to municipal organizations and seafaring (Teperi, 2014; Teperi & Puro, 2016).

PHASES OF INVESTIGATIONS:

1. Initiation of the investigation, gathering of background material (such as recordings and technical data) from the various parties.
2. Review of the background material related to the incident/deviation.
3. Drawing up the chain of events on a neutral, grey timeline in the middle of the chart (Figure 10.). What happened, step by step?
4. Identification and recording of the "failures and successes" during the different phases of the incident on the timelines above and below the incident description
   - In the green area, things that went well, functions that were handled well and successes in different phases of the chain of events in question
   - In the red area, the phases and issues that could have been handled better, that is, operational weaknesses and failures in handling the situation

5. Use of the HF analysis tool to number the human factors that impacted the incident: which factors at the individual, work, group and organizational levels enabled the incident to progress and, on the other hand, which factors enabled observing the situation and alleviating the consequences.

   - Issues in either the green or red areas in the different parts of the tool identify background factors that either reinforced or weakened safety during the incident. The actor is recorded in parentheses after the issue.

Below is an example of an incident that happened in 2010 in which passenger cars ran into a station building. The analysis uses a thorough report on the issue by the Safety Investigation Authority (SIA, 2010). The case was also used as part of the VR Group's HF training (Figure 10.).
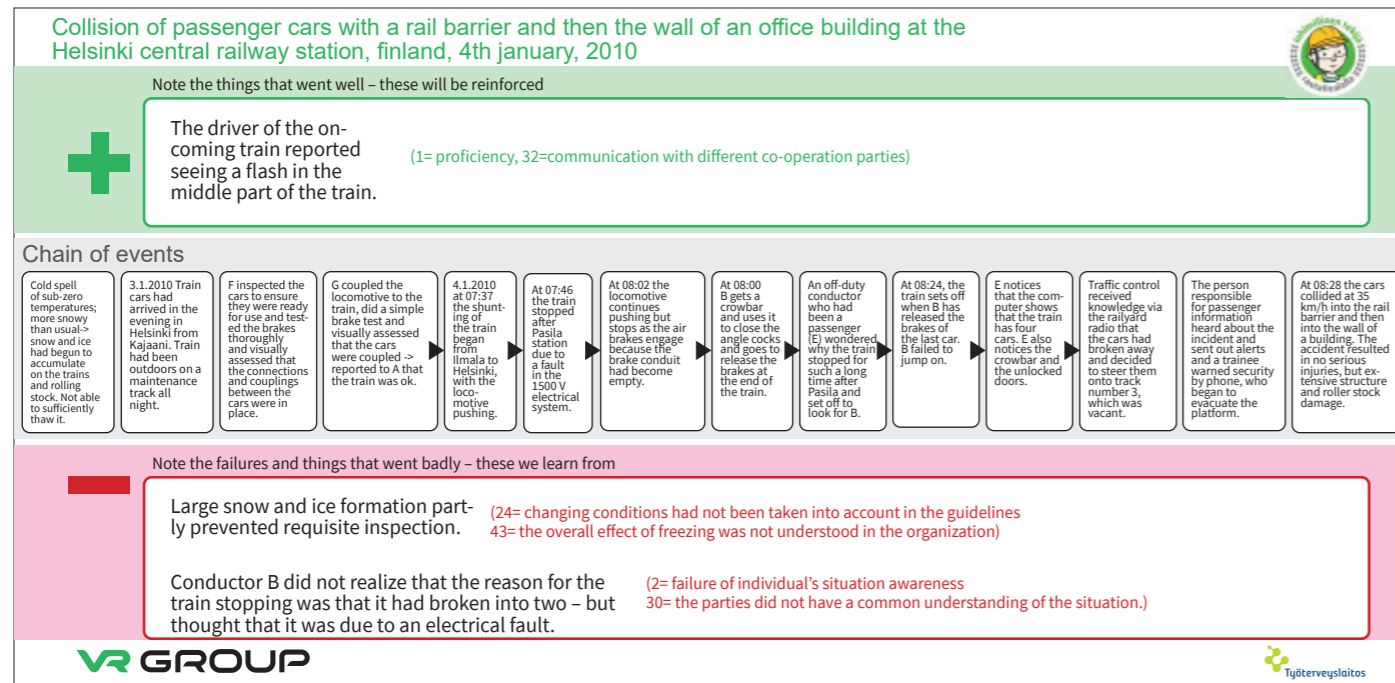
One issue that was observed using the investigation model is that previous investigations had only emphasized technical matters. The human perspective had mainly focused on identifying errors and considering whether sanctions would or would not be imposed as a consequence of the incident. One supervisor who participated in the ProHF study described the insights into the area of human factors that they gained as follows:

