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Procedia CIRP 54 (2016) 25 – 30

www.elsevier.com/locate/procedia

6th CLF - 6th CIRP Conference on Learning Factories

Railway operation research centre – a learning factory for the railway sector

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Abstract

The railway operation research center Darmstadt (EBD) developed from a pure simulation center towards an interdisciplinary learning factory. The paper presents methodical concepts for the three main fields of its application - the student's education, the advanced education and the research on railway operation. Education is focus on role and business games. The participants can slip in the role of operators or dispatchers training the regular or disrupted operations. Research projects complement the needed technique and enable new didactical concepts. Moreover new technical concepts are developed and tested in the EBD before they are used in railway operation.

Peer-review under responsibility of the scientific committee of the 6th CIRP Conference on Learning Factories

Keywords: railway simulation, railway operation, dispatching, experimental research, problem based training, learning factory

1. Introduction

How are trains able to run? How does the signal turn green? And what happens when a tree has fallen on a track? These and other questions can often not be answered and demonstrated within the real-time operation. For educating and training purposes training centers are necessary. Here, the course participants can learn the principles of railway operation. They can switch into different roles and experience the consequences of their decisions and activities without consequences for real trains or passengers.

The railway operation research center Darmstadt (EBD – Eisenbahnbetriebsfeld) is a simulation center for railway operation and dispatching. Based on a model railway with authentic signaling and interlocking technique different software systems for the railway operation and dispatching are installed. The EBD is operated by a collaboration of DB Training, Learning & Consulting, the Railway Academic Working Group (AKA Bahn) and the chair of Railway Engineering at the TU Darmstadt. At its current location, the EBD was opened in 2006. The history of interlocking simulation at TU Darmstadt goes back to 1914 where the first signal box was set up for teaching purposes. From 1935 to 1939, the initial laboratory, which consisted of several mechanical and electro-mechanical signal boxes, gradually expanded. Until the temporary closing in 2000 the laboratory was a pure simulation of the train operating process. The course participants of trainings switched into the roles of train directors. With the reopening, the technical possibilities were significantly expanded. Besides the techniques of the train director, dispatching software for the infrastructure and resource dispatcher were installed. Also, new didactical concepts are designed and applied.

Due to the wide range of technical elements and simulation software the EBD is used for highly versatile training and research purposes. Its miniature reality permits practical initial and advanced training in operations, control and scheduling.

The paper describes the conceptual design of the EBD (chapter 2). Afterwards the field of application in education and training (chapter 3) and experimental research (chapter 4), as wells as further development (chapter 5) are explained.

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doi:10.1016/j.procir.2016.05.071

2. Conceptual design

"A learning factory is a learning environment where processes and technologies are based on a real industrial site […]. Learning factories are based on a didactical concept emphasizing experimental and problem-based learning. The continuous improvement philosophy is facilitated by own actions and interactive involvement of the participants" [1]. Due to the technical and didactical development the EBD can be defined as a learning factory. In the following we describe the implementation of the key elements of the mentioned definition of a learning factory.

2.1. learning environment: railway operation & more

In the EBD all phases of railway operation are realized: from the planning phase over the operation phase to the dispatching phase, as shown in Fig. 1.

For all three phases the two perspectives of the train operating company (TOC) and the railway infrastructure manager (RIM) are performed. The TOC is responsible for the

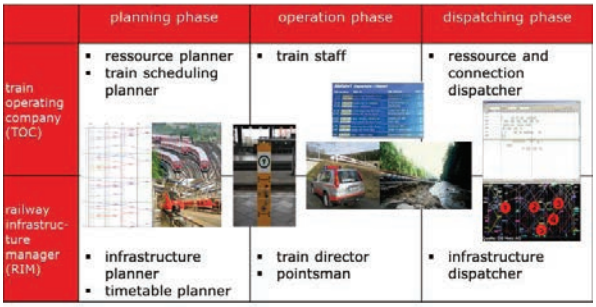

Fig. 1. the EBD learning environment

execution of train movement on the infrastructure provided from the RIM. The staffs of the TOC and the RIM interact in all three phases. In the planning phase the TOC calculates the needed resources (staff and trains) for a desired traffic concept. The RIM draws up the timetable based on the orders of all TOC. During the operation phase, TOC provide the train staff, from the driver to the conductor. The TOC and RIM staffs are responsible for safe and punctual railway operations. RIM employs the train directors and pointsman who are responsible for the signal boxes of a station. They set the routes for the trains. The dispatcher of the TOC controls the employed staff and trains. He intervenes when staff is unavailable, trains cannot fulfil a planned service or in case that lines have to be detoured. The dispatchers of the RIM control the infrastructure and regulate delayed trains. They inform the dispatchers of the TOC about trains that have to wait or get rerouted.

For a realistic railway operation simulation and a wide spectrum of training scenarios, different specific features are implemented: single-track lines, a foreign track line, a ferry terminal, freight stations and a crossing point to the urban traffic.

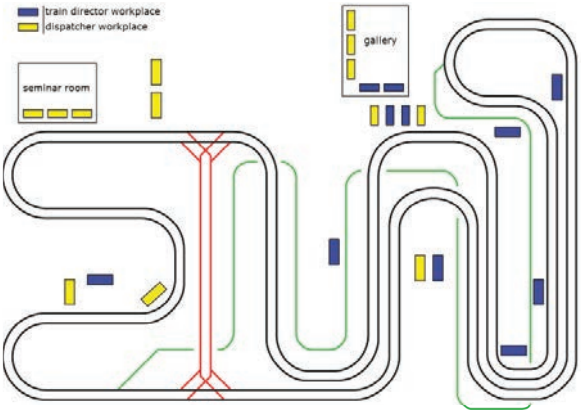

Fig. 2. Track layout and workplaces, according to [3]

2.2. real industrial site: the technical concept

Workplaces for the staff of the TOC und RIM are distributed over the entire plant (see Fig. 2).

The central element of the train director's workplace is the signal box. Four different types of original interlocking technologies from different epochs are implemented:

- mechanical signal boxes (1900; see Fig. 3),
- electro-mechanical signal boxes (1912),
- relay interlocking systems (1950) and
- electronic interlocking systems (1980).

With the help of the interlocking technology the train director switches the elements of the desired route, mechanically locks, electrically fixes the elements and adjusts the signal. Further information and communication systems, like the train message system, following the actual operation systems are implemented.

The workplaces of the dispatcher (TOC) offer different software systems for resource planning and traffic control. Special dispatching programs have been recreated based on software used in real operation. The vehicle resource planning tool is used for ad hoc vehicle management [2]. It displays all train services that are assigned to a vehicle. The dispatcher can create, edit and cancel services. The personnel resource

Fig. 3. mechanical signal box next to the model railway