Cross border railway operations: Improving safety at cultural interfaces

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KEYWORDS
Safety culture, railway, scenario analysis

ABSTRACT
Organizations with different cultures will be increasingly required to interface with each other as legislation is introduced to ensure the interoperability of railway systems across Europe. To approach the safety challenges related to interfaces between cultures, the International Union of Railways (UIC) initiated the project Safety Culture at Interfaces. The project covers the development of a method for assessing and trying to improve safety cultural interfaces. The project was performed by SINTEF. This paper presents the method, which is called SafeTrack. The project has piloted the method in three railway organisations with positive evaluations from the participants, identifying several issues that could improve safety at interfaces.

It is not possible to isolate safety culture at interfaces from the whole system such as environment, infrastructure, organization, individual and teamwork. Safety culture at interfaces is an integrated part of the "whole picture". Building safety culture at interfaces has been seen as a learning process that requires involvement and commitment between organisations. This is a difficult challenge. One of the first challenges is to motivate and get involvement from the relevant parties in the process. The next challenge is to develop real commitment from the organisations that is involved in railway traffic across borders to agree on common solutions. Our approach to these challenges has been to establish a quantitative method, consisting of questionnaires and exploration of scenarios where the involve parties feel confident of their knowledge and can be motivated to share experience. At the same time, we feel that involvement and participation from the workforce and management from the beginning of the learning loop will create ownership and commitment to the problems and their solutions. Participation will in addition ensure realistic and realisable solutions. An additional challenge is to get the suggested solutions implemented between the involved organisations across interfaces or borders. Our opinion is that the participation and collaboration during problem analysis and selection of agreed solutions would increase the probability of the implementation the solutions identified. The utilization of scenarios based on safety critical functions will facilitate the learning process in an operational way.

1. INTRODUCTION
As legislation is introduced to ensure the interoperability of railway systems across Europe [EU-96], the issue of safety at cultural interfaces has become a subject of considerable interest to the rail industry. It is recognised that different cultures exist in organisations that will be increasingly required to interface with each other. Cultural interfaces represent a potential source of safety problems, but also a potential for learning from other cultures. To approach this challenge proactively, UIC (*International Union of Railways*) initiated a project to develop a method to identify and improve safety problems that arise at cultural interfaces. SINTEF has been responsible for the method development and execution of the project.

The project included (1) a "state of the art" review on safety management at cultural interfaces, (2) the development of a method called SafeTrack for managing safety through the use of an assessment of the influence of culture on interactions at organisational interfaces and (3) pilot testing of the method in two European railway organisations. SafeTrack comprises (a) a questionnaire for exploration of safety culture at an organisational level, (b) an assessment of structural differences and (c) a scenario analysis where different cross border scenarios are explored.

The assessment of culture draws on a typology of organizational cultures which was proposed by Westrum (1993). This typology was later expanded in the "Hearts and Minds" program sponsored by Shell (Hudson and van der Graaf, 2002). The SafeTrack questionnaire is inspired by the "Hearts and Minds" program, but is developed to the needs of the railway sector through co-operation with several railway organisations.

The scenarios are real or hypothetical event sequences constructed to explore cultural differences or different ways to handle structural differences. The scenarios should be identified by the interfacing organisations, having caused incidents or accidents. An example scenario could be that track work is carried out near a border crossing, and trains from different countries are approaching. In order to explore the safety culture related to the scenario a group of people representing the various railway organisations, infrastructure managers, and the traffic controls are participating. The scenario analysis is based on the Sequential Timed Events Plotting Technique (STEP; Hendrick and Benner, 1987). STEP comprises a temporal plot of the event sequence leading to harm or possibility of harm and an evaluation of differences at interfaces.

The aim of SafeTrack is to assist the various railway organisations, infrastructure managers and other actors in identifying and solving safety problems that arise at cultural interfaces between organisations or across borders. Or experience suggests that the method also can help actors to exploit the opportunity to share best practices and thus improve operational safety.

This paper will present the method developed by SINTEF. In Section 2 we discuss our understanding of the term "safety culture" and of the nature of safety challenges found at cultural interfaces. In Section 3 we describe the SafeTrack method. Selected results

from pilot studies employing the proposed method are presented in Section 4. In Section 5 we discuss the potential and limitations of the proposed method, the preconditions for successful management of safety at interfaces, and the need for further work in this area. We also discuss the possibility of defining a best practice for safety management at cultural interfaces in railway operations.

2. SAFETY CULTURE AT INTERFACES

The following issues need to be explored in order to improve safety culture at interfaces:

- What is safety culture at interfaces, i.e. can we provide a useful working definition?
- How do we understand safety culture at interfaces, i.e. how do we scope and describe safety culture?
- How could we improve safety culture at interfaces?

2.1. What is safety culture at interfaces, i.e. can we provide a useful working definition?

"Safety culture" is a hot topic in safety work, but also one which creates confusion (Hale, 2000).[1] A representative definition is the one proposed the Health and Safety Executive (HSE, 1993):

> *"The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine commitment to, and the style and proficiency of, an organisation's health and safety management."*

However, this definition is too broad and too difficult to provide a clear focus for safety management at cultural interfaces. In this study, we focus on:

[1] It is outside the scope of this paper to review theory and research on safety culture. The reader is referred to the special edition of Safety Science on Safety Culture (Vol. 34, 2000), e.g. the review by Guldenmund (2000), and to Haukelid (2000). The special edition of Safety Science emphasises psychological approaches, whereas Haukelid writes from a social anthropology point of view.

"Characteristic interaction patterns when organisations interface each other, i.e. how people collaborate and communicate at interfaces."

This implies that we view culture as a property of collectives – e.g. groups, organisations or communities – rather than as an attribute of a single individual. Moreover, we emphasise action and interaction as symptoms of the underlying attitudes and values. This corresponds to the popular notion of organizational culture "the way we do things here". This focus is also approaches Argyris and Schön's (1978) notion of "theories-in-use" – i.e. the values and principles that are reflected in our actual actions, as opposed to the values and principles we claim to have ("espoused theory").