"I learned why there have been deviations. If we had understood human factors before, we could have found more appropriate solutions and corrective measures."

HOW ARE INVESTIGATIONS PROCESSED FURTHER AND HOW CAN WE LEARN FROM THEM?

The further processing of a completed investigation in the organization depends on the type and severity of the deviation. For example, in Fleetcare, the safety manager presents the most significant completed investigations to FleetCare's executive team, which considers whether or not corrective measures are required. The supervisors provide information in Teams meetings to their colleagues on completed investigations, which allows other parts of the organization to learn from the deviations. The executive team always reviews investigation summaries.

Lessons learned from the procedure are shared further, both nationally and internationally. Sharing the lessons learned from investigations and the using HF tools outside the organization is a sign of good safety thinking. Completed investigations have been presented; for example, in the national Rata2018 seminar (Rautatietekniikka 1/2018, 99-103), in the HOF network led by Traficom, and internationally in events organized by ERA. FleetCare's development work is also the topic of a dissertation (Ohvo, 2017) in the Safety and security management programme of Aalto University.

Collision of passenger cars with a rail barrier and then the wall of an office building at the Helsinki central railway station, finland, 4th january, 2010

Note the things that went well – these will be reinforced

The driver of the on-coming train reported seeing a flash in the middle part of the train.
(1= proficiency, 32=communication with different co-operation parties)

Chain of events

Cold spell of sub-zero temperatures; more snowy than usual -> snow and ice had begun to accumulate on the trains and rolling stock. Not able to sufficiently thaw it.	3.1.2010 Train cars had arrived in the evening in Helsinki from Kajaani. Train had been outdoors on a maintenance track all night.	F inspected the cars to ensure they were ready for use and tested the brakes thoroughly and visually assessed that the connections and couplings between the cars were in place.	G coupled the locomotive to the train, did a simple brake test and visually assessed that the cars were coupled -> reported to A that the train was ok.	4.1.2010 at 07:37 the shunting of the train began from Ilmala to Helsinki, with the locomotive pushing.	At 07:46 the train stopped after Pasila station due to a fault in the 1500 V electrical system.	At 08:02 the locomotive continues pushing but stops as the air brakes engage because the brake conduit had become empty.	At 08:00 B gets a crowbar and uses it to close the angle cocks and goes to release the brakes at the end of the train.	An off-duty conductor who had been a passenger (E) wondered why the train stopped for such a long time after Pasila and set off to look for B.	At 08:24, the train sets off when B has released the brakes of the last car. B failed to jump on.	E notices that the computer shows that the train has four cars. E also notices the crowbar and the unlocked doors.	Traffic control received knowledge via the railyard radio that the cars had broken away and decided to steer them onto track number 3, which was vacant.	The person responsible for passenger information heard about the incident and sent out alerts and a trainee warned security by phone, who began to evacuate the platform.	At 08:28 the cars collided at 35 km/h into the rail barrier and then into the wall of a building. The accident resulted in no serious injuries, but extensive structure and roller stock damage.

Note the failures and things that went badly – these we learn from

Large snow and ice formation partly prevented requisite inspection.
(24= changing conditions had not been taken into account in the guidelines
43= the overall effect of freezing was not understood in the organization)

Conductor B did not realize that the reason for the train stopping was that it had broken into two – but thought that it was due to an electrical fault.
(2= failure of individual's situation awareness
30= the parties did not have a common understanding of the situation.)

