A Model for the Development of Railway Trainers in Integrating Non-Technical Skills into Training and Assessment: An International Case Study of Train Driver Trainer Skills Development

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Abstract

Non-Technical Skills (NTS) are thinking skills underpinning technical tasks. A three-phased approach was used to develop operational trainers in integrating NTS into training content. The aim of the project was to get the trainer group to a level where they could independently develop NTS training materials. In between sessions, trainers experimented with ideas and developed NTS simulator scenarios for train drivers and operational managers. The project has achieved the objective of creating a small group within Nederlandse Spoorwegen (NS) who are able to develop and deliver NTS training materials. The approach is now being 'rolled-out' in the UK to a range of railway operators and engineering maintenance organisations.

1 Introduction

1.1 Non-Technical Skills

Non-Technical Skills (NTS) are the 'cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient task performance and occupational health and safety' [1]. Research has consistently shown NTS failure to be a major contributory cause of accidents and incidents. By developing NTS, railway staff in safety-critical roles can become more effective in dealing safely with a range of situations, including those that are more unusual (adaptive expertise). "As a critical determinant of safety in high-risk industries, poor non-technical skill performance should be reasonable enough for an individual to be deemed not competent" [2].

To date, much of the application of NTS within the rail industry has been in the train driving community, although NTS are now beginning to cascade into other disciplines, such as engineering maintenance, incident management, control room operation and platform dispatch. In addition, links are beginning to be made between NTS and other risk reduction concepts, such as Dynamic Risk Assessment [3].

The railway training community must be considered to be a key enabler for the successful introduction to NTS. For the railway training professional, the emphasis must be placed on developing the thinking skills and behaviours required to reduce the risk of error in the staff they train and assess. The challenge, therefore, is to develop the competence of the training community in applying NTS in training and assessment, whilst achieving understanding and buy-in to NTS concepts.

1.2 NTS and Safety Performance

Research has shown that NTS (such as situational awareness and decision making) underpin safe performance at work for safety critical staff. RSSB's Good Practice Guide [4], highlighted the importance of cognitive and individual factors on risk.

A growing body of research is emerging within the rail industry that highlights the contribution of failures in train driver NTS to accidents and incidents. The key emerging themes include skills-based errors that result from attention failure as opposed to procedural errors [5,6,7]. Analysis of signal approach incidents found forgotten or inadequate driver knowledge, driver inattention and faulty driver assumptions about the signal approach situation to be key factors [8].

In addition, very specific human factor risks have been associated with shunt moves within depots [9]. Analysis of incidents in depot and siding environments shows that at least 60% and possibly as much as 95% of incidents (the difference being explained by gaps in causal analysis data) are in some part caused by a failure in NTS [10]. Queensland Rail piloted NTS training with new train drivers and results showed that 13.71% of drivers who had been trained in RRM had a SPAD within the first twelve months of driving, in comparison to 26.32% of drivers who had not been trained in RRM having a SPAD in the first twelve months [11]. In addition, significant gaps in training NTS have been found in high-risk tasks, such as platform-train interface and train dispatch [12]. The application of a range of train driving strategies, such as point-and-call, have also been found to reduce the risk of human error [13].

1.3 Theoretical Model of NTS

Non-Technical Skills (NTS) are primarily thinking processes and behaviours. While personality can influence behaviour, developing NTS through training needs to focus on changing patterns of behaviour through appropriate training interventions rather than attempting to modify the individual's underlying personality [1,2,14].

In the aviation industry, accident analysis frequently found that unsafe flight conditions were related to a failure in pilots' NTS. As a result, there has been a shift in focus away from individual pilot characteristics (such as knowledge, attitudes, motivation and personality) towards identification of categories and training in NTS for pilots, specifically, task management, team working, decision making, situational awareness and stress management. Specialist training programmes, called Crew Resource Management (CRM) were designed to increase the use of NTS to improve safety on the flight deck [15]. Thomas [1] charts the origins of CRM training in the aviation industry from the sub-optimal model of several days based exclusively in the classroom, with instructional techniques limited to lectures, case studies, videos and role-play exercises, to the escape to more effective scenario-based training and simulation. This is very clearly the direction that the rail industry needs to follow.