Our "scoping" of "safety culture" refers to interfaces between organisations. Figure 1 shows the most important stakeholders and interfaces based on interviews and discussion with the industry. The stakeholders are not subset of each others, but are separate entities, having different key interests across interfaces. The entities are organisations or persons. (The regulatory authorities are different across EU, as we have tried to illustrate by a separate entity.) The outlined boxes show the most important stakeholders according to our discussions with the railway industry.

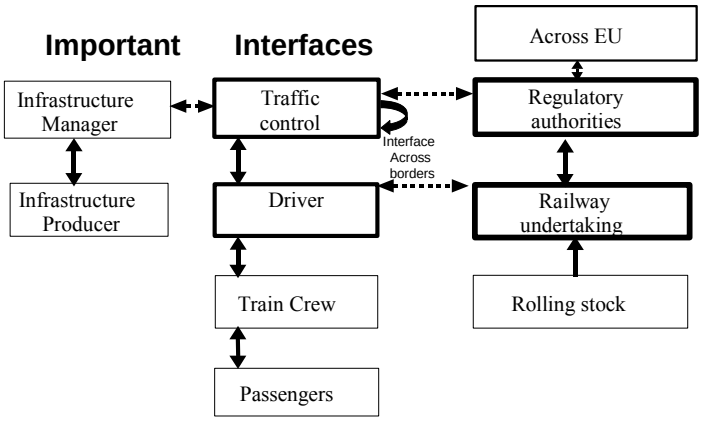

Figure 1 Important Interfaces and stakeholders

The deregulation in EU and the increased competition among railway companies imply that the primary interfaces to be analysed are (1) between train drivers and rail traffic control centres (signallers) across borders within EU and (2) interfaces between infrastructure operators and maintenance operators.

Our approach to the analysis of safety culture views it as characteristic patterns of interaction. At one extreme, we may study interaction among two or three persons in a specific situation. At the other extreme, we may identify characteristic interaction styles in a large organisation. We will now consider these two analysis levels in more detail.

2.2. How do we understand safety culture

In the present study we are considering safety culture closely related to an explicit qualitative risk model. This risk model is spanned by a set of relevant *scenarios*, and each scenario is influenced by a set of *safety critical functions*. "Safety critical functions" are defined as "functions of a system for which a malfunction would immediately increase the risk of injury, or damage to health". In more popular terms, we may think of safety critical functions implemented by tasks that are necessary to keep the risk at an acceptable level. These tasks may be carried out by hardware, software, humans, or any combination of these. Examples of safety critical functions are:

- Ensuring that a train does not enter a block section which is reserved for another train.
- Ensure the safety of passengers at stations.
- Ensure that rolling stock is maintained adequately.

Like all tasks, safety critical functions can be identified at different levels of detail. For instance, "ensure the safety of passengers at stations" can be broken down to subtasks (lower level safety critical functions) such as "notifying passengers about passing trains" and "minimising the need for passengers to cross tracks where trains can be expected".

Many tasks can be accomplished in more than one way, i.e. by performing different sets of subtasks. Similarly, somewhat different sets of safety critical functions may be used to accomplish the safety objectives of railway operations. For instance, under certain conditions trains may be allowed to enter a block section which is already occupied by another train, whereas this would be unacceptable under other conditions.

Safety culture can influence the safety critical functions in two ways. In the first place, a safety critical function may involve the interaction between persons

belonging to different organisational cultures. Safety culture, understood as typical patterns of interaction, thus enters directly into the implementation of the safety critical function. Secondly, safety culture may have an indirect impact on a safety critical function. For instance, "cultural barriers" may cause train drivers not to report on track deficiencies to the infrastructure owner, and thus delay correction of the problem. Correlation between safety culture (as morale and motivation) and accident/incident rate has been documented by Itoh, Andersen and Seiki (2003). Correlation between focus on safety culture and accident/incident rate has been documented by Hudson and van der Graaf, (2002).

The risk model and how it connects to the safety culture is further elaborated in Section 3.

When analysing safety culture we will need to be rather explicit about what safety culture is and we differentiate between two situations:

- Safety culture as a set of properties of an organisation that are unconditionally positive with respect to the safety level. (An example is a *reporting culture*.)
- Safety culture as a pattern of behaviour and commitment to reach an agreed safety standard, but it does not exist "a best practice" to reach the agreed safety standard. (An example is *problem solving.)*

When treating safety culture as a set of properties of an organisation, these properties could be seen as key elements of safety culture (See Reason 1997). In an international literature survey (Johnsen et al. 2003), we have identified some common key elements of importance related to safety culture at interfaces, ref Table-1. These elements have been used as building blocks in our method.
The key elements of safety culture from literature were discussed and elaborated related to interfaces in our workshops and in the pilot studies. The participants discussed the key elements and documented the most important issues related to interfaces related to the railway industry.

Table 1 Key elements of safety culture from literature related to safety culture at interfaces

Key elements of Safety culture	***Key elements of Safety culture related to interfaces***

Key elements of Safety culture	*Key elements of Safety culture related to interfaces*
Management involvement and commitment	Management involvement and commitment at interfaces regarding safety: Identifying who is involved, establishing clear responsibility, common communication and common understanding across interfaces.
Shared commitment and level of care for hazards	Shared commitment across interfaces. Commitment may reach outside the border of the company, to other companies or suppliers, when safety is at stake.
Flexible rules and regulations to reduce risk	Systematic evaluation and adjustment of rules and regulations to reduce risk at interfaces. (Flexibility in adjusting the rules when needed across interfaces.)
Focus on shared organisational learning	Focus on shared learning from participants across border: reporting of relevant incidents, open discussion with participants across border, good co-opting processes. (Meaning co-operation between management and workforce across the different organisations into a meeting arena where ideas and experience can be exchanged and actions can be agreed upon.)
Reporting culture	A reporting culture, also considering incidents across border or at interfaces. Reporting of specific operational safety problems that may occur at cultural interfaces. Obligation to report any condition that could imply a risk for other companies. (These matters must not be kept secret.)
A just culture	A just culture between interfaces.(The organisation itself must also has a just culture). Suppliers doing out-sourced work is not being punished when incidents are reported or error committed. Competition across interfaces is not unjustly blamed.
Industry wide co-operation and information sharing	Focus on industry wide learning including participants across border and new entrants to the industry, regarding safety. Establishing common competencies across interfaces.
Legislative Co-operation	Co-operation and information sharing between legislative authorities across border. Focus on legislative wide learning from participants across border.

