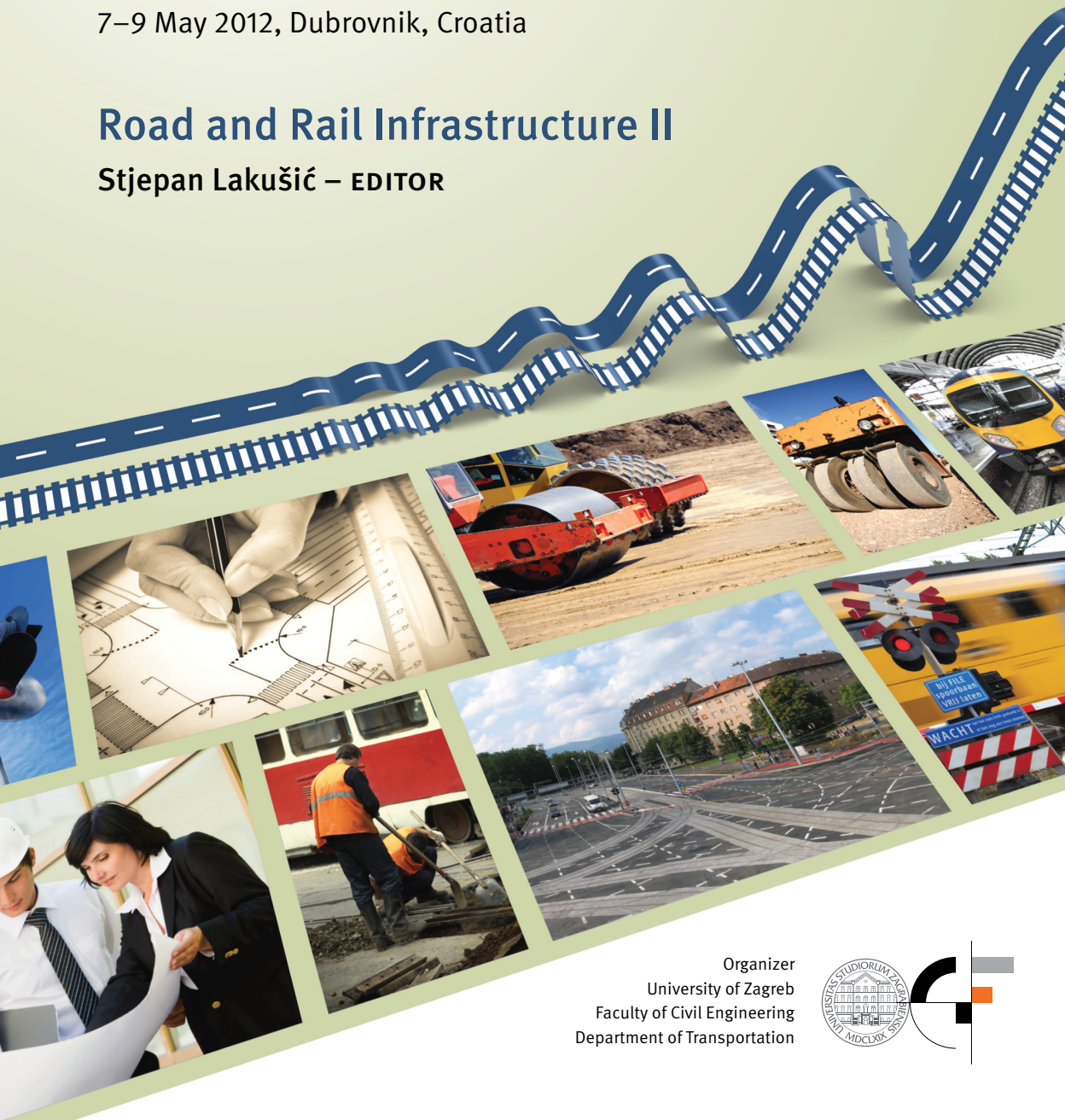
CETRA 2012

2nd International Conference on Road and Rail Infrastructure
7–9 May 2012, Dubrovnik, Croatia

Road and Rail Infrastructure II

Stjepan Lakušić – EDITOR



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NEARLY 10 YEARS OF TEACHING RAILWAY SIMULATION AT THE VIENNA UNIVERSITY OF TECHNOLOGY

