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# VILLON – A TOOL FOR SIMULATION OF OPERATION OF TRANSPORTATION TERMINALS

*The paper deals with the modelling of transportation terminals operation (e.g. marshalling yards, factories, train care centres, airports, etc.) utilizing generic simulation tool Villon, which was developed using agent based simulation architecture ABAsim. Villon is complete simulation tool providing support for creation, configuration, experimentation and results evaluation tasks connected with simulation modelling of transportation terminals. Villon's unique features like its flexibility, detailed microscopic modelling of operation of various types of terminals, flowchart driven definition of operational procedures, user interaction, selection of decision strategies, 3D animation output and model creation process are explained. Project references and problems that can be addressed using presented simulation tool are also mentioned.*

*Key words: computer simulation, simulation tool, transportation terminal*

## 1 Introduction

The most important and evidently the most costly part of a logistic chain is transportation. The transportation itself is composed of a movement along the transportation route and of necessary manipulations (service processes) applied to transportation means and to transported commodities at specialised locations called transportation terminals (e.g. marshalling yards, factories, train care centres, airports, etc.). Terminals belong to the most complex service systems involving sophisticated technological processes and are equipped with quite complicated and costly technical devices.

Simulation methods currently represent widespread techniques supporting optimisations and planning related to transportation logistic terminals. Presented simulation tool *Villon* supports tactical (middle-term) and strategic (long-term) planning related usually to infrastructural or operational proposals, which are supposed to guarantee optimal (or at least effective) behaviour of modelled terminal. Villon is a generic simulation model which supports microscopic modelling of various types of transportation logistic terminals containing railway and road infrastructures (e.g. marshalling yards, railway passenger stations, factories, train care centres, depots, airports, etc.). Using Villon, users are able to create detailed simulation models of terminal operation, define simulation scenarios, make experiments with the model and evaluate results of simulation runs in one integrated user-friendly environment.

## 2. VILLON Simulation Tool

The simulation tool Villon allows users (professionals in the field of transportation) to create simulation models of transportation terminals, to run prepared scenarios as well as to evaluate results of simulation runs, all without the need to write a single line of program code – utilizing only Villon's user-friendly interface. The creation of complex simulation models of logistic systems, of course, requires a certain level of experience and knowledge. However, using the Villon simulation tool, even a less experienced user is able to create simulation models of simple logistic systems within a short period of time (few days).

Even though the development of this tool was motivated by the ambition to create a complex simulation model of a railway marshalling yard, nowadays Villon is able, thanks also to the architecture flexibility and its other valuable properties, to support modelling of various types of logistic transportation terminals (e.g. railway passenger stations, train depots, factories including road transportation, ground handling within airports etc.).

Villon is a complete generic simulation system; it provides the user with comfortable user-friendly editors to edit all needed data to run a simulation model, supports customisation of many aspects of simulation runs, offers animated output of modelled activities in 2D or 3D view as well as extensive set of post-run evaluation tools (including statistics, graphical protocols and others).

In comparison with other commercially available simulation tools used for modelling of railway operation (among many, we can mention RASIM [2], RailSys [1] or OpenTrack [4], Villon offers its users more precise modelling and visualisation of infrastructure (no schematic approach), detailed modelling of resource (personnel, engines) activities, as well as the possibility to model railway and road traffic in a single model to examine mutual interference. On the other hand, due to its focus on modelling of operation of terminals (nodes), Villon lacks support for modelling of large-scale railway networks or timetable creation abilities.

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In the following text some features of Villon simulation tool and the process of simulation model creation will be presented.

## 3. Creation of simulation model

The creation process of a simulation model of complex logistic system cannot be successfully accomplished without proper data related to various aspects of a modelled system. Following the internal structure of the simulation system, we can divide needed data into three main categories – resources, customers (orders) and operation (services executed). The creation process of a simulation model will be explained on the example of Bratislava-východ marshalling yard [3].

### 3.1 Resources

Since resources represent the vital element in operation of any logistic terminal, special attention has to be paid to their modelling. The infrastructure model is created by direct transformation of a map (plan), which is available either on paper, or in electronic form – an accurate, not only simplified (schematic) model of infrastructure is used in the simulation and therefore we can evade distortions caused by rough approximations. In case of Bratislava východ marshalling yard both forms were used (two thirds of a marshalling yard map were available as MicroStation files, one third as a scanned paper map). It was necessary to join both maps and to use AutoCAD software to prepare digital file (DXF format) which can be used by Villon. After the marshalling yard layout was "translated" for Villon, so called physical level of the infrastructure model was created. On this physical level a definition of track's profession is not possible. Profession is understood as an information about the purpose of each element, e.g. in a marshalling yard model the track will be used as a reception siding, hump track or departure siding, etc. Information about track profession is essential to further development of a simulation model, especially during the editing of service technologies and technological activities. For example, in technological activity "Shunting locomotive movement to train" it is necessary to define the profession which will be used for the locomotive movement. Professions are assigned to tracks by a simulation model creator, based on the knowledge of the real infrastructure. The result of professions assignment is a logical level of an infrastructure model.