Regarding problem solving it could be difficult to treat safety culture as a property, e.g. there is "no best way" of solving problems. A study of cultural differences across nations looks upon culture as a collective phenomenon which could influence decision-making and (in our case) safety (Hofstede, 1991). For example the management style and the mechanisms to resolve problems have been shown to differ between different national cultures, the "right" and natural solution in one culture was not seen as the preferred solution in another culture. As an example Hofstede refers to a conflict between two department heads within a company. This case was presented to students from France, England and Germany who recommended a preferred ("correct") solution to the conflict. The suggested "correct" solution differed between each country as described:

- The French solution was for the opponents to take the issue to their common boss, who would issue orders for settling such dilemmas in the future
- The German solution was to establish specific procedures or routines to be used
- The British solution was to recommend a management course to the opponents to improve their interpersonal skills

In this situation it is apparent that the different cultures could not be classified as "good" or "bad" with respect to safety, it is different way of doing things. This fact is of vital importance when aiming at improving safety culture and resolving conflicts related to different cultures. Our message is to document culture and scenarios in such a way that we can foster discussions and increase understanding cross interfaces and cultures. If a "best practice" is found – this could improve safety, however it is important to accept the differences as a starting point.

The scenario approach based on the STEP method has been shown to be an important technique to increase understanding cross interfaces, and help us identify "best practice". This has been shown in our workshops and Pilots.

2.3. *How could we improve safety culture at interfaces?*

We view culture as a property of collectives – e.g. groups, organisations or communities – rather than as an attribute of a single individual – and to be able to improve safety culture, we must gather the relevant people in a group setting to identify and improve the relevant safety issues. We must establish some sort of organisational learning between the organisations meeting at interfaces.

We have identified that there is some "culture confusion" – the concept of safety culture is challenging. In order to have a useful and relevant discussion of safety culture in a group setting - we must select some "key issues of safety culture at interfaces". To ensure understanding of safety culture and ensure commitment to improve safety we are trying to establish examples of "good" and "bad" safety culture. "Good" safety culture which are conducive or supportive to safe operation and "bad" safety culture which may increase the likelihood of unsafe acts or practices.

To be able to explore relevant incidents related to safety culture at interfaces, the discussion of relevant scenarios is a key enabler. A group discussion with participants cross interfaces are going to expose differences in safety culture "in use".

Based on the preceding discussion and material, our opinion is that to be able to improve safety culture at interfaces, we must establish a methodology based on:

- The concept of organisational learning, to ensure that the safety culture is improved in a group setting
- Examples of "good" and "bad" safety culture to ensure understanding of safety culture and commitment to improve safety
- Scenario approach

Organisational learning

In the literature different concepts for organisational learning and development are found, and in this study we have based our approach on Agyris and Schön (1978), to be able to improve safety culture at interfaces.

Organisational learning could work at many levels; at the operational level we have the specific railway organisations, and their subcultures, and how they interact with other railway organisations and actors in railway operation.
On a regulatory level we have the European Commission responsible for the Safety Directive. In addition UIC is an important actor related to common recommendations and best practice across the railway industry.

Improvement and learning should take place at all levels where organisations interface each other. Therefore our approach has been designed to:

- create a common ground across the "top level" such as UIC to improve communication and understanding
- get involvement and commitment from the local railway organisation both management and the workforce must participate to ensure the possibility of organisational improvement and change.

Examples of good and bad safety culture to improve communication and understanding

The notion of safety culture and improvement of safety culture has been seen as a complex issue by the participants from the different railway organisations. Based on table-1, interviews, workshops and pilot studies we have identified and later verified 21 key questions to assess the most important aspects of safety culture at interfaces. To improve understanding and identify possible improvements of safety culture, we have exemplified what is considered "denial based" safety culture, "rule based" safety culture and "best practice" for each question. The framework for this work has been Westrum (1993) and Hudson (2002). Westrum established a framework to be used to assess culture and Hudson has refined and based his work on the work of Westrum. We have been inspired by Hudson.
The examples in each question have been developed, tested and verified trough extensive interviews and pilot studies. The work in the pilot studies has so far verified the questions and what has been considered "best practice". See Johnsen &al. (2004) for a documentation of these "best practices".

In the method, the participants start with filling out and discussing the questionnaire, identifying differences and challenges in safety culture. The questionnaire contains examples of what is considered "bad" safety culture e.g. "denial based" safety culture and "best practice" safety culture. This is establishing a common perception of what is considered "bad" and "best" safety culture among the participants. This has been found very useful in setting the scene for the scenario-approach, by establishing common "mental models" and improving communication among the participants.

Scenario-approach to ensure communication, involvement and commitment

A "scenario-based" approach has been chosen to ensure good communication and involvement from the stakeholders. The workshop and pilot studies did show that the scenario approach using the STEP technique improved communication and understanding and at the same time ensured active participation and commitment. The scenarios should be analysed by an experienced team of management and operating personnel. Suggested participation is from traffic control, train drivers, maintenance and railway management across interfaces– to ensure that the participating organisations as a whole can learn and develop.
To ensure an approach focusing on relevant scenarios, we are using the experience of the participants based on incidents/near misses and a generic list of scenarios.

Experience show that participants feel more comfortable analysing a scenario where they are knowledgeable (Kjellén, 2000).

The involvement of the different stakeholders as work force and management is important if change shall take place. The stakeholders should be able to change routines, competencies, management directives or even influence laws or regulations.

In our concept *the analysis of scenarios and safety culture* could not be treated independent of the arena of *organisational learning* and vice versa. Therefore these elements are integrated in "one method" and will be outlined explicitly in Section 3. Proposed Method.

