DEVELOPMENT OF COMPUTER SIMULATION AND ITS USE FOR THE NEEDS OF LOGISTICS

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Abstract

The article deals with the development of computer simulation with a focus on the use in the field of logistics. Computer simulation has passed since the last century long development. The beginnings associated with general program tools with a focus on random number generators have gradually replaced systems that are specially and exclusively oriented to modular, block creation of computer simulation models. At present, it is common and obvious that the computer simulation model is made up of blocks that perform precisely defined functions. Within logistics, the use of computer simulation is common and desirable. Logistics is made up of elements such as purchase - production - sales in relation to other identical chains. This chain allows simulation to use the same principle of creating computer simulation models that are made up of typed blocks such as input, queue, service device, output. Principles of computer simulation models still remain the same but changing the view of the resulting display and conduct simulations which enable new and realistic 3D and realistically oriented computer simulation systems.

Keywords: Computer simulation, logistics, development, trends, systems

1. INTRODUCTION

Simulation and modelling as branches have come a long way, but their importance is still sizeable. Simulation is an established analysis method for manufacturing and logistic purposes. It is frequently used when decisions with high risks have to be taken, and the consequences of such decisions are not directly visible, or no suitable analytical solutions are available [1]. Simulation tools are becoming increasingly dynamic to capture the interaction between level of service and potential revenue generation. Since there are substantial economies of scale in logistics, increased demand offers the potential to reduce cost which, in turn, offers potential incentives to increase demand [2]. The use of simulation for manufacturing systems design and analysis is rightfully recognized by scientists and industrial managers. Traditionally, simulation has been used for offline decision-making. One of the limitations of its use for online decision-making is the considerable amount of time spent in gathering and analysing data. In real-time control, the three key issues are data acquisition, quick response and instantaneous feedback [3]. Simulation experiments can determine the best available trade-off in any particular situation such as achieving the lean logistics aim of minimum reasonable inventory whilst retaining high customer service levels [4].

A simulation of the systems makes it possible to experiment besides real objects, resp. these objects do not have to exist in reality. Simulation as a term means an imitation of some real situation, thing, condition, action, event of process [5-7]. Simulation is a research method, the essence of which consists of the replacement of an essential dynamic system by its model, simulator, and we perform experiments with the purpose of getting the information about the essential system. The origins of the creation of simulation models goes back to the 1950’s, when universal, general programming systems were used to create simulation models. A gradual development and progress is every area of production, science and practice required increasingly difficult simulation models and applications. General programming systems proved to be maladroit and not dynamic enough to create fast changes in the simulation models. A special category of programming systems has gradually been invented. These systems are called simulation systems.

Simulation systems are adapted for the purposes of simulation. They allow us to create program simulation models in such form to create models representing the simulated systems [8-11]. The simulation models allow us to perform quick changes in the created models, in case they are needed, in such a way that the created models correspond to the changes that can occur in a real system.

For solution, realization, modelling and simulation of the logistics, transportation and production systems are important input data, quality of systems analysis, methods and methodology of solution and available and quality of simulation systems too [12-21].

The evolutional phases of the simulation systems change in time and naturally evolve (**Table 1**) [22]. The recent state is characterized by object and realistically oriented simulation with the support of 3D animations and video on a professional level.

Table 1 The Generation of simulation systems [22]