VR GROUP

Työterveyslaitos

Figure 10. Timeline model used in the investigations
(original investigation model created in Finavia's Safety and quality unit, described also in Teperi, 2014; Teperi & Puro, 2016).

4.3 PROACTIVE IDENTIFICATION AND MANAGEMENT OF RISKS

HUMAN AND ORGANIZATIONAL FACTORS and matters that affect them have traditionally been viewed from the perspective of deviations and the related investigation. This is important in order to minimize similar risk situations. However, safety research has often found that such a reactive approach alone is not sufficient.
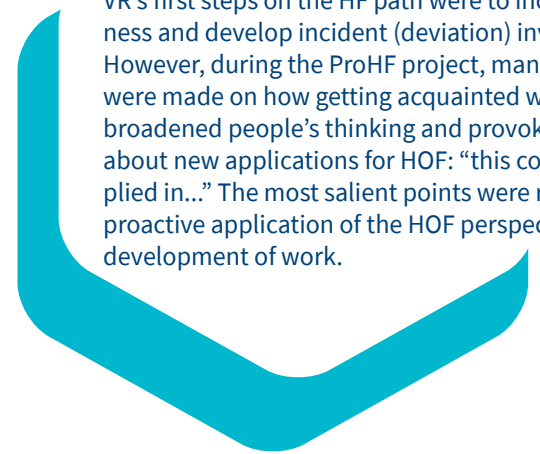
In constantly changing dynamic and complex situations, the mastery of safety and human factors requires looking ahead in a flexible manner. This is a proactive approach. A proactive organization will identify risks before any damage occurs. On the practical level, this could mean acknowledging human and organizational factors in leadership and management, in safety management systems, and in the overall development of work and everyday work routines.

Safety-critical industries have recognized that the significance of the characteristics of work and the related processes is intrinsically connected to HOF management. The aviation industry, for example, aims to standardize all of its work processes as exactly as possible in order to minimize differences in "ways of working". Communication takes place in compliance with exact guidelines and standardized phrases. The standardization of work and related processes can be considered a continuum that should be applied more rigidly as the likelihood of a risk event increases. Actions related to safety-critical work or work phases should be very strictly standardized. Correspondingly, a wider margin may be allowed in a less critical phase or one that is more clearly externally observed. Naturally, there are very few tasks in which all work processes could be standardized.

From a proactive safety management perspective, it is important to not only identify where risks may occur but also to be able to adopt the human factors perspective. In safety critical industries, when changes are made to the work or in the organization, this type of HOF approach should be part of normal operations.

Normal limits of human information processing related to matters such as working memory and attention should be taken into consideration because interruptions and disturbances in the work environment can easily have an impact on them. When changes are made to work, the demands for information processing (cognition) may also change. Normal limits of memory and attention can be managed by employing practices such as working in pairs and utilizing checklists.

Proactive risk identification can begin by simply observing the work process, and with the employee and supervisor discussing the content and phases of work and the factors that have an effect on them. Usually, it is the employee who can best identify the places that have risks and the factors required for work to flow smoothly. When considering the impact of human and organizational factors, it is important to keep the conversation emotionally neutral and avoid blaming. Listening to employees in an open and appreciative way usually ensures success in the development of work. It is also important to create structures in the work community that allow employees to express ideas for developing work as easily as

VR's first steps on the HF path were to increase awareness and develop incident (deviation) investigations. However, during the ProHF project, many comments were made on how getting acquainted with the topic broadened people's thinking and provoked thoughts about new applications for HOF: "this could be applied in…" The most salient points were related to the proactive application of the HOF perspective and the development of work.

Although the HF Tool™ was not primarily developed for the purposes of developing work, maintenance employees found many parts of their work that, from a human factor perspective, should be improved. Optimally, the tool is not limited to only facilitating the development of work from a HOF perspective; it also acts as a way of examining the condition of work-related human factors when changes are made to work or working conditions, such as in the case of organizational changes.