Creation of a physical level, track professions list and logical level of infrastructure is followed by the definition of routes, which are used by locomotives and trains for movement from one track to another. The definition of routes is based on the knowledge of the real station.

Mobile resources (e.g. personnel, engines) are modelled individually, respecting their working hours, profession and other properties. For example, in the model of Bratislava východ marshalling yard we modelled shunting locomotives that are used for hump processes and for displacement of wagons from sorting tracks to departure tracks. It was not necessary to model all the personnel of the marshalling yard – only those personnel professions were modelled that work on trains in reception or departure yards.

### 3.2 Customers

Data about customers (from a simulation theory point of view - e.g. trains, cars) are provided in the form of arrival timetables with the possibility of probabilistic modification of their properties (arrival time, loading, composition, ordering of groups, etc.). Timetables could be imported from XLS files (many terminal disposition systems are able to export to this format), which greatly reduces the time required to input the data.

For Bratislava-východ marshalling yard the data from "PIS" (Service information system) were used. Further data about trains and wagon groups were used from "Train-formation plan" of the ZSR Company. Before usage, all the data were checked by employees of the ZSR Company. Thanks to these data, approximately 70 incoming trains were imported and about 50 outgoing trains defined.

### 3.3 Operation

The main operational procedure inside logistic terminals (similarly as in any other service systems) is serving customers entering the system. Since Villon is a generic model and has to support the modelling of various logistic terminal types, it does not contain any hard-coded service procedures – simply said, Villon itself is not able to perform any task without proper "program", which is entered in a form of a flowchart by the user during creation of the model. Flowcharts are composed of activities which represent single tasks executed during serving customers (e.g. loading, resource assignment, brake testing, etc.).

Flowcharts define succession and mutual dependence of activities in a service process. The defined parameterized activities are reusable and can be used in more than one flowchart. Flowcharts are created in a comfortable graphical editor (Fig. 1) with support for automatic validation of entered flowcharts (guarding required succession of some activities and appropriate resource handling). The ready flowchart is then assigned to a customer (e.g. a train or truck). Once defined the flowchart can be reused – the same flowchart can be applied to different customers with the same attendance procedure.

In the model of Bratislava-východ marshalling yard it was necessary to define nearly twenty flowcharts for incoming trains and more than ten flowcharts for outgoing trains. One flowchart has approximately 35 nodes and nearly 50 edges. Because all the trains incoming from same input line are served in the reception yard in the same manner, only one defined flowchart can be used for all of them.

Other operational procedures that were, thanks Villon capabilities, possible to simulate were, for example, the exchange of