In the UK rail industry, there has been significant variation in the development of NTS categories and elements used to introduce NTS concepts into rail organisations. An RSSB briefing guide for Rail Resource Management Training (RRM) the UK rail industry [16] highlighted four core factors (situational awareness, decision making, co-

operation and leadership / managerial skills) providing synergy with Flin's categorisation of NTS. In addition, at this point, RSSB also highlighted the three phases of training, in line with established practice (see section 2), and the importance of behavioural markers.

However, by the time RSSB published its industry NTS guidance for drivers [7], the list of NTS categories had expanded to seven, supported by twenty-six NTS 'skills', many of which (such as motivation, conscientiousness, attention to detail, etc) are more aligned with personality characteristics. Indeed, RSSB recognised these as individual factors (concentration ability, extraversion, conscientiousness) in their publication RS232 [4]. As Flin observes, the focus of training must be on changing patterns of behaviour rather than impacting on underlying personality. The UK Rail Accident Investigation Branch (RAIB) make a similar observation that the ability to remain vigilant is a 'hard-wired' part of the human condition and not a skill as such [17]

The behavioural markers developed by RSSB to support the twenty-six skills are also not sufficiently specific to train driver tasks. RSSB's work at this time also ignored the progress that First Group had been making since 2010 integrating NTS into their train driver Competence Management System (CMS), using four NTS categories (situational awareness, personal behaviour and vigiliance, decision making and problem solving, co-operation), which were supported by train driver specific behavioural markers (such as scanning inside and outside of the train for cues, reacting to AWS, changing driving position, etc) [18].

The complexity of the updated RSSB model, coupled with the blurring of 'skills' with personality traits, lack of task specific behavioural markers and structured development for trainers probably explains much of the uncertainty in the UK industry about how to integrate NTS and the difference between NTS and other lifestyle factors [18]. What is needed is a much more targeted approach, based on a clear understanding of the thinking skills and behaviours required within tasks.

In a very significant move, the UK Office of Rail and Road [20], in their updated industry guidance on managing staff competence, highlight the need to use Flin's four 'core' NTS categories and elements [Appendix A], the importance of developing specific behavioural markers and the need to separate cognitive abilities and personality traits from the development of skills through training. Similarly, RAIB note that NTS will not address all of the risks associated with cognitive abilities – some are innate, while others are more closely linked to traits – and are not amenable to training [17]. The ORR guidance gives the rail industry an opportunity to re-assess where it is with the development of NTS and look at things afresh. The industry should not resist such a re-assessment, as the aviation industry, often considered to be the pioneer in discovering the importance of NTS, are currently on their sixth generation of CRM [21].

1.4 Approaches to NTS Development

A range of industries in the USA adopted human factors style training courses during the 1980s and 90s. These included the airline industry, where the approach became known as Crew Resource Management (CRM). The subsequent reduction in the number of airline accidents attributed to human error prompted the development of CRM for the U.S. rail industry [22].

The training approach in the US was structured on three phases recommended by previous research [23], namely;

- **Awareness phase:** Formal classroom introduction and group exercises to learn the basic components of CRM
- **Practice and Feedback Phase:** Participation in realistic scenarios, perhaps using simulation, and receiving performance feedback
- **Reinforcement Phase:** CRM concepts become embedded in company training and operational practices

The advantage expert-level railway trainers should have, is the ability to apply their understanding of information processing, as it applies in learning theory, to their appreciation of NTS theory and concepts. As such, it was felt that the development of a small, but expert, cadre of railway trainers, should enable an organisation to become self-sufficient in developing behavioural markers aligned to task and operational context and embedding NTS and appropriate strategies into skills development and assessment.

The importance of behavioural markers cannot be over-stated and the development of Risk-Based Training Needs Analysis, with the focus on understanding task and strategies, supports the trainer in identifying appropriate markers more readily for simulated training environments. This approach should help the industry to move away more quickly from the current dominant sub-optimal model of stand-alone classroom-based NTS modules at the start of training programmes, towards the reinforcement phase, where NTS is embedded throughout training.

1.5 Project Objective

The requirement was to provide a development programme for a target audience of five Nederlandse Spoorwegen (NS) delegates comprising operational managers, professional train driver trainers and an educational expert to develop their understanding of NTS, such that they would achieve a level of competence where they could introduce develop their own NTS behavioural markers and introduce NTS into their own training programmes and simulator sessions.

The target audience had no prior theoretical experience with NTS concepts. The group composition was a guarantee for lively discussions between practitioners and theorists.

