Applications of Mass Handling Theory in Vehicles Operation and Maintenance

Stanislav Antonicky[1], Alois Danek[2], Jaromir Siroký [3]

[1] *Institute of Transport, Technical University Ostrava, Czech republic, http://www.vsb.cz*
Tel:(+0421696994428), Fax:(+04216916490), stanislav.antonicky@vsb.cz
[2] *Tel:(+0421696994577), alois.danek@vsb.cz*
[3] *Tel:(+0421696994553), jaromir.siroky@vsb.cz*

Abstract: Paper shows the connection of theoretical teaching part and computer simulation in framework WITNESS. The computer and dat a projector are used in the course of teaching. That increases efficiency of teaching process and causes better assumption of knowledge by students. Servicing processes have in vehicle's repair the considerable character. Here deals about different process models, beginning from pump station, vehicle's washing and different operations in course of repairs and maintenance. For effective designs such workrooms is necessary into teaching comprehending necessary theoretical experience about character and solving theses processes. To obtain the solving of theses processes in enclosure shape exists possibility only for some elementary distribution functions of job stream and handling time period. For practical solving is advisable to apply computer's software framework, for example WITNESS. This allows to describing some complicated job stream distributions and handling period too. It enables to acquire thereby the review and variant solving - including process arrangement.

Keywords: teaching, simulation, maintenance, repair, vehicle.

1. Introduction

Study programme of the Faculty of Mechanical Engineering VSB-TU offers the possibility to study a transport problematic on all the levels of the university degree: - bachelor (BSc), - master (MSc), - doctoral studies (PhD)

System of master and doctoral study for Transport problems has two specialisation:

1. ***Transport Techniques*** - study and dissertation works will be orientated in these problems:
actual transport problems and their optimised solutions
searching possibilities of automation of operations
searching of new technical solutions
modelling of operations

Solution of problems connected with safety and reliability of transport means including its modernisation and reconstruction will be benefit. For this study we have compulsory and optional subjects:

-- Reliability and Renewal Theory of Vehicles - Technical diagnostics of rolling stock - Optimum technical and economic model of maintenance system. - Life cycle emissions of the road vehicles. Organisation and management of repair services.

2.*Transport Technology* - study and dissertation works will be orientated in these problems:
actual problems of transport and its technologies and its new concepts
modelling and simulating of transport operations
optimisation of technologies

For this study we have compulsory and optional subjects: Applied Mathematics, Methods of the Measurement Evaluating of the Physical Dimensions, Logistics and Circulation Processes-- New Repair Technologies - Development and software for models, structures, preliminary variants of models, the choice of appropriate program environment, formulation of inputs, development of algorithms.

From listed above review follows, that problematic of mass handling process has for named honours great importance.

2. Theoretical introduction

Paper shows an example of the teaching in studying of vehicle' s operation, maintenance and repairs, for students of the fifth year or Ph.D. student' s specialisation "Operation. and maintenance of road vehicles" and "Construction, operation and maintenance of rail vehicles".

At first all necessary theory is lectured to essential extent. Theory is amended by demonstration of simulation in computer environment WITNESS. In seminar students get homework, which are similar to following example. This homework is then individually solved.

Typical random process from practice is accumulation of units, which are to be processed by certain system, this means process of mass handling. Among such units belong e.g. machines waiting for repair, customers in supermarket at cash desk, vehicle at pump station and so on.

Random processes of that type can be practically solved by means of. Markov' s model. These models are available tools for series of tasks in operational analyses, technical cybernetics etc. - [1].

In compliance with above-mentioned criteria system of mass handling can be classified in few categories. Most used is for example Kendall' s classification of mass handling system. This classification isn't evidently comprehensive; it is used mainly for its own simplicity in basic characteristic.

3. Formulation of task and its solution

Task is focused on systems operation with two handling– for example car washing in a washer with two stands. Handling requirements creates Poisson' s process with intensity λ. Time till handling has exponential distribution with mean value $\frac{1}{\mu}$. Suppose, that two cars can be handled altogether. Find out location of number of units in system (number of handled and waiting for handling), then $p_0, p_1, p_2, \ldots\ldots, p_n$ for $n \geq 2$. Quantities and equations and values are written in Table 1, Table 2 and Table 3. -[2].

