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DEVELOPMENT & USE OF A MULTI-ACTOR SIMULATION ENVIRONMENT FOR DUTCH RAILWAYS

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ABSTRACT

As part of future railway infrastructure and timetable changes in the Netherlands, a multi-actor simulation environment is used to test concepts of train operation. In this environment, different operators can use their real-life or simulated control systems that are connected to a microscopic simulation of the timetable, infrastructure and safety system. In the poster session, a recent case will be highlighted, i.e. the investigation of a frequency increase of trains in 2018 on the Amsterdam – Utrecht – Eindhoven corridor. On this heavily used trajectory the frequency of intercity trains has been increased to run one intercity train every ten minutes. The goal of the simulation sessions is to allow operators to explore the impact of risks, to provide input and feedback, and to let them familiarize themselves with new concepts. Four simulation days were organized with about fifty persons involved as participants, actors, facilitators and observers.

1 INTRODUCTION

In December 2017 a new timetable was introduced by the Dutch railways, which included a higher frequency on the train corridor between Amsterdam and Eindhoven. Prior to its implementation, doubts existed about whether the increased frequency would cause more issues, such as extra delays and train cancellations. Several initiatives were started by ProRail – the Dutch railway infrastructure manager – and NS – the principle passenger railway operator – to reduce these risks, one of which was to organize multi-actor simulation sessions of train operations control and dispatching in the case of incidents. Our research goals can be summarized as follows: to 1) obtain insights in the operational consequences of the frequency increase, 2) identify "unknown unknowns" caused by the higher frequency, and 3) collect ideas for improvements of future train traffic operations. Beside these goals, the simulation gave operators the opportunity to experience the new timetable and to become familiar with its distinguishing properties. Although ProRail has ample experience using human-in-the-loop simulations (Kortmann and Sehic 2010), this was the first time this cross-company multi-process dispatching process was simulated at this scale.

2 SIMULATION ENVIRONMENT

The setup of the simulation environment focused on a single train corridor. The environment is a human-in-the-loop distributed simulation and consists of a collection of coupled modules. These modules are mostly real-life (or simulation-built versions of) control systems that controllers use at their workplaces and they are connected to a microscopic discrete event simulation of running trains, infrastructure and safety system. Messages between modules are handled by middleware software according to the High Level Architecture (HLA) (Kuhl et al. 1999). Actions of controllers or updates in the simulation state are communicated to subscribed modules to create realistic behavior in the different control systems.

3 SIMULATION SESSIONS

Seven traffic control centers with in total 23 operators in total were involved in the simulation sessions. Furthermore, four train drivers were acting and communicating as if they were driving the simulated trains, and a diverse group of five to ten experts from NS and ProRail where observers. In the simulation, the operators had to solve seven different incidents over four days with severe impact on the train operation, such as a defective train on the track. In these simulation sessions of up to ninety minutes, the operators did not receive special instructions other than to conduct their usual tasks. After each session a discussion took place between the different players and observers.

4 LESSONS LEARNED

The simulation sessions presented us with the following insights about the simulation environment and our methodology, of which the most important lessons are:

- The increase in scale lead to performance and robustness problems, and also practical issues in configuration and starting up the simulation. For example, scenario testing, software testing and reproduction of bugs is hard due to multiple human inputs.
- As live modules are not built for simulation purposes, issues occurred with exchanging information and time management. For the future, a list of specifications is made that are crucial to couple live systems to a simulation environment, for instance, it is essential to adapt the live modules to integrated simulated time and to be able to feed the modules with specific starting data at each session.
- In the debriefing sessions multiple "unknown unknowns" and possible improvements were identified and discussed. It was hard to draw conclusions about the impact of these problems and proposed solutions during the debriefing. The advice is to reserve time to simulate some of these problems or solutions more in-depth and with more instruction for better insights.
- There was a strong involvement of the operators in the simulation. The balance between fidelity of the simulation environment and the immersion was a challenge (Meijer 2012). The realism of the cases, the usability and familiarity of the workplace, the fact that operators had the information they needed, and the quality of the overall organization were all important building blocks to obtain this level of involvement. As a result, this particular multi-actor simulation setting proved to be a very powerful tool to experience a new dispatching situation.

5 CONCLUSION

All in all, the simulation games were considered successful, as they helped reach consensus and build confidence about the controllability of the higher frequency timetable. Also a lot of potential improvements were reported of which several were implemented. The debriefing sessions with the operators, actors and observers from different regions and organizations were considered a success, as they gave operators insight in each other's world, beside achieving the research goals.

REFERENCES

Kortmann, L., and E. Sehic. 2010. "The Railway Bridge Game: Usability, Usefulness, and Potential Usage for Railways Management". In *Proceedings of ISAGA*.

Kuhl, F., R. Weatherly, and J. Dahmann. 1999. *Creating Computer Simulation Systems: An Introduction to the High Level Architecture*. Prentice Hall.

Meijer, S. 2012. "Gaming Simulations for Railways: Lessons Learned from Modeling Six Games for the Dutch Infrastructure Management". In *Infrastructure Design, Signalling and Security in Railway*. InTech, 2012.