The HF Tool™ can be used in risk and safety assessments prior to any large changes to equipment, systems or the organization. In some industries, the HF Tool™ has been integrated into digital risk assessment systems, which enables assessment of the impact of a change on the actions of individuals and teams, as well as on different characteristics of work, as part of proactive safety management. If a digital risk assessment process has not yet been deployed, the HF Tool™ can still be utilized separately for assessing the impact of changes, organizing ideas and identifying issues.

Individual work phases can also be examined by utilizing parts of the HF Tool™ to identify which things are already in order and which require further development.

5. IN CONCLUSION – CRITERIA FOR SUCCESSFUL DEVELOPMENT

THIS GUIDE DESCRIBES what is meant by human factors (including organizational factors), why their development is important, and how their mastery can be promoted in practice. The practical tools and examples from the ProHF research project show that fostering safety thinking requires a great deal of development work from different parts of an organization: strategic management, supervisory work and practical everyday work.

As such, improving the mastery of human factors is not a single development project; it requires a long-term commitment to continuous learning and joint development on the part of the organization. How do we know we are progressing on the development path? How do we know where we have succeeded and what requires further development?

To answer the above questions we must learn together through continuously following up and evaluating development. In practice, this means events and opportunities for people to discuss human factors, pose questions and provide new ideas. To evaluate successes and the areas that need development, we need the views and experiences of various parties. What has the development of human factors management concretely meant for your work? What has it affected and what has not been affected? Which matters do you think should be considered in the future?

A set of criteria for successful development in either a unit or the entire organization can be drawn up to help evaluate development and shared learning. The following list of elements central to human factors and their development, compiled from the literature, can be helpful (Teperi, 2020.)

MASTERY OF HUMAN FACTORS – CRITERIA FOR SUCCESSFUL DEVELOPMENT (TEPERI, 2020)

1. POSITIVE, SOLUTION-BASED VIEW OF HUMAN PERFORMANCE

According to modern safety thinking, the focus should not only be on mistakes and errors; it is also important to observe and communicate that, for the most part, work goes well because people are professionally competent, functionally able, and act in accordance with commonly agreed practices – they succeed in their work. Safety conversations should not focus too much on threats, risks or failures. Of course, when these do occur, they should be openly, directly and constructively processed. Highlighting success is important in safety work.

2. SYSTEMIC INTERACTION – FOCUSING ON INTERCONNECTED RELATIONS BETWEEN DIFFERENT PARTS OF THE SYSTEMS RATHER THAN INDIVIDUAL ISSUES

Being connected to many actors and complex changes is typical in modern work. Changes and developments in one part of the work system affect the work of many other actors. In fact, many issues that affect human factor mastery are on the level of the organization or its networks. Thus, these factors must be observed systemically.

3. CONCRETE PRACTICES, METHODS AND TOOLS FOR MASTERING HF IN REAL WORK

Mastery of HF cannot remain a strategic goal. It requires practical everyday procedures and applicable methods. This in turn requires actions and competence at different levels of the organization – not only in operative work but also in expert work, work and production planning, supervisory work, and management.

4. UNDERSTANDING HOW HUMAN PERFORMANCE VARIES AND PROVIDING SUPPORT IN DIFFERENT CONTEXTS

Mastery of HF means creating preconditions and opportunities for people to succeed in their work. However, the variability of human performance is a central part of human nature. Understanding this and taking it into consideration is important when planning work and designing the work environment. Sometimes, success and failure are very close to each other; a chance occurrence or good luck may prevent a situation from escalating.

5. MASTERY OF HF PLANNED AND LED BY A MULTIDISCIPLINARY GROUP

Human factors mastery should be led in a co-ordinated way. Its planning and development require multidisciplinary understanding of the factors that affect work from the perspective of different functions and professions. For this reason, the development group should have multidisciplinary competence: technical and psychological knowledge as well as competence in managing and developing the organization.