Table 1

Probability of no vehicles waiting for washing	$p_0 = \frac{1}{\sum_{k=0}^{n-1} \frac{\beta^k}{k!} + \frac{n^n}{n!} \sum_{k=n}^{\infty} \rho^k}$
Mean number of vehicles waiting in queue for washing	$\gamma = p_n \frac{\rho}{(1-\rho)^2}$
Mean number of occupied stands	$\upsilon = \beta$
Mean number of vehicles at washer totally	$\kappa = \gamma + \upsilon$

Table 2

λ.... Mean number of vehicles in 1 hour	$l = \frac{60.60}{80} = 45$
μ... Mean number of vehicles, which line served in 1 hour	$\frac{1}{m} = \frac{1}{\frac{2,5}{60}} = \frac{60}{2,5} = 24 \Rightarrow m = 24$
Determination β:	$b = \frac{l}{m} = \frac{45}{24}$

Determination ρ:	$r = \frac{l}{n.m} = \frac{45}{2.24} = \frac{45}{48} = 0,9375 < 1$ $r < 1....condition - of - system - stabilisaton$

Table 3

Probability, that by washer is no vehicle	$p_0 = \frac{1}{\sum_{k=0}^{n-1} \frac{\beta^k}{k!} + \frac{n^n}{n!} \sum_{k=n}^{\infty} \rho^k} = \frac{1}{1 + \frac{45}{24} + \frac{2^2}{2!}\left(\frac{45}{48}\right)^2 \frac{1}{1 - \frac{45}{48}}} = 0,0323$
Probability, that vehicle waits	$p = p_2 \frac{1}{1 - r} = 0,0567 . \frac{1}{1 - \frac{45}{48}} = 0,907$
Mean number of vehicles at washer totally	$k = g + u$ =13,61+1,87=15,48
Mean lost time one' s vehicle in queue	$EW = \frac{p}{nm - l} = \frac{0,907}{2.24 - 45} = 0,302\ hour$
Mean time for one vehicle in system	$ER = EW + \frac{1}{m} = 0,302 + \frac{1}{24} = 0,344\ hour$

4. Simulation of system

For simulation of given problem is necessary choose calculation environment, which allows creation of discreet events models. For the chosen group of problem is necessary, so the media was able realize the stochastic access to enter of input, output and status variable models. Therefor was chosen simulation program WITNESS® from company Lanner Group Ltd.

Basic attributes, which are with advantage used by model creation:

- Intuitivity by control (standard by Microsoft);
- Possibility of the encapsulation of application;
- Cooperation with other standard technologies of Microsoft;
- Existence of integrable component unit (WITNESS VR, WITNESS Optimalizer, integration with CAD systems and additional);
- Possibility of application expert systems with cooperation modular structure;
- Last but not least is the operative application for system observation in real time and reaction at existing state
- For practice is important the possibility of generic modeling from other medium.

There are advantages of simulating media WITNESS, which is used by modeling of manufacturing and technological processes. Program however serves for the model creation and simulation of handling processes and facilities. For model implementation are used 3 basic building items:

- **Elements** (part, stack, machine, conveyor-belt, path, vehicle, labor force, FP conveyor-belt, variables, display elements and others);
- **Input – output laws** for single bindings component model realization;
- **Action** – by means of that realizes the model control function of events.

For monitoring and evaluation of the simulation experiments serves several report types in tabular and graphics form, as well as their export in many formats supported of Windows platform.

5. Model

Model of the washer line is composed of 3 elements. Base is composed of element **Car** type Part, that browses through system and on its pass we observe the model manners. Element **Front** represents excepting vehicle queue and relaxes of element type **Buffer**. Washer is realized of element with description **Machine** effect single. Simulation is realized through passage Car with active input of probability distribution from the task.