3. PROPOSED METHOD – Called "The track to safety"

Based on the preceding discussion, it seems that a method to identify and improve safety culture at interfaces must consist of the following parts:

- Establish a **common ground to succeed** across the interfaces between different railway organisations in Europe, including common goals, visions and methods as suggested in SafeTrack. Assure commitment and a sense of urgency related to safety culture at interfaces. (If there is no sense of urgency – complacency could set in and the issue of safety culture could be ignored.)
- Establish a **method to foster organisational learning** based on management commitment and work force participation. This process must be robust enough to be used in different national cultures. The method should benefit from organisational learning, and take place in an arena where the important stakeholders can participate. The method should exemplify "good" and "bad" safety culture, and exploit a scenario approach.

An approach to succeed cross border

To succeed cross border, the railway industry should prioritise the challenges related to safety culture at interfaces. Each organisation must be involved in identifying risks and prioritisation of actions. An important element is the co-operation between management and workforce in a meeting arena across different organisations where ideas and experience can be exchanged. This arena could be the source to share best practice and improve operational safety and could aid in establishing a continuous learning and improvement process.

The participants should consist of stakeholders in accordance with the scenarios to be elaborated, as described in Figure 1, for instance:

- Traffic controller from each interface (from each country)
- Driver from each interface (from each country)
- Maintenance personnel (where relevant, not necessary in the proximity)
- Management from Railway organisations and infrastructure
- Facilitator and scriber/secretary

The suggested approach includes the following steps: (described in figure 2).

1. *Develop a common ground.* Get management commitment to accept the necessary analyses and possible changes, establish common goals, and establish learning arena. Involve workforce, management and regulation authorities (if possible). Build common ground across the industry.
2. Assessment of Safety Culture via a Questionnaire to identify challenges at interfaces
3. Describe relevant scenarios based on safety critical functions and perform Scenario analysis – identify differences and safety challenges at interfaces
4. *Identify actions* and adjust based on good co-opting processes. (a co-opting process is used to describe a decision process involving both management and work-force where the issues are discussed freely prior to a decision.)

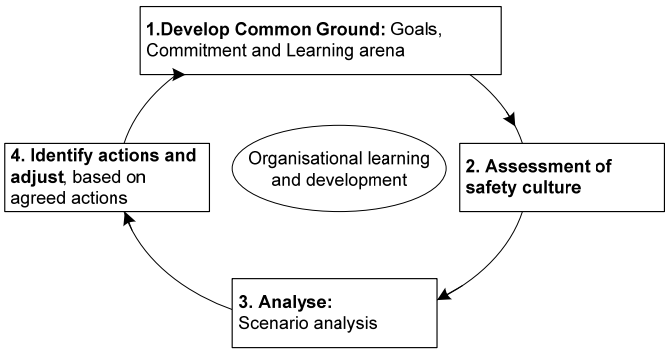

Figure 2 Suggested approach to foster organisational learning

The approach is used both proactively and reactively. For example to aid in:

- Establishing good routines when a Railway organisation is going to establish a new international connection, (has all risks been identified and addressed?)

- Assessment of safety culture across organisational interfaces when a new interface is added, such as after organisational changes or outsourcing activity
- Identifying root causes of incidents and accidents

The steps 1 to 4 in figure 2 are further described below.

3.1 Develop a common ground (Step-1)

Before the method is used, it is important to create a "sense of urgency", identifying the "problems to be solved" and a commitment from the relevant stakeholders in the Railway organisations. If there is no sense of urgency – complacency could set in and the issue of safety culture could be ignored. The best way to create a "sense of urgency" is to identify the problems and challenges related to safety culture at interfaces.

The management must be committed to the analyses and the possibilities of change, and agree to perform the necessary workshops. The "common ground" as described in the UIC method must be accepted. To sustain the learning environment, the elements of the method should be continuously improved based on experience and best practice from the users and discussions within cross border authorities as UIC and EU.

3.2 Assessment and development of Safety Culture (Step-2)

The assessment of safety culture should be carried out by using the questionnaire consisting of 21 questions. For each question there are three described alternatives to be used representing differences in culture. The three described "cultural" levels are:

- Denial culture (Level 1)
- Rule based culture (Level 3)
- Proactive /Generative culture (Seen as "Best practice" – Level 5)

This assessment should be done in two steps. First the individual participants will complete the questionnaire on their own, and then subsequently in the work-group. The idea is to evaluate the organisation at each question, and then place it within one of the safety culture levels in the range from 1 to 5.

The participants should identify areas where the safety culture could be improved. Reasons to improve the culture are a cultural level too far from "best practice" or

because the differences in "cultural levels" between the actors meeting at interfaces are significant and could lead to misunderstanding or even an incident/accident.

The aim of the questionnaire is to help the organisations to identify and manage the differences between safety cultures at interfaces between rail companies. In the process of developing *The Track to Safety Culture* we have based our approach on responses and "best practice" from the Railway Industry. (We have been inspired by the structure and positive experiences from Shell's *Hearts & Minds* program. Shell has used the program for several years with excellent results, ref Hudson (2002).)

The structure and layout of the questionnaire is illustrated in Figure: 2.1.

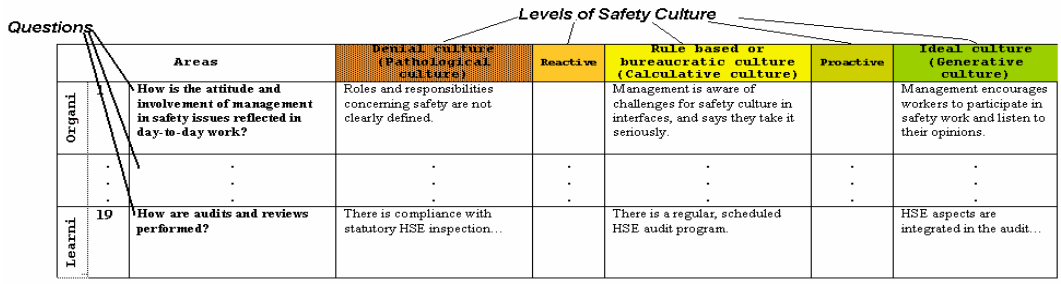

Figure 2.1 The Track to Safety Culture Questionnaire

The questions to be elaborated are documented in Appendix B.
Examples of one question, number 19, and descriptions of the three major "cultural levels" are: **Question 19. How is experience feedback used in the organisation?**
The suggested descriptions and examples of the three major "cultural levels" to be chosen by the participants are:

- **Denial culture (Level 1):** Many accidents are not reported. A database of serious accident reports exists but it is incomplete and not considered being useful. The system does not have open access and SHE personnel fill out reports.

