SIMULATION MODEL OF MARSHALLING YARD LINZ VBF (AUSTRIA)

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ABSTRACT

The paper describes the problems connected with the simulation of Linz marshalling yard operation. The mentioned yard is nowadays supposed to be rebuilt in order to be able to handle more trains as a consequence of cancellation of smaller yards in the surroundings. There was used the special simulation tool called VirtuOS® which provides a convenient environment for making simulation experiments with the operation of any railway junction. Realised simulations enabled to verify the future operation of rebuilt Linz yard and they can serve as support arguments for approval of yard reconstruction.

1. INTRODUCTION

The working and developing team from the Faculty of Management Science and Informatics (University of Žilina, Slovak Republic) has been concentrating recent years on the development of simulation tools, which model the operation in railway junctions on the different level of details.

There were developed the following tools:

- *Ablaufberg*, which simulates in detail the dynamics of train cars from a hump;
- *Simform*, which calculates the optimal train formation using simultaneous sorting;
- *Parallelablauf*, which shows the possibilities of parallel humping from one hump;
- *VirtuOS®*, which provides the experimental environment for simulation of the railway junction operation as a whole (www.eltis.org/en/index.htm).

All mentioned tools were used in several kinds of real projects in order to rationalise or investigate the operation in the different railway junctions.

The simulation study of Linz Vbf represents the most complex project within the frame of which the simulation tool VirtuOS® was applied. Therefore we would like to describe the main tasks and results which are connected with Linz Vfb in this paper.

2. WHY A SIMULATION STUDY OF LINZ VBF?

There is a strategy in Austria to rationalise the processes within the railway network. There is paid attention to some „problematic“ points on that network. The Linz region represents one of these points. The main task in the mentioned region is to concentrate into the existing marshalling yard Linz Vbf the train forming processes from the surroundings where the small and old yards are located.

It was clear from the beginning that the concentration of train forming processes in Linz Vbf would require a reconstruction and an extension.

In order to investigate all possible solutions the General Directorate of Austrian Federal Railways (ÖBB) contacted the working team from University of Žilina two years ago. At the beginning of the year 1998 the project, focused on the mentioned region, started.

3. SIMULATION TOOL VIRTUOS®

Let us now briefly mention the main facts about simulation tool VirtuOS®. This tool was developed in order to enable to build a simulation model, which reflects the whole complex system of a railway junction (marshalling yard, passenger station, private siding etc.). The essential motivation was based on the need to be able to realise simulation experiments, the results of which could be applied to the real yards and help to improve their operation.

However, VirtuOS® itself does not provide automatic solutions of the problems, which occur within the yard. It represents an experimental environment (a laboratory) within the frame of which it is possible to study many variants of a studied yard operation, trackage topology etc. Principally it is possible to say that using VirtuOS® the user-experimenter can answer the questions: „What will happen if...? " Therefore it is expected that VirtuOS® is handled by the well trained railway technologist who, in addition, co-operates with the management of a studied yard.

The work with VirtuOS® can be divided into three basic stages:

- input data collection from a real yard and the building of its model,
- simulation experiments (the runs) on the model and
- recommendations for the yard operation based on the results of simulation experiments and their analysis

In order to build up the above mentioned model it has to be collected the data about:

- *infrastructure* (trackage) - there is scanned and vectorised the paper documentation of a yard (physical infrastructure) and then the function of each of track is defined (logical infrastructure),
- *mobile service resources* (personnel and shunting locomotives) - there are defined the numbers, professions and working shifts for all these resources,
- *trains* - the information about train flows (incoming and outgoing) has to be defined and it is also needed to get the statistics about incoming trains composition,
- *technological processes* - there are defined the train *service technologies* (in the form of network graphs) after train arrival and before train departure, train *sorting* and train *forming processes* (simultaneous train formation, primary and secondary humping, sorting using a hump or flat humping etc.),
- *control* and *decision making strategies* - there are set up the managements of service resources, the decisions of changes of simultaneous train formation schema etc.

When the building of a model is finished, there is made its verification and validation. After that it is possible to start process of making simulation experiments which investigate the yard operation under the required different conditions.