6. CO-OPERATION BETWEEN ACTORS WHEN IMPLEMENTING SAFETY

Whether or not HF has been mastered is tested and measured in everyday work. Safety targets provide a guideline, but the way in which to achieve them is constructed through co-operation between various parties. Effective co-operation, safety measures and communication are needed in order to achieve a common understanding of the overall situation.

7. HF POLICIES AND PRINCIPLES BASED ON RESEARCH EVIDENCE

A great deal of research evidence exists in the field of human and organizational factors. The organization and its experts should be aware of current developments and well-functioning evidence-based models backed by research that could be applied in their own organization. Significant changes should not be implemented on the basis of a hunch.

WHAT ARE SUCCESSFUL HOF ACTIVITIES?

The participants of the ProHF workshop (2020) compiled a list of criteria that describes successful HOF activities: issues that may be affected by development and how progress on the development path is visible in practice.

MINDSET, COMPETENCE
- commitment through communication – competence related to human and organizational factors is firmly established and understood
- application and utilization in everyday operations – how understanding the HOF perspective affects an individual's actions

METHODS, TOOLS
- creating operational methods based on the tools
- learning from deviations throughout the organization
- finding root causes

CONTINUITY
- continuous, systematic research and development of operations
- network of experts
- human and organizational factors integrated into workplace activities

SAFETY CULTURE
- improving safety culture, culture of no blame
- communications, such as management info sessions
- caring about your own safety and the safety of your colleagues

COMPREHENSIVE HOF
- part of the management system, description of the management of human and organizational factors
- taken into account in other management areas in addition to safety, utilized where applicable
- safety work and targets described, transparent safety activities

POSITIVITY
- a positive approach
- raising solutions and development ideas
- difficult matters are easier to digest

IMPACT ON WORK
- creating opportunities and preconditions
- making it concrete, e.g. clarifying the impact of changes to work
- maintaining and developing training