- **Rule based culture (Level 3):** There is a database with detailed descriptions of near accidents and accidents, which is used internally. Efforts are made to use it actively, but it is not yet fully established as a useful tool.

- **Proactive /Generative culture (Seen as "Best practice" – Level 5):** The company's own and other companies' experiences are actively used to continuously improve our own safety performance as well as the industry as a

whole. Interfaces are seen as an important learning arena. Simulators are used as a training tool to gain experiences cross interfaces and create understanding.

3.3 Describe and analyse relevant scenarios (Step-3)

Description of relevant Scenarios

The scenarios should represent significant areas of concern for the stakeholders, and be based on:

i. Near misses
ii. a generic list of scenarios that has been developed by the project in co-operation with the industry
iii. a brain storming process at the start of the meeting

Experience from a Norwegian study (Tinmannsvik and Rosness, 2004) indicates that scenarios derived from near misses can give a good generic coverage. It is, however, important to update the scenarios to cover new technology, changing regulations and new operational experience.

The scenarios should be illustrated by a STEP-diagram (Hendrick and Benner, 1987), see Figure 4 for an example.

Identification of Safety Critical Functions

To analyse a scenario we have introduced the concept of Safety Critical Functions (SCF). The SCFs could be viewed as "basic events" in a Fault Tree Analysis (FTA), or "barriers" in an Event Tree Analysis (ETA). Combining SCF analysis with STEP-analysis has proved fruitful both with respect of getting a good understanding of the scenario being analysed, but also to ensure user commitment. An example is given in Figure 4 in relation to the Safety Critical Function:

> "Ensuring that a train does not enter a section that is occupied of another train"

A complete set of safety critical functions would be of value when conducting a scenario analysis. So far we have categorised the safety critical functions into 7 areas:

1	SCFs related to normal operation
2	SCFs related to ordinary traffic disturbances

3	SCFs related to technical failures in signalling /Central Train Control (CTC)
4	SCFs related to degenerated infrastructure
5	SCFs related to work on the track
6	SCFs related to deficiency on rolling stock
7	SCFs related to cross border activity

Each area is divided in several primary safety critical functions, and these are listed in Appendix A.

We will give an example to illustrate our method. Two trains are on a collision course because of misunderstandings related to where the trains are crossing (Ref Figure 3.).

Maintenance is carried out in a track 1 near a border crossing. Train B is instructed from rail traffic controller in country B to cross to track 2 from station 2 towards station 1. The rail traffic controller in country B, informs the train traffic controller in country A correctly about the crossing.

However the train traffic controller in country A understands that train B is going to cross to track 2 from station 3 towards station 2. The train traffic control in country A allows train A to continue on track 2, from station 1 to station2. This leads to an incident where train A collides with train B on the track between station 1 and 2.

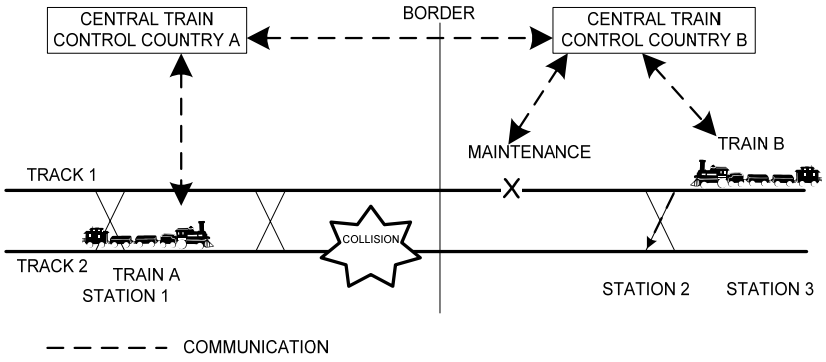

Figure 3 Interactions in cross border Rail-Traffic (Simplified example)

This accident is illustrated in a STEP diagram, as illustrated in Figure 4. The time-line is along the x-axis and the different actors or stakeholders are listed along the y-axis Each box illustrates an action by one of the actors. The critical actions is illustrated by a Safety Critical Function, in this example the SCF is “Ensuring that a train does not enter a section that is occupied by another train”

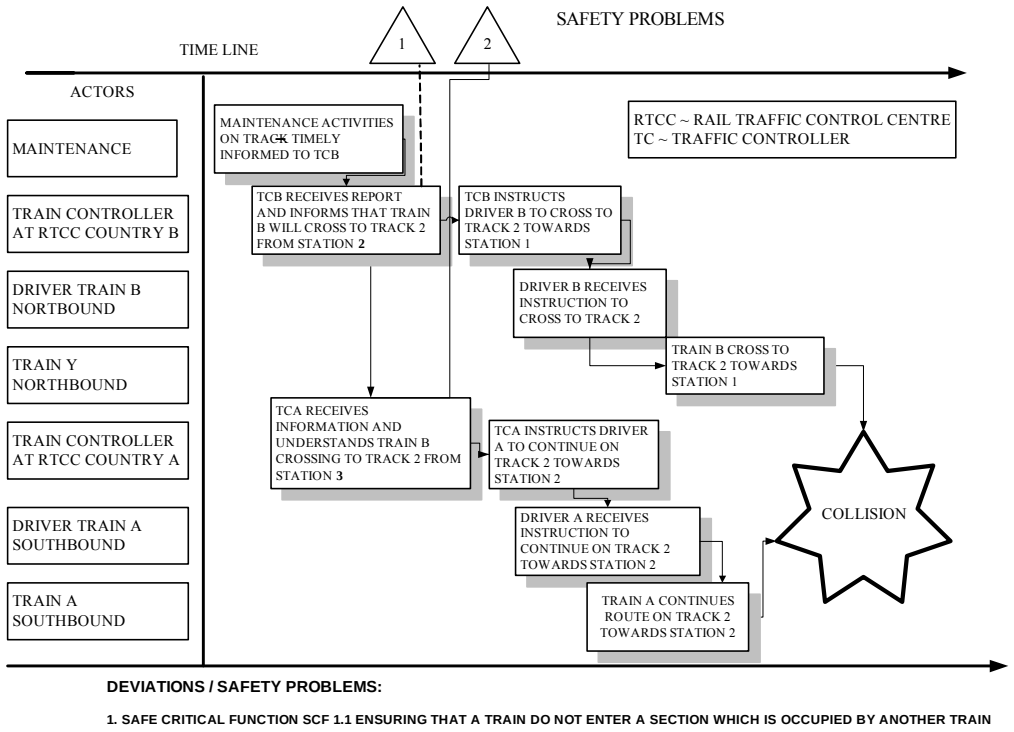

Figure 4 STEP diagram of collision between two trains

Perform Scenario analysis

To identify the major safety challenges at interfaces we analyse the safety critical functions that have been identified in the preceding scenario analysis.

