A Study on NTS Training and Assessment Simulation for the Human Performance of Railway Resources

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In this paper, a study on simulation training and assessment of Non-Technical Skills (NTS) for the safety performance of the railway crews will be presented. Individual tasks and cooperative tasks among the train driver, crew, traffic controller and local (station) signaler shall be considered in developing the NTS assessment program which is composed of several simulation modules and scenarios for various accidents and hazardous events in normal, abnormal and emergency conditions. The human NTS assessment can also contribute to continuous development of safety performance as well as competence verification for the railway employee.

I. INTRODUCTION

The human factor (error or violation) in the following defective conditions is thought to play a key role in the recent Korean railway accident and incident according to the investigation reports by ARAIB in 2007-2014 years. [1]

· Lack of failure identification and risk monitoring for the railway infrastructure, train/rolling-stock and vital safety equipment

· Insufficient preparation for the real-time sharing system of critical safety information or changes such as changing train service or maintenance schedule

· Insufficient communication between train driver and the traffic controller and a field worker

· Absence of practical training and assessment on human performance in selection or routine check process

TABLE 1. Korean railway accidents investigated by ARAIB in 2007-2014 years

Hazardous events / **Accident types**	Sum	**Wrong rote setting**		**Operation handling violations**			**Line-facilities failures**		**Train or rolling-stock failures**			**Others**
		Block/ Interlocking	Line switch	Signal,	Over-speed	Braking	Track irregularity	Power supply	Explosions	Drop objects	Running device	Management failures
Collision	7	1		5	1							
Derailment	45		6	11		1	12			3	10	2*
Train Fire	4								4			
Level-crossing accident	3			2(car driver's violation)								1**
Power supply failure	3							2	1			
Damaged Line-facilities	1		1									
Casualties -Employee	1											1***
Totals(cases)	**64**	**8**		**20**			**14**		**18**			**4**

Korean railway run the qualification system for driver and traffic controller which go through a physical examination, aptitude inspection, task training and field placement. In particular, for a driver and controller selected in respective fields, individually functional education and training on field placement for their duties are provided, but a cooperative training program including mutual communication, exchange of information or collaboration with others, etc. does not exist.

In this study, the simulation program to develop and assess individual and cooperative Non-Technical Skills will be introduced. The main contents is as follows.

· Development of scenarios for NTS training and assessment in the various accidents and hazardous situations

· Development of simulation modules for NTS training and assessment in normal, abnormal and emergency response conditions

· A proposal for improving a procedure on the human performance verification and competence management

The NTS training and assessment program using the simulation technique will make a significant contribution to verify the safety performance and competence conformity for the railway human resource.

II. HUMAN PERFORMANCE AND COMPETENCE

The Office of Rail Regulation's (ORR's) Railway Safety Publication 1 (RSP1) *Developing and Maintaining Staff Competence* breaks down the components of competence as: '*...**practical and thinking skills, experience and knowledge...***' Competence development is actually the result of experiences that have provided the opportunity to learn and develop skills. Consequently, learning is a change in behavior that results in better performance. [2]

The components of competence (i.e. the opportunity to learn and develop the skills) are comprised of the following terms:[3]

• Technical skills and underpinning knowledge: These are the practical skills combined with the knowledge needed to practice them. For example, operating an equipment through knowing how it works as driving skill.

• Non-technical skills (NTS): NTS have been defined as the cognitive, social and personal resource skills that contribute to safe and efficient task performance and complement technical skills.[4] General examples of NTS are conscientiousness, communication, rule compliance and workload management etc.

• Functional skills: These are core practical skills in language, numeracy, and information and communications technology (ICT). These allow people to build a Key Skill needed to get the most out of work, education and all apprenticeship frameworks.