Generation	Years	Characteristics	Software (e.g.)
Generation 1	1950-1960	General programming languages, no special support for the simulation	FORTRAN, ALGOL, ASSEMBLER, ...
Generation 2	1960-1970	Programming languages, support for generating random numbers, processing of statistics.	GPSS, SIMSCRIPT GASP II, SIMULA, ...
Generation 3	1970-1980	Discrete events, continuous and combined simulation	GASP IV, ACSL, ...
Generation 4	1980-1985	Special problem oriented simulators, 2D animation, simulation as a project	SIMAN/CINEMA, SIMFACTORY, SEEWHY, ...
Generation 5	1985-1990	Artificial intelligence and expert systems in simulation	SIMKIT, SIMULATION CRAFT, SIMPLE, ...
Generation 6	1990-2000	Object oriented simulation systems, mathematical modelling support	SIMPLE++, ARENA, EXTEND, MATLAB, FLEXSIM, ...
Generation 7	2000-2010	Object oriented simulation systems, 3D animation, 3D simulation	EXTEND (4-6), SIMUL 8, WITNESS, TECNOMATIX, ...
Generation 8	2010-present time	Realistically oriented simulation systems, 3D simulation, real display of systems, virtual reality, large-scale simulation projects, complex simulation of manufacturing systems	TECNOMATIX, WITNESS, EXTEND (7-9), ...

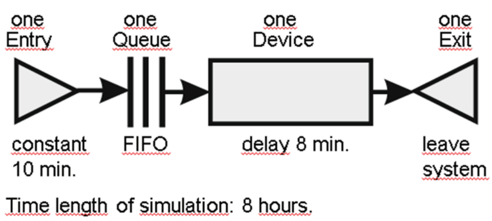
The main ideas of the article are possible to define as:

- Where is going the development of simulation programs?
- Are older simulation programs as good as new (in terms of simulation results not design of simulation models)?

Goal of the article is to compare a several computer simulation programs for design of the same model.

2. DESIGN OF THE SIMULATION MODEL FOR THE SIMULATION PROGRAMS COMPARING

For comparing of the simulation programs will be used a simple queuing system (SQS) (**Figure 1**).



(FIFO - First In First Out)

Figure 1 Formal schema and parameters of the researched simple queuing system

2.1. Design of the simulation model in the General Purpose Simulation System - GPSS

General Purpose Simulation System is system of 60´s years, the second generation of simulation systems. GPSS is still live and active system. GPSS is possible to download for example from links http://www.minutemansoftware.com/simulation.htm, http://www.wolverinesoftware.com/GPSSHProducts.htm. For our comparing we will use GPSS product of the Minuteman software company (**Figure 2**).

```
*Segment I. - SQS model
          SIMULATE
          GENERATE  10
          QUEUE     RAD
          SEIZE     STR
          DEPART    RAD
          ADVANCE   8
          RELEASE   STR
          TERMINATE

*Timer 480 min.=8 hod.
*Segment II. - timer of simulation
          GENERATE  480
          TERMINATE 1
          START     1
```

Figure 2 GPSS simulation model of our researched system

After the process of the simulation, the system offers us to save the report to the disk as a text document and opens the text document containing a complex statistics of the processed simulation (**Figure 3**). The report of the simulation shows us, that the researched system is utilized up to (0.813) circa 81%. The total number of requirements in eight hours was 47. The average time of service according to one requirement was circa 8.132 minutes. The total number of inputs into the queue was 48. The total average time the requirements spent waiting in the queue was 5.014 minutes. The report follows, that the running of the system is adequate with one device. If there were more requirements attending the system, it would be necessary to buy one more device. If there was one more device bought to the system, the simple queuing system would become parallel service system, resp. multichannel service system.

```
              GPSS World Simulation Report - GPSS_JSHO.44.1
                   Monday, June 26, 2017 09:30:56
           START TIME           END TIME  BLOCKS  FACILITIES  STORAGES
                0.000            480.000     9         1          0

              NAME                       VALUE
                                      UNSPECIFIED
          RAD                         10000.000
          STR                         10001.000

 LABEL              LOC  BLOCK TYPE     ENTRY COUNT CURRENT COUNT RETRY
                     1    GENERATE            48             0       0
                     2    QUEUE               48             0       0
                     3    SEIZE               48             0       0
                     4    DEPART              48             0       0
                     5    ADVANCE             48             1       0
                     6    RELEASE             47             0       0
                     7    TERMINATE           47             0       0
                     8    GENERATE             1             0       0
                     9    TERMINATE            1             0       0

FACILITY         ENTRIES  UTIL.    AVE. TIME AVAIL. OWNER PEND  INTER RETRY DELAY
 STR                48     0.813       8.132   1        49    0     0     0     0

QUEUE              MAX CONT. ENTRY ENTRY(0) AVE.CONT. AVE.TIME   AVE.(-0) RETRY
 RAD                 3    0     48     21     0.501      5.014      8.914   0
```