One of the early key considerations was to select an NTS structure to apply to the project. NS Reizigers were presented with the three different approaches described above (RSSB, First Group and ORR / Flin) and opted to work with Flin's categories and elements and to define their own behavioural markers based on an understanding of task sequence and requirements. It was felt that Flin's categories and elements are very 'operational' and already provide a description of behaviour. This makes it easier for the railway training practitioner to relate the terms to train driver thinking skills and work behaviour.

Another key consideration in the design of the programme was the potential difficulties with language, especially when trying to work with potentially complex theoretical models in a second language. In this respect, it was a requirement that each learner had a good level of English language competence. At the same time, the design of training had to present the NTS concepts in a readily accessible manner and carefully paced. All training materials were in English, with the exception of the Phase 1 case studies, which were in both English and Dutch.

2 Methods: Development Programme Design

The development programme was designed to develop trainer competence incrementally over three one-day training interventions, delivered in the NS Leercentrum Simulator Centre in Amersfoort, NL. The programme was structured against the three phases recommended by Prince et al (1992) [22]. There was a gap of approximately four weeks between each phase, during which delegates experimented with ideas for training materials.

2.1 Phase 1: Awareness Phase

This phase provided a classroom-based introduction to the concept of NTS, focusing on;

- The differences between a technical and a non-technical skill
- The importance of NTS in helping to anticipate, mitigate and manage risk
- The information processing model in the context of both train driving and learning theory
- Cognitive style and learning design
- Key NTS categories and being able to state the component elements of each
- Use of case studies to identify contributory factors, identifying whether these were primarily technical or non-technical and identifying potential mitigation strategies that could have been used by the driver
- Behavioural markers and train driving strategies

2.2 *Phase* 2: Practice and Feedback

This phase focused on the development of realistic simulator scenarios that incorporate NTS into skills development. In order to do this, a suite of appropriate positive behavioural markers needed to be developed specific to each simulator scenario and tasks contained within that scenario. This included the assessment of NTS and methods for providing feedback. Options covered included the application of Situational Awareness Rating Techniques (SART) and the design of scoring templates.

This phase also considered the provision of one-to-one support to train drivers who have had an incident where NTS failure was a contributory factor and the learning that had been gained from the training designer's previous work in this area [17].

2.3 *Phase* 3: Reinforcement

The final phase focused on collating trainer feedback from their experiences of using and assessing NTS within training and simulation exercises and considering the cultural implications within the business for the onward development of NS training resource and for 'rolling out' NTS within NS. This included consideration of strategies for constant reinforcement of NTS within all training interventions.

3 Results

3.1 The Three-Phase Development Programme

The project successfully delivered a one day theoretical NTS module, supported with elements of simulated experience, which can be delivered to a group of up to twelve learners, who have no prior experience of NTS. The Flin categories of NTS were easily understood by the trainer audience and were seen as readily applicable for train driver NTS development.

The programme design for the first phase created an environment where all learners were very motivated to participate in the three sessions. The real challenge was to make the theoretical concepts practical and applicable – to bring them to life. This is what the group really needs to get - their engagement, understanding and buy-in to the concepts. This was achieved through 'explaining with experimentation', so participants experienced, very directly, the constraints of working memory, selective attention, change blindness and other core NTS concepts in the training room. In this way, they were able to make the connection to daily work practice.

The second phase (*practice and feedback*), for simulated experience has greatest impact when it is specific to the individual's job role and they are provided with developmental feedback. The simulation experience is at its best when every participant has the opportunity to be in the driver's seat while the observers look for behavioural markers. This more 'constructivist' design approach, ensures observers are also actively engaged in the learning experience and, indeed, often there is more learning through observation and discussion than from the experience of driving the scenario.

3.2 Implementation

Following the NS trainer NTS development programme, the professional train driver trainers and educational expert developed a NTS module for train drivers and operational managers. The group also developed simulator scenarios where NTS concepts could be experienced and feedback provided. A short preview module was presented to one hundred and fifty NS operational managers. The reaction to this 'teaser' was positive and they were willing to subscribe to the full module. Many train driver managers within NS are interested in NTS development. They are eager to get some more in-depth background information about the issues they normally pay attention to during their driver guides on the train, like the importance of alertness and perception. However, in order to successfully implement one-to-one support to train drivers and debriefing with train drivers who have had an incident where NTS failure was a contributory factor, a trainer/manager needs high levels of communication and interviewing skills, coupled with a good mastery of NTS concepts and how they apply to the job role.