Human factors have been considered to be a key area in the recent railway accidents. Hazard analysis consistently shows that the absence of NTS actually plays a key role in incidents. NTS could be considered the 'thinking skills' referred to in the ORR definition, as well as a particular set of skills and knowledge relating to how risks can be managed at the front line. In the process of developing the NTS skills, staff can learn how to deal with various hazardous situations, including situations that are more novel.

Competence management is an important strategic objective for all companies. The purpose of a CM is to control in a logical and integrated way activities within a company or organization that will assure and further develop competent performance at work. The aim is to ensure that individuals are clear about the performance that is expected of them, that they have received appropriate training, development and assessment, and that they maintain or improve their skills over time. The periodic checking process is also designed to continually improve competence.[3]

Risk-based training needs analysis is a process that allows companies to minimize risks associated with tasks through learning, assessment and competence management activities. It helps to ensure that training (including refresher training) and assessment reflect the nature of the tasks and the safety risk associated with them.[3]

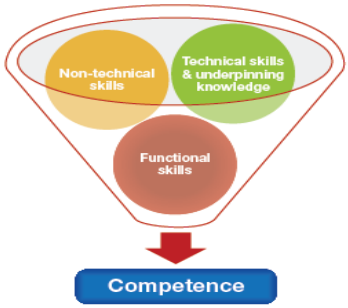


Fig. 1. Components of competence

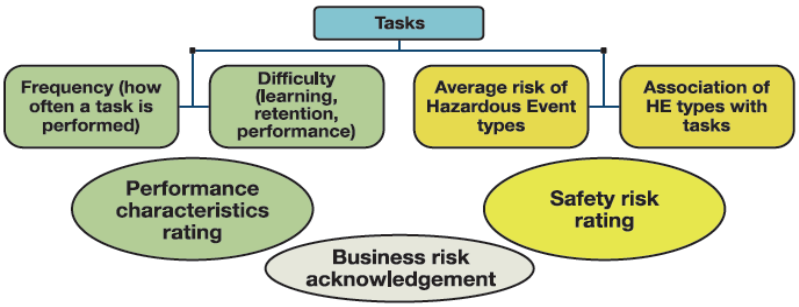


Fig. 2. Training needs priority assessment overview

III. NTS TRAINING AND ASSESSMENT SYSTEM

NTS is key contributor to hazardous events in analysis of the railway accidents, but there is very little formal coverage of NTS in the driver and traffic controller's competence management system. At present, training programs for operational staff within railway industry are based largely on rules, functional and technical skills, and ongoing competence development and assessment have not been conducted.

Human error is inevitable but people can develop NTS and expertise that can help them to mitigate risks. For example, a driver who shows signs of being conscientious might be more likely to quickly notice threats as they occur and if they are good at managing workload and communicating with others they might effectively mitigate that threat.[4]

RSSB's Research Program, "Non-technical skills for rail: A list of skills and behavioral markers for drivers, with guidance notes"[5] has suggested the NTS category and relevant NTS skills of table 2.

TABLE 2. RSSB's NTS category and relevant NTS skill for railway drivers

	NTS Category		NTS Skill
1	Situational awareness	1.1	Attention to detail
		1.2	Overall awareness
		1.3	Maintain concentration
		1.4	Retain information (during shift)
		1.5	Anticipation of risk
2	Conscientiosness	2.1	Systematic and thorough approach
		2.2	Checking
		2.3	Positive attitude towards rules and procedures
3	Communication	3.1	Listenting to people (not stimuli)
		3.2	Clarity
		3.3	Assertiveness
		3.4	Sharing information
4	Decision making and action	4.1	Effective decisions
		4.2	Timely decisions
		4.3	Diagnosing and solving problems
5	Cooperation and working with others	5.1	Considering others' needs
		5.2	Supporting others
		5.3	Treating others with respect
		5.4	Dealing with conflict/aggressive behaviour
6	Workload management	6.1	Multi-tasking and selective attention
		6.2	Prioritising
		6.3	Calm under pressure
7	Self-management	7.1	Motivation
		7.2	Confidence and initiative
		7.3	Maintain and develop skills and knowledge
		7.4	Prepared and organised

III.A. NTS training and assessment program

The NTS training and assessment program will be intended for a train driver and crews, traffic controllers and local (station) signalers. Two training courses needs to be developed as part of the NTS assessment program, one for front-line staffs and one for their managers.