The analysis is based on identifying the differences across interfaces. Known differences have been named “direct influencing factors”. Examples of these influencing factors could be environmental factors such as Language (different languages), Climate (such as more ice on track) and Nature (such as more steep hills). For each of these differences we analyse the safety challenges related to collaboration and communication at interfaces.

We have divided the influencing factors into indirect and direct (tangible) influencing factors. The direct influencing factors are documented in Table-2, and have been developed based on work done by Helmreich (1998).

The indirect influencing factors such as “National Culture”, “Organisational Culture” and “Professional Culture” works through the direct influencing factors and is accommodated trough the analysis of the direct influencing factors in the group setting, trough the safety culture questionnaire and trough the scenario analysis.

Table 2 Direct Influencing factors (Based on Helmreich (1998)):

Direct Influencing factors	**Description and examples of relevant influencing factors**
Environment	Public opinion, Climate/Nature, Legislation, Authorities, Language, Regulations,
Infrastructure & rolling stock	Tracks, Signalling systems, Communication equipment, Rolling stock, Human machine interface
Organisation	Structure, Goals, Strategies, Management, Co-operation across borders,
Safety culture at interfaces	Management involvement, Shared commitment, Focus on organisational learning, Reporting culture, A just culture, Industry wide co-operation, Legislative Co-operation
Routines	Work descriptions, Contingency and emergency plans
Individual and Team	Motivation, Risk perception, Identity, Competence, Communication

All the relevant influencing factors are listed and explored in Table-3, and are being used to identify the major differences and major challenges.

By analysing the safety critical functions, example "Ensuring that a train does not enter a section that is occupied of another train", we could identify major differences and safety challenges related to collaboration and communication at interfaces as suggested in Table 3. (In the method SafeTrack a complete Table-3 based on the relevant influencing factors from Table-2 has been made to aid in identifying the safety challenges).

Table 3 Analysis – identifying Safety Challenges

Relevant Influencing factor	**Major Differences**	**Safety Challenges**
Environment – Language	Different Language being used	Misunderstanding between Traffic control
Infrastructure – Communication equipment	Different systems being used, different frequencies	Important messages could be delayed in a contingency

For each influencing factor the safety challenges must be identified. To ensure user involvement it could be important to discuss the challenges based on a visual diagram such as the STEP-diagram, as illustrated in Figure 4.

A graphical illustration of the steps is given in Figure 5.

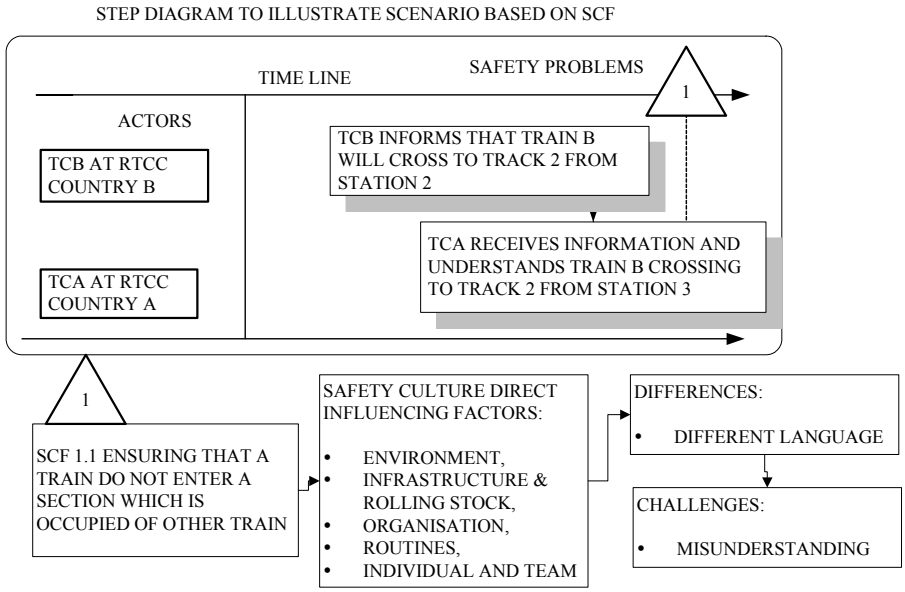

Figure 5 The steps in the method - from a SCF to the Challenges

3.4 Identify actions and adjust based on good co-opting processes (Step-4).

The adjustment of the governing variables must be done in a way that ensures that safety is improved at interfaces. Adjustments and changes must be done in co-operation across interfaces and both management and the work-force must support the changes. Each adjustment must be discussed in a "co-opting" process with employees and management from the two countries (organisations) present. The "co-opting" process and the actions are equally important.

Actions could be implemented by management, by employees and could consist of changes of routines, training, organisation or other actions, as suggested in Table 4.

Table 4: Actions based on challenges (example).