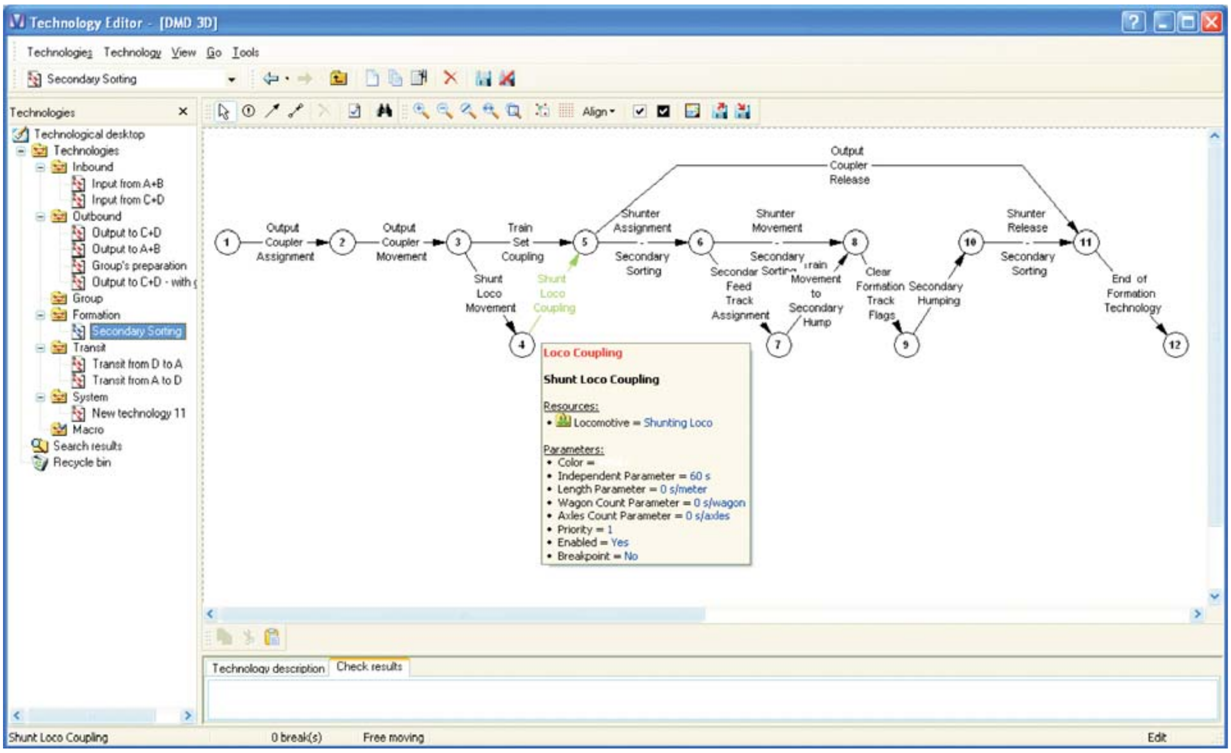


*Fig. 1 Example of a flowchart defining technological procedure of serving a customer*

wagon groups in trains, secondary humping and sorting, the handling of wagons with special service requirements (e.g. wagons loaded by gasoline that can't be sorted on hump).

## 4 Simulation model data structure

In Villon each model consists of *Model Data, Run Properties* and scenarios (called *Configurations*).

Model data are loaded respecting the hierarchy – high level data are loaded first, which enables to perform pre-run validation of entered data and also allows comfortable editing. For example, Villon checks if the incoming track for a train, which is defined at lower level (when defining timetable), is present in the infrastructure data and, on the other hand, Villon's timetable editor allows a user to select only such an incoming track that is defined in the infrastructure data as a track suitable for arrival of trains.

Run Properties portion of model define attributes of simulation run – duration, animation settings, simulation protocol options and cooperation options.

A user has the chance to create many variants (represented by distinct data files) of every data type. A simulation scenario is then simply created by selection of a single variant of every data type (e.g. the user selects one variant of infrastructure, one variant of personnel and so on Fig. 2). The scenario created such a way is associated with a specific name and can be stored in the database of scenarios (configurations).

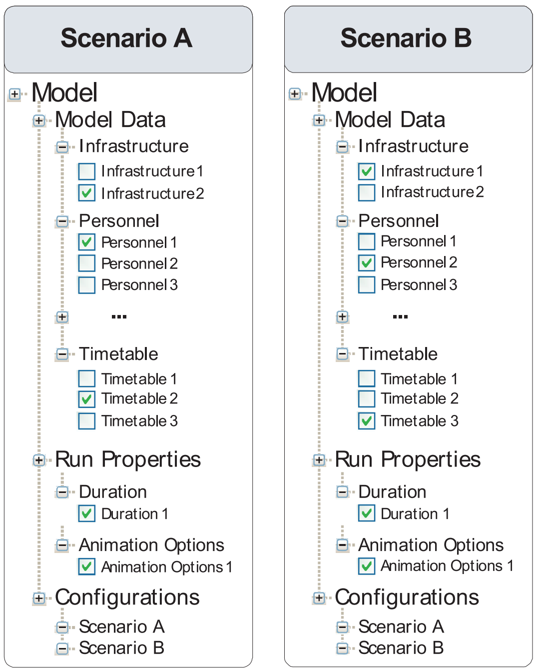


*Fig. 2 Villon model data structure and scenarios*

For the model of Bratislava-vychod marshalling yard we defined three scenarios (configurations). The first scenario reflects current operation. The second scenario reflects operation after the modified schedule for secondary sorting application. The third scenario shows the operation after changes in train-formation rules in Bratislava region.

## 5. Simulation run

Once all the needed data are collected and the scenario is chosen, the simulation run can be started. During the simulation run animation of all movements of vehicles (train sets, cars, airplanes, locomotives, etc.) is presented to the user. The user can choose between two or three dimensional view of the scene (Fig. 3).