Figure 3 GPSS report of the simulation

2.2. Design of the simulation model in the EXTENDSIM

EXTENDSIM is system of ends of 90´s years and beginning of the 21st century. EXTENDSIM belongs to the group of simulation systems, which combine the options of discrete and continuous simulation. This is the reason why EXTENDSIM is the most desired simulation tool for computers using Windows and also Macintosh platform.

EXTENDSIM simulation system is the product of the company Imagine That, Inc. USA. The company offer EXTENDSIM in four versions which are different from each other in the use, resp. in the number of blocks, from which it is possible to create simulation models. The company offers the version EXTENDSIM Demo for the beginning creators free-of-charge and its actual version is downloadable directly from the website of the producer www.extendsim.com.

The demo version is fully functional according to the process of the simulation, but its disadvantage is that it is impossible to save the created simulation models for further use and the simulation model cannot be created from more than 25 blocks. Despite these limitations, the demo version is sufficient enough to gain general knowledge about the work with this simulation tool. Our researched system is created from a several blocks (**Figure 4**) of the system EXTENDSIM.

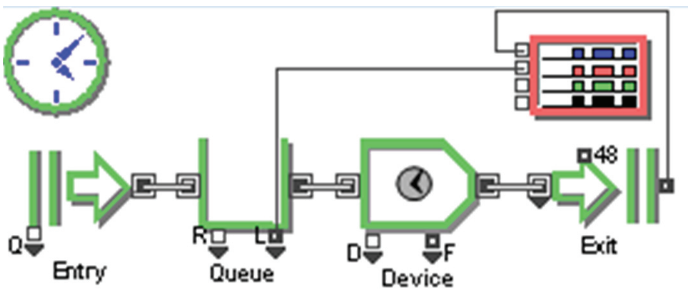


Figure 4 EXTENDSIM simulation model of our researched system

After the process of the simulation, the system offers us to save the report to the disk as a text document and opens the text document containing a complex statistics of the processed simulation (**Figure 5**). The report of the simulation shows us, that the researched system is utilized up to (0.8) circa 80%. The total number of requirements in eight hours was 48. The average time of service according to one requirement was circa 0.133 minutes. The total number of inputs into the queue was 48. The total average time the requirements spent waiting in the queue was 0.00 minutes. The report follows, that the running of the system is similar as in GPSS.

```
ExtendSim Statistics Report - 26.6.2017 22:16:29
Run #0

ACTIVITIES_____
Block Label      Number Name         Length  Ave Len Max Len Wait
---------------- ------ ------------ ------- ------- ------- -------
Device           3      Activity     0       0,8     1       0,13333

                 AveWait MaxWait Arrive  Depart  Preempt Util
                 ------- ------- ------- ------- ------- -------
                 0,13333 0,13333 48      48      0       0,8

QUEUES_________
Block Label      Number Name         Length  Ave Len Max Len Wait
---------------- ------ ------------ ------- ------- ------- -------
Queue            2      Queue        0       0       1       0

                 AveWait MaxWait Arrive  Depart  Reneges Util
                 ------- ------- ------- ------- ------- -------
                 0       0       48      48      0       0
```

Figure 5 EXTENDSIM report of the simulation

2.3. Design of the simulation model in the Tecnomatix Plant Simulation System

Tecnomatix Plant Simulation system (TPS) is modern system beginning of the 21st century. TPS system belongs to the group of simulation systems, which are oriented to discrete simulation with quality of 3D animation. This is the reason why TPS system is very popular for modelling and simulation of processes in automobile industry.