Major Differences	**Safety Challenges**	**Actions (agreed between participants)**
Different Language being used	Misunderstanding between Traffic control	1. Common Language training of Traffic Control Centre (TC) and Train Driver(TD) 2. Formal communication template, common set of phrases being used across interfaces. 3. Repetition of key information between TC and TD to ensure common understanding. 4. Long term: Common language established in all communication (as in aviation)

4. RESULTS

SafeTrack has been developed via research, interviews, workshops and pilot testing. The workshops took place at:

- UIC in Paris in September 2003, involving ZSR, Railway Safety, NMBS/ SNCB, Jernbaneverket(JBV), UIC/SNCF and MAV
- SINTEF in Trondheim in October 2003, involving the Norwegian organisationsConnex, BaneService, NSB, JBV, FlyToget, Cargonet and Lokomotivmandforbundet (Union of Train Drivers)

The pilot testing of SafeTrack took place at:

- MÁV/Hungary in Budapest, conducting a Pilot in February - 2004.
- BV/Sweden in Stockholm conducting a Pilot in February – 2004.
- EUROSTAR in London conducting a "mini-pilot" in April - 2004, discussing their experience related to interface issues

The use of the method has proven not too resource demanding. The effort needed in a SafeTrack analysis is around 3 to 4 day's effort from the involved organisation. The main activities are listed in Table 5.:

Table 5: Activities and effort in SafeTrack analysis.

Effort	**Activities**
½-1 Day	Preparation and Organisation –Identify relevant scenarios and identify people to attend the workshop, fill out questionnaire in advance.
2 Day Workshop	Assessment and reflection of Safety Culture cross interfaces. Scenario analysis and reflection performed by an experienced team. Actions – as agreed in team-work.
½-1 Day	Follow up of agreed actions, to insure that action is taking place by the proper responsible person.

The pilot studies were considered a success by the participants. The pilot studies and work-shop demonstrated the strength of the tools used in the finished method. The scenario analysis based on the STEP technique was shown to be very powerful communication tools cross borders. Participants from different countries could understand a scenario very quickly and discuss relevant problems and actions.

4.1 Results from BanVerket(BV) in Sweden

We performed a SafeTrack pilot study together with the Swedish infrastructure manager, BV. The participants were from infrastructure manager, train control and infrastructure producer/maintenance operator.

The pilot study resulted in identification of challenges and actions for safety culture in the interface between infrastructure manager, train control and infrastructure producer, described later in this section.

In Sweden the accident rates have been steadily decreasing with an annual decrease of 3.6 per cent (Bäckmann, 2002) in the last 40 years The Swedish deregulation has resulted in a flourishing operator market and better services, as for instance lower freight consignment prices (Nilsson, 2003).

Challenges and actions related to the challenges were agreed upon in the group setting and responsibilities for the actions were assigned, as described in Table 6.

Table 6: Examples of challenges and actions at BV.

Challenges	Actions
Common safety strategies should be established to improve collaboration and communication	Try to establish common strategies related to safety.
Communication should be improved,	Visits to each other work sites, to improve communication and understanding of tasks. Upgrading and simplification of forms should be done cross the industry
Common Responsibility	Visits to each other work sites, to understand roles and responsibility
Common Competency	Skills upgrading, educator gatherings

4.2 Suggested best practice

During the work-shops and pilot studies some "best practice" from BV, MAV and EuroStar were suggested. It is an open question if it is possible to identify best practice, but as a starting point we have combined and incorporated what has been named "best practice" in our method. Some of the key elements suggested from the Railway Organisations were:

1. "Grey areas" of responsibility should not be tolerated. It is essential in services to have a perfect clarity in tasks definition and responsibilities cross interfaces.

2. Obligation to report any condition that could imply a risk for other companies. As far as business is concerned, it is important that all parties share their databases regarding safety events and the resulting recommendations.

3. The use of protocols or formalised communication templates is essential when communicating cross interfaces. Pre-determined protocols and forms reduce difficulties in understanding.

4. Harmonisation of procedures by project teams cross organisational boundaries. Experience show that groups consisting of representatives from each of the companies (or countries) involved in operations should be established, these groups should meet face to face, to establish common procedures and create confidence and common understanding.

5. Common rules and procedures. Decide on one set of rules and change this as little as possible. An important aspect of this issue is to ensure that not only the basic rules are the same, but also the common understanding of the rules.

6. Intensive standardised training for operators, focusing on communication and handling of deviations. A clearly defined specification and procedure for training is required at the start and as ongoing activity of competence. It is especially important to establish common "mental models" and understanding that can be shared among the operators. Good experience has been obtained by the use of simulator. In a simulator - scenarios including deviations from normal operations can be tested, and participants from the other side of the interface can be included.

7. It would be helpful for both parties to agree on a similar model for identifying and managing risks and the resources to control risks. Some of the most difficult issues to resolve stem from differences in the conceptualisation of risk management.

8. Both interfacing organisations will benefit from the ability to admit that they are different without inferring value or preference. One partner's solution is not necessary the only right solution, even though it may seem like the only

rational solution, but a better suggestion is to share experiences to provide an opportunity to learn from each other.

5. DISCUSSION AND CONCLUSION

It is not possible to isolate safety culture at interfaces from the whole system such as environment, infrastructure, organization, individual and teamwork. Safety culture at interfaces is an integrated part of the "whole picture". Building safety culture at interfaces has been seen as a learning process that requires involvement and commitment between organisations. This is a difficult challenge.

One of the first challenges is to motivate and get involvement from the relevant parties in the process. The next challenge is to develop real commitment from the organisations that is involved in railway traffic across borders to agree on common solutions.

Our approach to these challenges has been to establish a quantitative method, consisting of questionnaires and exploration of scenarios where the involve parties feel confident of their knowledge and can be motivated to share experience. At the same time, we feel that involvement and participation from the workforce and management from the beginning of the learning loop will create ownership and commitment to the problems and their solutions. Participation will in addition ensure realistic and realisable solutions.

An additional challenge is to get the suggested solutions implemented between the involved organisations across interfaces or borders. Our opinion is that the participation and collaboration during problem analysis and selection of agreed solutions would increase the probability of the implementation the solutions identified. The utilization of scenarios based on safety critical functions will facilitate the learning process in an operational way.

We would like to point out that the method does not seek to solve all problems but to improve safety culture at interfaces.

It would be a mistake to assume that safety culture is improved once root causes and corrective actions have been identified. It is required to implement the chosen solution and to evaluate that the solution has the anticipated effect. Continuous learning is important to complete the learning loop process as shown on Figure 2.