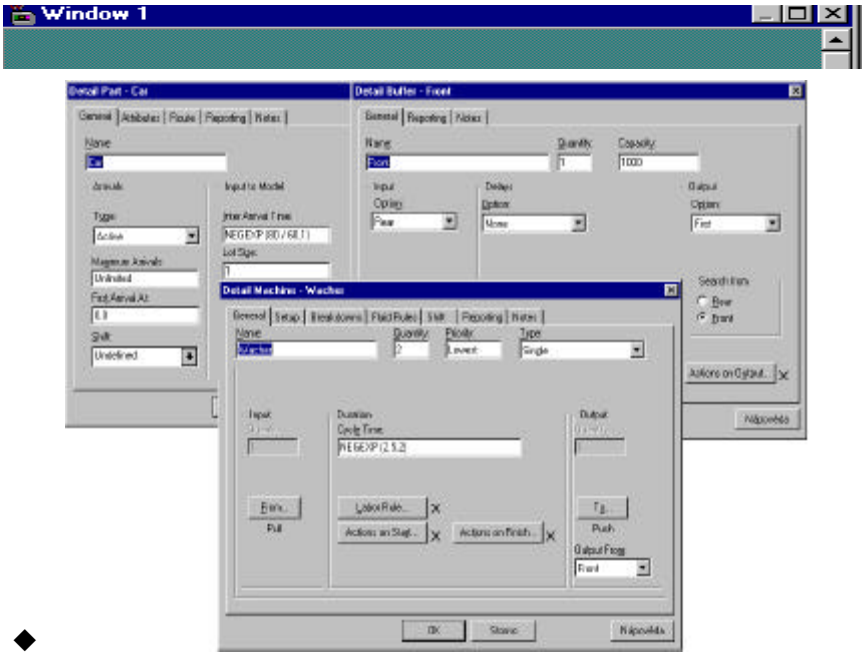

Fig. 1: Parameter of single model components

Fig. 1.shows the basic single component characteristics.

As simulation unit is choose 1 minute. Total simulation time is given in 43200 simulation' s units. After his expiration we can view simulation results according output chart in Fig.2.As simulation unit is chose 1 minute. Total

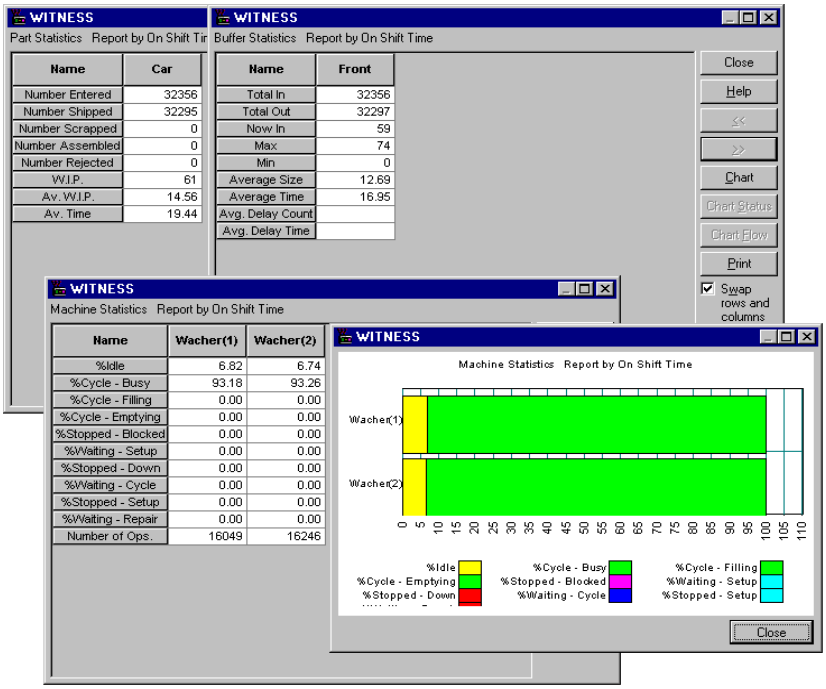

Fig. 2: Summmary reports of componensts.

simulation time is given in 43200 simulations units. After its expiration we can view simulation results according output chart in Fig.2.

This result we compare with results of theoretical computation. (Table 4). If we change the number of stands to 4, are results of simulation in Table 5.

Table 4

Par.	**Calc.**	**Sim.**
γ	13,61	12,69
ν	1,88	1,86
κ	15,48	14,55
EW [h]	0,302	0,2825
ER [h]	0,344	0,324

Table 5

Par.	**Calc.**	**Sim.**
γ	0,1	0,13
ν	1,88	1,86
κ	2	1,99
EW [h]	0,003	0,003 h
ER [h]	0,045	0,045 h

Conclusion

Results from computation (according to Markov's processes) are comparable with results from simulation experiment. Some parameter from calculation can not be realized by simulation. The comparison of both methods shows possibilities their applications by the description of mass handling systems in practice.

7. References

[1] Maixner, L.: Markovovy procesy a jejich aplikace, skriptum UP Olomouc, 1991
[2] Daní k, A., Bronèek, M. a kol.: Opravárenství silniční ch vozidel. Skriptum VŠB-TU Ostrava.