TPS system is the product of the company Siemens. The company offer TPS system in a several variations. The company offers the version TPS Student version for the beginning creators free-of-charge and its actual version is downloadable directly from the website of the producer https://www.plm.automation.siemens.com/en/academic/resources/tecnomatix/simulation-download.cfm. The demo version is fully functional according to the process of the simulation, but its disadvantage is that it is impossible to use it for commercial utilization. Our researched system is created from a several blocks (**Figure 6**) of the system TPS.

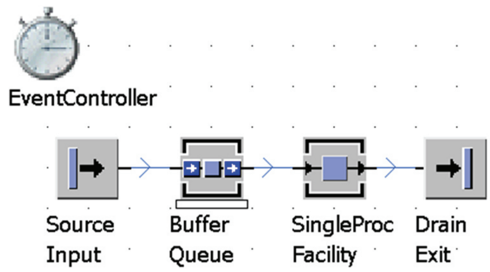


Figure 6 TPS simulation model of our researched system

After the process of the simulation, the system can show for us the report of the simulation process (**Figure 7**). The report of the simulation shows us, that the researched system is utilized circa 80.33%. The total number of requirements in eight hours was 48. The average time of service according to one requirement was circa 8.00 minutes. The total number of inputs into the queue was 48. The total average time the requirements spent waiting in the queue was 0.00 minutes. The report follows, that the running of the system is similar as in GPSS and EXTENDSIM.

Material Flow Properties

Object	Number of Entries	Number of Exits	Minimum Contents	Maximum Contents
Buffer	48	48	0	1
Source	48	48	0	1
Drain	48	48	0	1
SingleProc	48	48	0	1

Working Time

Object	Portion	Count	Sum	Mean Value	Standard Deviation
Buffer	0.00%	0	0.0000	0.0000	0.0000
Source	0.00%	0	0.0000	0.0000	0.0000
Drain	0.00%	48	0.0000	0.0000	0.0000
SingleProc	80.33%	48	6:24:00.0000	8:00.0000	0.0000

Figure 7 TPS report of the simulation

3. CONCLUSION

After comparing of simulation programs and results of our simulation example we can consider that methodologhy of simulation system activity is still the same or very similar but system of simulation model design is new. New computer simulation programs can realize 2D and 3D animation (**Figure 8**) what is impossible in the older simulation program versions.

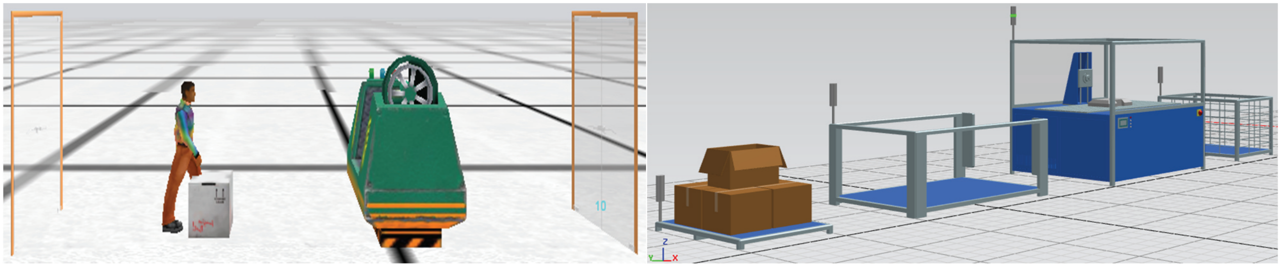


Figure 8 An examples of the 3D animations of advanced simulation systems

In the next research of the simulation systems comparing we would like bring the answer for the question *"How is quality of the simulation systems on the market?"* For the future and in the next article we will realize comparing of the concrete simulation programs by examples of a parallel, serial and multichannel systems.

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