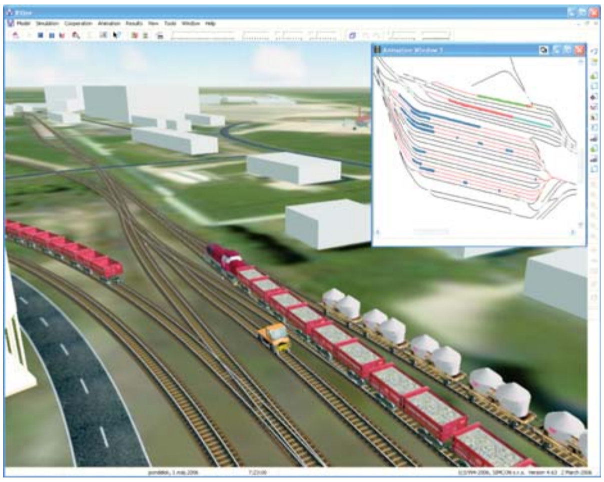

*Fig. 3 Example of 2D and 3D animation in Villon*

## 6. Results evaluation

As the simulation proceeds the user can follow a "live" development (change of values) of selected characteristics in a graphical presentation (e.g. status of personnel or utilization rate of a selected locomotive). Another type of output information is the overall information retrievable after termination of the simulation run. To this purpose, a detailed protocol on simulation is generated during the simulation run. These protocols can be processed separately and a sought for information can be retrieved from them. Various statistics are obtainable from the palette of pre-defined evaluations. The palette is open for adding new items according to the user's wish. Besides the graphical presentation of simulation results using time dependent reports on utilization of resources, waiting times, etc. (Fig. 4), statistical evaluations are also provided, in the form of tables, graphs and charts.

Villon also offers the chance to export all the collected information to the XLS file for further processing using a spreadsheet editor.

An important feature of Villon is the possibility of deploying a special Viewer version executable of the simulation tool to the customer. This Viewer version enables customers (e.g. the owner of examined terminal) to execute simulation runs prepared by model designers and also exploit complete range of run-time and post-run evaluation options Villon offers. Of course, the Viewer does not allow the customer to change any model data, which could have unpredictable consequences.

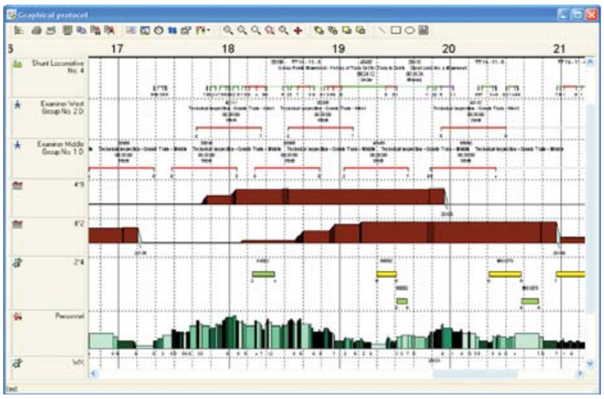


*Fig. 4 Graphical time dependent reports example*

## 7 Conclusion

The tool Villon was applied in commercial environment within simulation studies of marshalling yards in Austria (Vienna, Linz), in Germany (Hamburg Alte Süderelbe, Oberhausen-Osterfeld), in Switzerland (Lausanne, Basel), and in China (Mudanjiang, Harbin). Other applications of the discussed tool concentrated, for example, on investigation of a new proposed design of the railway depot in Ulm (Germany); verification of operation of the Prague Masaryk passenger station (Czech Republic), or proof of the internal railway-road traffic concepts inside the car production company Volkswagen Bratislava (Slovakia). Among other applications in industry (mostly connected with production increase in modelled facilities) following can be mentioned – the factory sidings of the chemical plant BASF Ludwigshafen (Germany), the internal railway traffic of the paper producing company SCA Laakirchen (Austria) and steel production companies Voest Alpine Linz (Austria) and Teesside Cast Products Middlesborough (United Kingdom).

The substantial decisions in the field of transport, respecting the contemporary level of information technologies and simulation methodologies, should not be adopted without modelling their consequences. The software tool Villon supports microscopic simulations of the most complex and large-scale transportation terminals and enables not only to investigate the consequences of adopted decisions but also (by means of the reasonable sequence of experiments) to choose the best solution and to save the financial resources.

The generic character of the Villon simulation tool brings one important consequence: once built, verified and validated the model of one specific node can be used repeatedly in seeking for solutions of a different type. For example, the same simulation model can be utilized for investigation related to optimal reconstruction of a terminal (long-term planning); on the other hand, it can be also useful during the real reconstruction in order to study operation within different reconstruction stages (medium-term planning).

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