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Abstract

Railway simulation is a powerful tool for answering various questions in railway network planning and analysing different solutions. Today, railway simulation is used by railway operators, consultants and universities. At the Vienna University of Technology the course Railway Simulation is part of the curriculum since 2003. The focus of this article is to give an insight into this course and to show its successful application.
The course Railway Simulation is offered at the Research Centre for Railway Engineering, Traffic Economics and Ropeways of the Institute of Transportation at the Faculty of Civil Engineering. The course is open to all students at the Vienna University of Technology but it is especially aimed at students studying civil engineering during their Master studies who have gained an overview of railway engineering in their Bachelor studies.
The aim of the course is to give an insight into railway operation. The course is divided into two parts. The first part is an introductory lecture to repeat the main terms of railway operation and the basic software elements. In the second part the students work with the railway simulation software OpenTrack (by OpenTrack Railway Technology Ltd., Switzerland) to solve various tasks. For example, one task is to determine the travelling time and the minimum headway time of different trains on a given infrastructure. Another task is to identify how track improvements can influence the travelling time and to develop a fixed interval timetable for a given infrastructure.
Overall, there is a good interest in this course and this course is very useful for the students to understand the specific characteristics of railway operation.

Keywords: railway simulation, running time, timetable, education, fixed interval timetable

1 Introduction

Since 2003 the Research Centre for Railway Engineering, Traffic Economics and Ropeways of the Institute of Transportation at the Faculty of Civil Engineering at the Vienna University of Technology (Austria) offers the course Railway Simulation. The course has been created to enable students to answer questions of railway operation with the help of simulation software.

1.1 Admission to the course

The course is open to all students at the Vienna University of Technology, but it is especially aimed at students studying civil engineering during their Master studies who have gained an overview of railway engineering in their Bachelor studies. Approximately 45 students attended the course each semester in the past three years. Most of students are studying civil engineering, but there are also students from other Bachelor and Master programmes at the Vienna University of Technology (e.g. mechanical engineering, computer science). The course

is offered in German, but can be taught in English as well, as the language of the user interface of the software used in the course is in English.
There are no restrictions to take the course, although a basic knowledge of railway engineering is helpful. As the students have differing previous knowledge, there is an introductory lecture at the beginning of each semester in order to reach the same level of knowledge for every student at the course. This introductory lecture is on the one hand a repetition for the civil engineering students and on the other hand probably new information for the other students. In the introductory lecture the basic principles of railway operation are explained with a special focus on the tasks that will be given to the students during the course.

1.2 The introductory lecture

The aim of the introductory lecture, as well as of the whole course, is to teach students the basic terms of railway operation. According to technical literature (see [3]) there are two main characteristics of railway transportation. One main characteristic is track guiding and the other is the fact that the braking distance exceeds the viewing range of the driver because of the coefficient of adhesion between steel wheel and steel rail [2]. These characteristics, that are significantly different from road traffic, influence the design and operation of railways. Because the stopping distance is generally longer than the range of vision, train separation by the sight of the driver is not possible. Therefore railway tracks are divided in block sections with fixed signals so that train separation is done through fixed block distances. Only one train can occupy a block section exclusively. Therefore a train must not enter a block section until that section has been cleared by the train ahead [2].

2 Software OpenTrack

In the course, the students use the software OpenTrack representatively for other simulation software. During the simulation, predefined trains run on a railway network according to a timetable [1]. To conduct a simulation, the software OpenTrack needs the following three components: rolling stock, infrastructure and timetable (see Fig. 1). While in this course the components infrastructure and rolling stock are already given, the students only work with the timetable component (see grey label in Fig. 1) containing the tools courses, timetable and simulation.

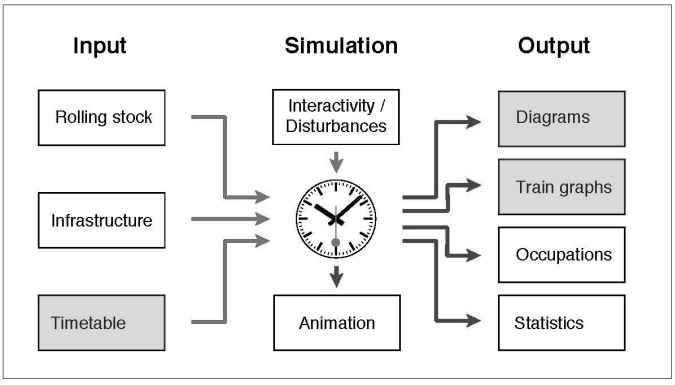

Figure 1 The components of the simulation [1]

In the following subsections, the two given components infrastructure and rolling stock are described.

2.1 Infrastructure

In the tasks given for the students, the infrastructure is already defined. The students work with two different infrastructures. Both infrastructures are single track and are based on existing railway lines in Austria, but are simplified for the use of this course. The first infrastructure is simplified as a single line section because that is sufficient for the purpose of the tasks. Whereas the second infrastructure has additional tracks in some stations to allow trains to overtake and cross each other (see Fig. 2). The first infrastructure is about 300 km long; the second infrastructure is 25 km long. The trains are governed by fixed signals along the track (main and distant signals).

