Behavioural and physiological non-technical skills assessment in simulated electricity distribution tasks

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Abstract
Simulation has proved to be a useful method to improve learning and increase the safety of work operations in several domains (healthcare, road safety, etc.), both for technical and non technical skills (NTS). However, the observation, assessment and feedback about these skills is particularly complex, because the process needs expert observers and the feedback is often provided in judgmental and ineffective ways during the post-simulation debriefing. In our research, we wanted to apply simulation to the electric domain as a new method to enhance the NTS and foster best practices. We developed and tested a set of observation and rating forms of the NTS behavioural markers of electric workers. In addition, we outlined the framework for observing behaviours based on non-verbal cues, like movement in the operational environment. The analysis of social signals and face-to-face communication patterns (e.g., kinesics, proxemics, interpersonal synchronization), could be combined with performance metrics (e.g., feedback on the NTS, self and peer assessment of performance efficiency, etc.). By automatically quantifying human behaviour using wearable and non-invasive sensors, we can find relationships between sensor data and team performance and thus identify optimal behaviour patterns that would lead to improved and safe performance.

Project overview
Simulation has proved to be a useful method to improve learning and increase the safety of work operations. It has become a relevant tool for safety training in aviation and other domains (healthcare, road safety, etc.), both for technical and non technical skills (e.g. Crew Resource Management, in aviation). The debriefing session, after the scenario, is the core of the simulation, since it allows participants to integrate the experience with the theoretical frameworks and the procedural guidelines. Notwithstanding the evidence of the relevance of non-technical skills (NTS) for the safe and efficient accomplishment of operations, the observation, assessment and feedback about these skills is particularly complex, because the process needs expert observers and the feedback is often provided in judgmental and ineffective ways. In the context of a Saf€ra 2016 grant, we will develop new methods based on real cases analysis, useful to enhance the NTS and identify the best practices to be implemented. The aim of this study is therefore to develop and test a set of observation and rating forms for the NTS behavioural markers of workers involved in a simulation of electric tasks. In addition, we want to add a new method for observing behaviours based on nonverbal cues, like movement in the operational environment. We aim at developing a new generation

of sensor-based systems and indexes for monitoring team coordination. By automatically quantifying human behaviour using wearable and non-invasive sensors, we can find relationships between sensor data and team performance and thus identify optimal behaviour patterns that would lead to improved performance. The developed method could be shared with internal and external stakeholders through an effective communication campaign, in order to inform all interested actors about the development of the project and the results achieved. The transfer of such method to stakeholders is relatively easy, since it is based on paper-and-pencil assessment system (the NTS checklist) and a NVC tracking system that could be implemented, after proper validation, on current smartphones and on software and hardware for the recording of scenarios during the simulation.

Aim of the study

The aim of this study is to develop a tool for the peer observation of specific behavioural markers for electricians as single operators and as a team during simulated scenarios. In addition, we want to add a new sensor-based method for observing behaviours based on non-verbal cues (NVC), like movement in the operational environment.
The main strengths of the project are:
- simulation is an effective method for competences development in many domains;
- metrics: self and peer assessment tools and a sensor-based system for monitoring team coordination during the simulation; - key factors: learning by doing, peer-assessment, metacognition and reflection on work activities, visual and concrete representation of teamwork non-verbal dynamics;
- New mechanism for learning: simulation and debriefing, sensor-based system for monitoring team coordination;
- Integration with top-down safety management: simulation is a very effective tool for behaviour change for safety's sake, the training of new procedures, the discussion of "hidden practices", the clarification of attitudes and beliefs.

Stakeholder impacts

The stakeholders interested in these results will be practitioners working in electricity distribution belonging to other local units of Enel Distribuzione or other distribution companies. However, once validated, the method could be easily disseminated to other technical domains (e.g., High Voltage workers, Power plant workers, etc.), or even other work domains (e.g., team of fire-fighters). For the first time in the electric industry, it will be possible to explicitly analyse NTS by means of a structured form, based on the specific activities, and, most of all, NVC will be tracked and used for addressing often vague and ill-defined concepts like teamwork and coordination. Moreover, the analysis of NVC will reveal specific patterns of behaviours that are correlated with safe performance and, therefore, could be explicitly addressed during the professional training.

Innovation

Simulation has been extensively proved to be an effective method for fostering metacognition about NTS and therefore reinforcing safe attitudes and behaviours. However, the effectiveness of simulation is strongly dependent on the debriefing session, since learning actually occurs when it is based on proper feedback aimed at stimulating metacognition and reflection about team dynamics. The ability to analyse each other's performance retrospectively is crucial when it is focused not only in talking about what went well and what did not, but also on why it went well and why something else did not. Therefore, a proper tool for observing specific behaviours during simulation scenarios is of paramount importance, especially for the balanced training on technical and non-technical skills. Notwithstanding the presence of some tools for the observation of teamwork and communication during simulated scenarios, there is a lack of structured tools for the observation of NTS in electricians working on electricity distribution power lines. Moreover, at the best of our knowledge, NTS-oriented simulation has never been adopted in a technical activity such as electric distribution operations. We will develop an innovative training method based on simulation. Its novelty is due to the formalized blend of technical and non-technical skills, the development of a validated checklist for the observation of NTS for electricians, the visualization and analysis of NVC that underlie an effective teamwork. The debriefing after the simulation will therefore enrich the learning process and foster the adoption of proper attitudes for safe team performance. We aim at developing a new generation of sensor-based systems for monitoring team coordination in both routine and extreme situations, namely a context simultaneously marked

by high levels of uncertainty, change and risk. The analysis of social signals and face-to-face communication patterns (e.g., kinesics, proxemics, interpersonal synchronization), will be combined with other sources of information such as survey and performance metrics (e.g., feedback on the NTS, self and peer assessment of performance efficiency, etc.). We argue that these systems could help teams to design interventions aimed at enhancing individual and group performance, especially for coordinating efficiently and ensure their resilient capacity to face risk and overcome perturbations, a critical aspects of extreme situations. By automatically quantifying human behaviour using wearable and non-invasive sensors, we can find relationships between sensor data and team performance and thus identify optimal behaviour patterns that would lead to improved performance.

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