LEARNING
- communicating about investigations, disseminating information to the organization
- assessing investigations and learning from them
- HOF network experts, i.e. those already active in the field, learning from each other and utilizing their knowledge both within and outside their companies
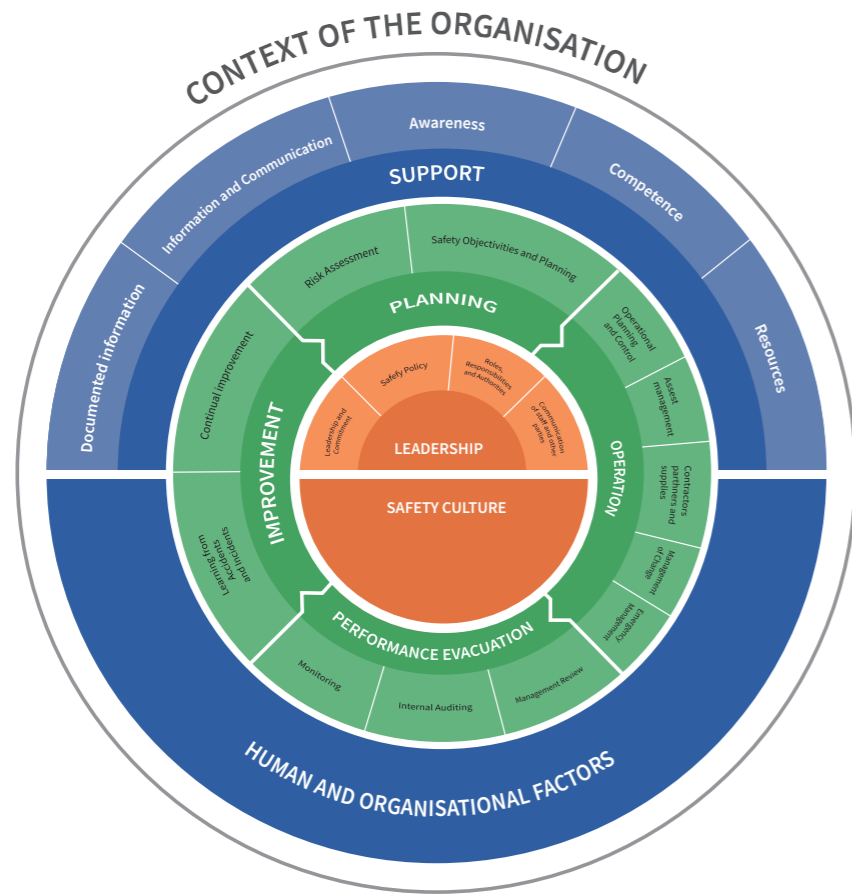
Appendix 1. European Union Agency for Railways' (ERA) elements of safety management, so-called safety management wheel.
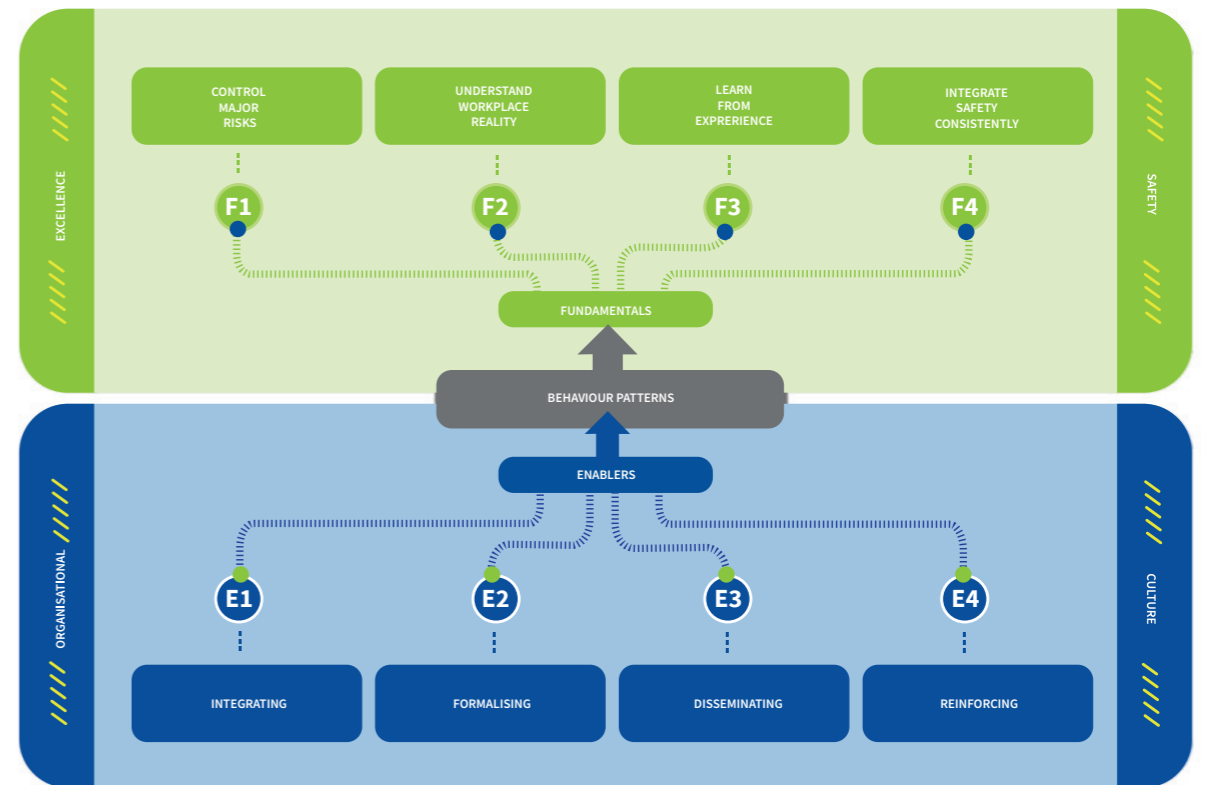
Appendix 2. European Union Agency for Railways' (ERA) safety culture model. Translated into Finnish by Kirsi Pajunen, Traficom.

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