• The individual and/or team course helps front-line staffs to experience the reasons why things can go wrong, and how NTS can be used to anticipate, manage, mitigate and recover from risks and errors in the safety critical railway operations.

• The manager course deals the observation, measurement and effective feed-back of NTS, which enable the managers to support theirs staff on an ongoing performance basis.

The NTS training and assessment programs are organized into three parts as following.

• Scenarios for NTS training and assessment for various accidents and hazardous situations in normal, abnormal and emergency response conditions

• NTS training and assessment simulation modules for each and team staffs: individual training modules primarily have to deal with situational awareness including hazard identification, a team (joint) training module mainly will address an information exchange, communication and work cooperation etc.

• Human performance verification and management program: It will be processing performance measurement for individual and team, vulnerability analysis, proposal for improvement, competence verification and feed-back management etc.

The NTS training and assessment simulation system consist of three individual simulation modules and an integrated management program as follows.

• Train crew's NTS SIM. Main tasks is to confirm and deliver of train departure message and to treat door operation. NTS assessment have to be linked to task in normal, abnormal and emergency conditions. Auto detection function about handling or reaction shall be equipped with Monitor/Record of behavior, communication.

• Train driver's NTS SIM. Main tasks is to stop and start the train, to confirm and deliver of operation order, instruction or message, and to response to train failures or accidents. NTS assessment have to be linked to task in normal, abnormal and emergency conditions. Auto detection function about handling or reaction shall be equipped with Monitor/Record of behavior, communication.

• Traffic controller/Signaler's NTS SIM. Main tasks is to monitor and control the traffic and signal, to issue an order or instruction for train operation. NTS assessment have to be linked to task in normal, abnormal and emergency conditions. Auto detection function about handling or reaction shall be equipped with Monitor/Record of behavior, communication.

• Training and assessment program-Integrated management modules. It has Driving Cab. Layout Library (DB), Operation Condition Library (DB) and various NTS Training and Assessment Scenario Library (DB). All operation and handling is to be recorded for analysis of NTS performance and review of NTS behavioral features. Also an individual or team diagnosis and feed-back functions shall be supplemented