During the NTS module NS focused on the NTS situational awareness. It was found that most of the train driver managers are perfectly able to identify a list of NTS behavioural markers, aligned to job role tasks. They also found that some behavioural markers are situation specific and related to route knowledge.

There were then two successful pilot performances. Overall, as a result of the pilot study, the NTS module and content developed within NS seems (with small adjustments) interesting for different groups: new aspirant train drivers and experienced train drivers (and managers). However, progress in rolling-out the programme to front line NS drivers has been hindered by a shortage of available training time, due to more urgent training needs resulting from the introduction of new rolling stock. Secondly, there is a shortage within NS of suitable trainers who would be sufficiently competent to deliver the NTS module.

To overcome these constraints, the theoretical part of the module is now transferred into a content format which can be delivered in a Massive Open Online Course (MOOC) for team managers only. The idea is that they can use parts of the MOOC during quarterly meetings with train drivers. In addition to developing the MOOC module, NTS related events are now subsumed within existing planned rehearsal simulator training scenarios. So, in spite of the practical barriers for delivering the NTS module on a broad scale, there is a small group within NS who are able to develop and deliver NTS training materials and embed them throughout all training.

3.3 Organisational learning

There were also some important learning points gained from the NS pilot programme, such as;

- It would be beneficial to involve real trainee drivers to pilot some of the simulator scenarios that were developed
- Early involvement of the safety department, but also the key decision makers (higher management), to

create implementation ambassadors for rolling out the complete programme

- It was beneficial to have one of the training team members with a background in psychology, as this helped with translating NTS concepts to the native language.
- After the classroom introduction there is a need to plan at least three days per trainer to work on the ideas for training materials.
- The logistics of ensuring those involved were allocated time between sessions to complete 'homework'. This was easier to achieve for trainers, over which there was more direct control, than line-based driver managers. The time available between sessions is important for the learners to come together and rehearse / review the previous workshop, confirm understanding and generate ideas. In addition, trainers need this time to develop simulator scenarios aligned with NTS, with input from driver managers.
- More detailed 'homework' for completion between sessions, targeting very specific simulator scenarios and associated behavioural markers
- Recognition that the behavioural markers are specific to an operational context. In this respect, it was recognized that more work is required on defining behavioural markers and 'best practice' strategies in the context of dynamic route knowledge.
- Finally, the safety department of NS uses slightly different categories of cause (perception error, distraction error and expectation error) in their SPAD reports than were used in the NTS training. Although a member of the NS safety department was invited to participate in the NTS development programme, they were unable to join due to the holiday period. As a result, updates about the success of the programme have been required in bilateral meetings. Better synergy would have been possible if the NS Safety Department had been able to participate directly in the programme.

4 Conclusion

The success of this project provides a model for railway trainer and training material development in NTS internationally and across multiple railway disciplines, that moves away from the sub-optimal model of conventional classroom delivery only for NTS to a more meaningful use of simulation and feedback. Furthermore, the approach embeds NTS expertise in the train operators' own, internal, training team, which supports the sustainability of independence and cost-efficiency, in the field of NTS for the long-term.

The use of Flin's NTS categories and elements were easily understood by the trainer target audience. The three phase approach allowed participants to experiment with training design ideas and to access expert-input from the facilitators in a managed process. As a result the NS trainers were able to develop their own materials.

This approach is also currently being used in the UK with train driver trainers from an operator for the introduction of new rolling stock, where tasks and information cues differ from the existing stock they operate and, therefore, different NTS and behavioural markers are required for safe operation.

Finally, research into the application of NTS within the railway industry is still very much in its infancy, with much centering on English-speaking operators. This paper has focused on the application of NTS in an operator where English is not the first language. The encouragement of further projects and publication of research across the boundary of language and operators is required to ensure that learning is spread across our industry globally.

Appendix A: 'Core' NTS Categories (ORR, 2016)

Category	Elements
Situational Awareness	Gathering information Interpreting information Anticipating future states
Decision Making	Defining problems Considering options Selecting and implementing options Outcome review
Communication	Sending information clearly and concisely Including context and intent during information exchange Receiving information, especially by listening Identifying and addressing barriers to communication
Team Working	Supporting others Solving conflicts Exchanging information Co-ordinating activities

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