Safety culture should be regarded as a common interest within the railway industry. Competing railway organisations must learn from each other. Safety culture at interfaces should not be seen as a way to compete at interfaces, open exchange of experience and best practice must take place between the competing firms.

This is our first version of a method to identify problems attached to safety culture at interfaces. The method is based on the combination of existing tools, approaches and some new developments to get a method that is appropriate in the railway environment. The methodology has been developed in Norway, and has a "Norwegian" cultural bias, however the method has been used in other different cultures such as in Sweden, Hungary and England with the same positive experiences.

The method has been built on tools and techniques that has been verified and validated in other industries. However the validity and reliability of the instruments in the European Railway Industry must be explored further by more research. The focus of our future research is to do this and we are interested in partners to improve our methods. We invite the railway industry to join us to validate and improve the method to reduce the probability of safety issues at interfaces.

6. ACKNOWLEDGEMENTS

This research has in part been funded by the UIC Safety Culture at Interfaces project awarded by UIC to SINTEF. We would like to thank to Mr. Bill Gall, Mr. Teodor Grădinariu and the project team at UIC for their valued support.

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APPENDIX A: Safety Critical Functions in Railway

Main categories of safety critical functions are described.

SCF-1: SCFs related to normal operation

The situation is that all technical systems are functioning sufficiently. The infrastructure is also without any (apparent) deficiency, and the trains are within their schedules. We will assume that the line is either single or double track, and that the line is equipped with a complete signalling system. Six primary safety critical functions are evident in this situation:

- 1.1 Ensuring that a train do not enter a section which is occupied of another train.
- 1.2 Identify and take proper action if a train enters a section which is occupied, or reserved for another train.
- 1.3 Identify any "system" change that takes the system to a degenerated operation mode
- 1.4 Ensure the safety of passengers at stations
- 1.5 Safe operation of level crossings
- 1.6 Avoid excessive speed

SCF-2: SCFs related to ordinary traffic disturbances

The situation is similar to section 0. The situation now is that trains are delayed, cancelled etc. Hence it is required to change the scheduled crossings. A new SCF is thus:

- 2.1 Safe change of crossing

Note that change of crossing is usually not a problem. However, on lines without a complete signalling system (controlled by train messages) the change of crossings is important. For example on train message (single track) lines in Norway, the locomotive driver shall verify that the passing train has arrived before he enters the next block, even if the train dispatcher has indicated "green". Thus, when the scheduled crossing is changed, the procedure need to be altered as well.

SCF-3: SCFs related to technical failures in signalling system/Central Train Control (CTC) system

Relevant SCFs in these situations are:

- 3.1 Diagnose system in order to reveal which functions are trustful in the new degenerated state.

- 3.2 Allow trains to enter sections that could not be confirmed free from other trains
- 3.3 Issue relevant traffic circular when e.g. level crossing is defect
- 3.4 For rolling stock; comply with orders given by traffic circular, radio messages etc.

SCF-4: SCFs related to degenerated infrastructure

When the infrastructure is degenerated, or threatened by extreme weather conditions it would be necessary to imply traffic restrictions. Further repair or maintenance activities must be conducted. Relevant SCFs in this situation are:

- 4.1 Issue relevant traffic circular (speed restrictions, signal out of order due to maintenance etc)
- 4.2 Comply with instructions in traffic circular

SCF-5: SCFs related to work on the track

When maintenance is conducted on the track, special safety arrangements are necessary. The most important SCFs are:

- 5.1 Issue relevant traffic circular
- 5.2 Comply with instructions in traffic circular
- 5.3 Put up signpost with reduced speed information
- 5.4 Install track coils with reduced speed signature
- 5.5 Comply with traffic circulars, signposts etc
- 5.6 Timely and accurate notification and dissemination of information in contingency situations

SCF-6: SCFs related to deficiency on rolling stock

When there are problems with the rolling stock, it is important that this is detected, and relevant actors are being informed. Relevant SCFs are:

- 6.1 Detect deficiency (by train crew, or by infrastructure systems like hot-boxes, stroke detectors)
- 6.2 Timely and accurate notification and dissemination of information in contingency situations

- 6.3 Take appropriate action (e.g. stop the train when necessary, and take the train to the nearest station with speed restrictions)
- 6.4 Fetching defect train
- 6.5 Emergency preparedness in case of accidents

SCF-7: SCFs related to cross boarder activity

- 7.1 Ensuring that rolling stock is compatible for cross border traffic
- 7.2 Ensuring that rolling stock is maintained adequately
- 7.3 Ensuring that train crew is qualified and trained for cross border traffic
- 7.4 Ensuring that technical systems are reset/configured when passing the boarder
- 7.5 Ensuring that dangerous freight is handled properly in relation to cross border traffic

APPENDIX B: The Track to Safety Culture Questionnaire

The questions in the track to safety culture are:

1. How is the attitude and involvement of management in safety issues reflected in day-to-day work?
2. Who causes accidents in the eyes of management?
3. How is safety prioritised when it competes with other concerns in the organisation, like profitability and punctuality?
4. How precise and transparent are the contracts between operators and contractors?
5. Is management interested in communicating safety issues related to interfaces with the workforce?
6. How do the organisations adapt to new interfaces and co-operation across borders?
7. How are rules and regulations used at interfaces?
8. How is emergency situations planned for at interfaces?
9. How is Benchmarking, trends and statistics used at interfaces?
10. How do individual attitudes towards competing organisations affect safety work at interfaces?
11. Do management and labour unions co-operate and work towards the same safety goals?

12. Is there willingness to co-operate with stakeholders across national borders?
13. Have arrangements been made to co-operate at interfaces?
14. How do the company co-operate with authorities?
15. What is the attitude in the organisation towards standardisation across borders?
16. :How is company structure adapted to manage cultural differences? Evaluate this question for how this is handled:
    a. within an organisation and
    b. between organisations.
17. How are skills upgrading and competency training ensured in the organisation?
18. How are incident and accident reporting, investigation and analysis performed? Evaluate how this is done both at:
    c. Domestic and
    d. International level.
19. How is experience feedback used in the organisation?
20. How is commitment to procedures and rules in the organisation?
21. How are audits and reviews performed?
22. *Your input or suggestions: "What issues are missing and should be discussed?"*