The simulation run can produce the different kinds of outputs. During the simulation run it is possible to see on the screen the animation of all movements of trains and service resources and also on-line statistics about utilisation of service resources are on the shelf. On the other hand the post-simulation outputs can be used. The simulation run reports its evolution into the simulation protocol on the disk. Afterwards, using the specialised tool, it is possible to obtain from the mentioned protocol any required statistics and the graphical protocols (using time scale) of the realised work of any service resource, any track occupation etc. In addition, it is possible to offer to the customers the software called *Viewer.* That software enables to have a look at the whole simulation run using animation outputs.

The results of simulation experiments are analysed and studied by the local technologists. Then there are made the concrete proposals of the real yard operation changes or the results show the need of additional experiments. It is possible to say that the adduced working procedure requires an iterative approach, which usually leads to the solution of some specific problem.

4. SIMULATION EXPERIMENTS WITH LINZ YARD

It was already mentioned that the main goal of Linz simulation study was to investigate the concentration of train forming processes in Linz Vbf. In order to manage all processes it will be necessary to modernise technical equipment and technological procedures in Linz yard.

The most costly part of marshalling yard is represented by trackage infrastructure. Therefore it was paid essential attention to the design of a trackage dimension within the frame of which the future operation will be realised.

The simulation experiments verified gradually the capacities of:

- reception siding,
- hump tracks,
- sorting siding,
- departure siding,
- loop track (which enables the direct train departure from sorting siding to the opposite direction) and
- individual developments of switches.

At the beginning we started to test the maximal variant of trackage infrastructure, which respected the required yard capacity, technological requirements and also the local limitations.

At first we were focused on reception tracks. The investigation of reception siding capacity had to include the problem of opposite train movements. These movements essentially influence the utilisation of a hump. Therefore the development of switches between reception siding and hump tracks was designed (and verified by simulation experiments) in the form which enables big number of parallel movements – the train arrivals to reception siding from the hump direction and humping of trains at the same time.

When the simulation experiments connected with reception siding were finished there was paid attention to sorting and departure siding. In order to propose the capacity of sorting siding mainly these factors had to be considered:

- number of humped wagons,
- technical equipment of sorting siding (wagon positioners, brake compressors etc.),
- interlocking system on a hump (which influences the humping speed),
- possibility of train set transfer to departure siding.

There were realised simulation experiments, which studied various humping speeds and also the occupation of departure tracks. At the end of this stage the numbers of sorting and departure tracks were proposed.

Because of capacity limits of railway network and operational effectiveness it is convenient for the distribution of wagons to form group trains within marshalling yards. The same requirement was defined also for the modernised yard Linz Vbf. The group trains were supposed to be formed using simultaneous approach. The secondary sorting during the simultaneous train formation was to be made on the secondary hump. There were studied those requirements within the several simulation experiments. The results of those experiments showed, that the process of secondary sorting was not realisable on the proposed trackage.

Hence, there were made, on the base of the above mentioned results, the changes of:

- emplacement of secondary hump,
- topology of departure siding and
- development of switches in sorting and departure sidings.

New trackage infrastructure design causes only the minimal interference between the secondary sorting process (as a part of group train formation) and the other train movements.

The individual simulation experiments showed (during solving essential problems) also some smaller inconveniences in the construction of switches developments, which were caused by missing, or bad located track connections.

After investigation of all trackage proposals there were studied within the further simulation experiments the numbers and compositions of shunting locomotives and personnel. The rest of simulation experiments paid attention to the prognostic flow of incoming trains which was sufficiently increased in order to verify the reserves of the new designed trackage infrastructure.

5. CONCLUSIONS

For projects which require to invest big amount of money it is necessary, before starting any construction works, to verify credibly the future effects of the mentioned investment.

The project studying marshalling yard Linz Vbf showed that using simulation methodology can be very useful for the managements of railway companies because they obtain the objective arguments, based on the results of simulation experiments, for making decisions which are connected with any kind of changes within the railway junction. Nowadays there are prepared further projects, which will study other railway junctions in Austria.

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