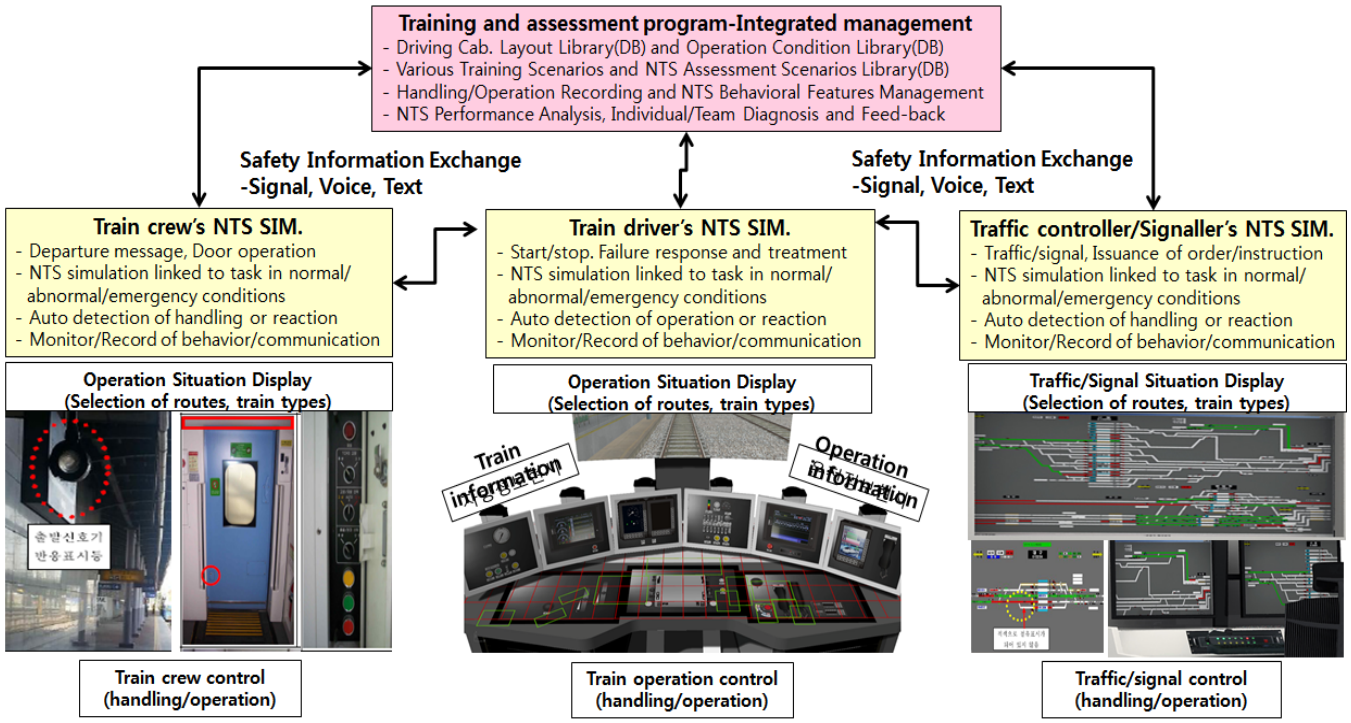


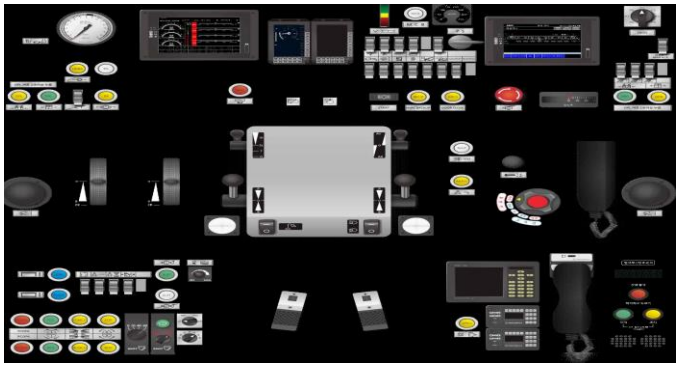
Fig. 3. The NTS training and assessment simulation system overview

III.B Core function and features of the NTS simulation system

Currently under development, the NTS training and assessment simulation system will hold the following core function and features.

• Implementation of Virtual-Engineering Objects (shape, function and effect) for equipment or display in driving cab, traffic control installation, and for train crew's devices.

- Driving and control equipment in driving cab, operation state and related information display
- Train crew: train departure message (signal post, sign, marker, response lamp, etc.), door operation handling
- Traffic and signal control, confirm and deliver of operation order, instruction or massage



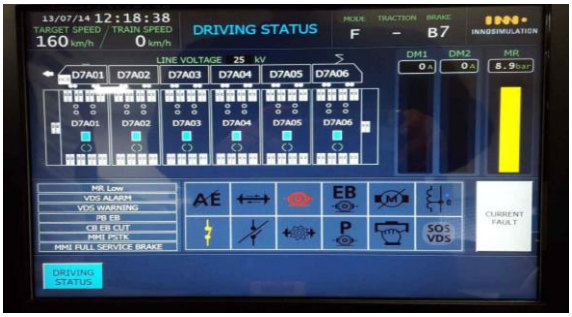
<For driving and control equipment in driving cab>