2.2 Rolling stock

The rolling stock, like the infrastructure, is also already given. The rolling stock database contains about 30 different trains ranging from high–speed trains to regional trains and freight trains.

3 Tasks

The tasks for the students are created to point out the characteristics mentioned in subsection 1.2. The students work in groups of two with a computer at the institute where the software is installed. After a short introduction into the relevant functions of the software, the students start working by themselves. After each task the results are being discussed together with the teaching assistant. The students work on five to seven different tasks, where they have to determine running times, determine minimum headway times and create fixed interval timetables. The tasks do not include operational aspects such as delays, connections or timetable stability analysis because these aspects would go beyond the scope of this course. The basic requirement of all these tasks is that the trains run without any conflict between the different train paths. Therefore the students create time–distance diagrams with blocking time stairways to show that the timetables they have created have no conflicts between the different train paths.
In the following subsections, five selected tasks are described.

3.1 Running time calculation

In the first task, the students have to determine the running times of different trains on a given infrastructure. This task serves also to introduce the students how to use the software tools courses, timetable and simulation. The students learn how to define a course, to choose an itinerary for it, to enter a timetable and to start a simulation. For the running time calculation the students choose ten different trains out of the rolling stock database. The students create speed–distance diagrams for each train simulated to see the maximum speed and the braking and acceleration curve of the train. Furthermore, they create time–distance diagrams to display the blocking time stairways.

3.2 Influence of train stops on running time

In the second task, the students have to conduct several simulations with the same train on the infrastructure given before in order to find out how additional stops influence the running time.

3.3 Time savings due to higher maximum speed

In the third task, the students have to improve the given infrastructure by setting a higher maximum speed in a specified track section. Then the students compare the running times of different trains before and after the improvement.

3.4 Fixed interval timetable for regional trains

The following tasks are performed on the second infrastructure with additional tracks in some stations to allow trains to overtake and cross each other (see Fig. 2). In the fourth task, the students have to create a fixed interval timetable for a regional train (see Fig 3). Unlike in the tasks before, where the trains were only going into one direction, in this task the trains go in both directions and can overtake and cross each other at the stations.

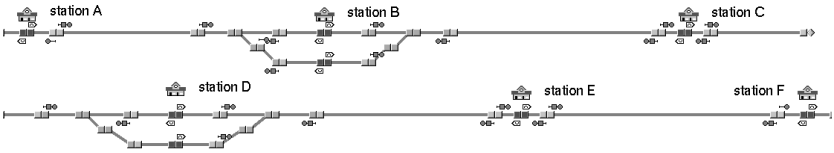

Figure 2 Screenshot of the second infrastructure

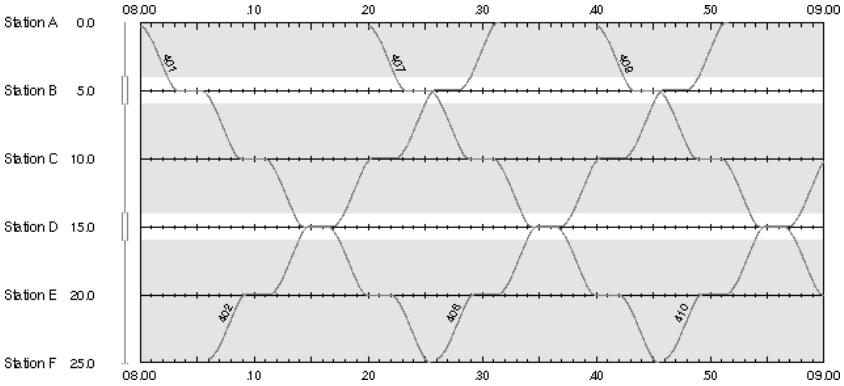

Figure 3 Screenshot of a time–distance diagram for a fixed interval timetable

3.5 Minimum headway time calculation

In the fifth task, the students have to determine the minimum headway time between slower and faster regional trains in order to understand the principle of signalling by displaying the blocking time stairways.

4 Outlook

After this seminar, some of the students continue working with railway simulation in a compulsory interdisciplinary seminar or master's thesis. Possible tasks for the interdisciplinary seminar are to optimise either an existing railway track or an existing time schedule. The students create all required input data by themselves that are rolling stock, infrastructure and timetable. Sometimes it is possible for the students to carry out a simulation in cooperation with a railway operator company.
Overall, also in the upcoming semester there is a good interest in this course and this course is very useful for the students to understand the specific characteristics of railway operation.

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