<For train crew's devices

Fig. 4. Simulation system using Virtual-Engineering Object

• Implementation of Auto-detection and recording for operation, handling, reaction and information exchange

- Auto detection of operation and handling and recording of confirm and reaction by touch screen
- CCTV monitoring of all behavior and voice recording for communication or information exchange



<Train information confirm/reaction-TCMS>

<Operation state confirm/reaction-MMI>

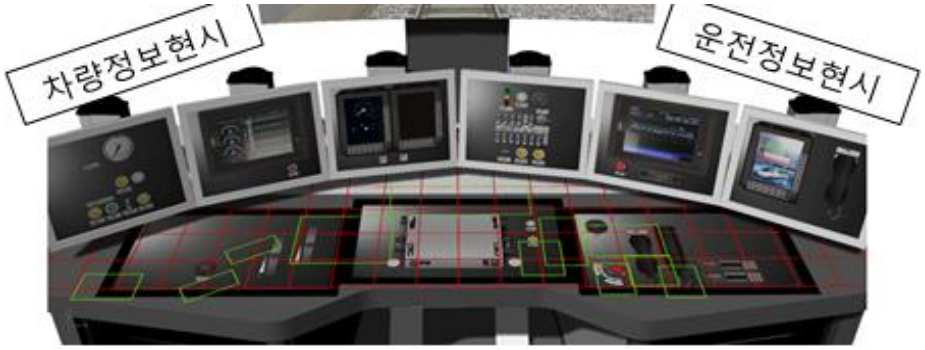


Figure 5. VE Object implementation of KTX-train driving desk and displays by touch screen

• Driving Cab Layout Library (Data-base): select a type of train, depending on for training purpose. For example, high-speed train (KTX), urban-transit train (VVVF), Diesel or Electric Locomotive, etc.

- Driving and control equipment: procedures for start-acceleration-deceleration-stop
- Handling and manipulation devices: pantograph, doors, brake, lighting, whistle (horn) etc.
- Operation and train information: state for normal or abnormal, failure condition for train or rolling-stock,

• Line Operation Condition Library (Data-base): select a route, operation situation or safety equipment etc., depending on for training purpose.

- Operation route or line: selection of track, station, switch, level-crossing etc.
- Occupation and protection for train or work
- Blocking (automatic or alternative), interlocking (entry and exit, branch or crossing)
- Signal or instruction for start, stop, shunt, delay, stand-by, change of route or order etc.

II. CONCLUSIONS

As a process of competence management for the railway staffs, the NTS training and assessment are very important in developing and maintaining individual and cooperative human performance. In this study, the need for the NTS program, the major components and implementation features of the simulation system are introduced as follows

- Development of the NTS training and assessment programs, including the various accidents and hazardous situations
- Implementation of individual simulation modules for NTS training and assessment in normal, abnormal and emergency response conditions

In the next study, this NTS training and assessment program will be applied for a beginner and an experienced groups in order to verify the safety performance and competence conformity for the railway human resource.

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REFERENCES

1. J.B. Wang and S.A. Kim, “An Hazard & Human Errors Analysis from Accident Histories in the Urban Transit”, Journal of The Korean Society For Urban Railway, Vol 3, No.2, June 2015
2. The Office of Rail Regulation (2007), Railway Safety Publication 1 (RSP1), “*Developing and Maintaining Staff Competence”.* (http://www.rail-reg.gov.uk/upload/pdf/sf-dev-staff.pdf)
3. RSSB (2013), RS/100 Issue 1, “Good Practice Guide on Competence Development”. (http://www.rgsonline.co.uk)
4. Flin, R., O’Connor, P., & Crichton, M. “Safety at the Sharp End: A Guide to Non-Technical Skills”, Hampshire: Ashgate Publishing Limite (2008)
5. RSSB (2012). Research Programme T869, “Non-technical skills required in the train driver role: skills, behavioural markers and guidance notes (v2.0).