

PROCESS SIMULATION AND METHODS OF GENERATING RANDOM NUMBERS

Gabriela Ižaríková

TU of Košice, Faculty of Mechanical Engineering, Institute of Special Technical Sciences, Department of Applied Mathematics and Informatics, Letná 9, 042 00 Košice, e-mail: gabriela.izarikova@tuke.sk

Keywords: simulation model, mathematical modelling, random number generation

Abstract: The article deals with the process of the simulation and the random number generation. Simulation, especially computer simulation has been in a rapid growth in recent years. The simulation is experimenting with computer models based on the real production process in order to optimize the production processes or the system. The simulation model allows to perform a number of experiments, analyze them, evaluate, optimize and afterwards apply the results to the real system. Production enterprises investing in technical training, to affect the time between research, development and production. In order to reduce this time interval is used in the design of the technological process by computers with suitable software. The mathematical description of the technological process whose outcome depends on factors entering into the process is defined as a mathematical model of the process. If the outcome of the process can not be expressed mathematically dependent on factors entering into the process it is a simulation.

1 Introduction

The current period is characterized by the development of technology where the most significant are computers and information technology. IT extends to all areas of our lives and also pushed through in engineering production and in particular the planning and design of production, modeling and simulation of production in production management, etc.

Production enterprises investing in technical training, to affect the time between research, development and production. In order to reduce this time interval is used in the design of the technological process by computers with suitable software. The mathematical description of the technological process whose outcome depends on factors entering into the process is defined as a mathematical model of the process. If the outcome of the process can not be expressed mathematically dependent on factors entering into the process it is a simulation [1].

Mathematical modeling is commonly defined as modeling, in which the shape of the mathematical model structure, as for instance variables, programs, functions, equations, logical conditions, operators and other mathematical objects. Mathematical system can not only have quantitative characteristics of site systems and processes, but also is characterizes by the qualitative aspect. Simulation is defined as the research method, which is characterized as during experiment on a dynamical system is replaced by its simulation model as it attempts are made to obtain information about the original investigation system [2]. Experimental testing process compare to the actual manufacturing equipment (model) is costly and time-consuming. Mathematical modeling and simulation of technological processes is using computer technology to optimize the production process

without any real production equipment. To build such models for complex technological processes consisting of a large number of operations at a number of production machines is challenging and it is used the simulation approach. The modern concept of the production process is a Computer Integrated Manufacturing (CIM), the scheme is on Fig.1.

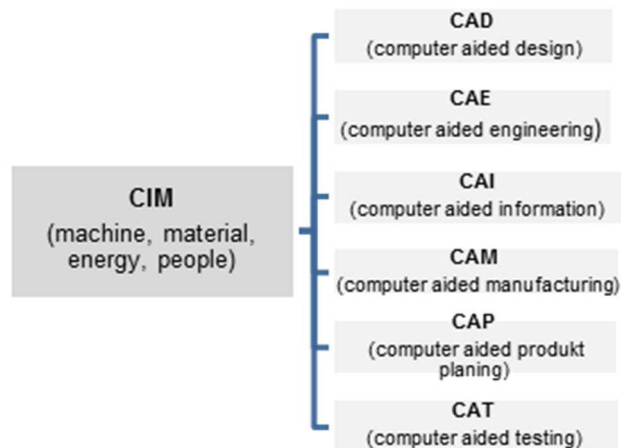


Figure 1 Structure of production process – CIM

2 Phases of the simulation process

The simulation consists of the following steps - build the model, design of simulation experiments, perform simulation analysis [3], [4]. Modeling is probably the most important part of simulation, simulation modeling involves the following steps:

PROCESS SIMULATION AND METHODS OF GENERATING RANDOM NUMBERS

Gabriela Ižaríková

- *Formulation of the problem* - defining specific problem, defining the overall objective of the solution and the impact of measures (quantitative criteria).

- *The collection and processing of data in the real system* - the collection of data about the systems specifications, gathering input variables, gathering information about the performance of the existing system, identification of randomness in the system.

- *Creation of the model* - the formulation of a development model, development schemes and network diagrams systems, setting simulation runs, transcription conceptual model into the simulation software in an acceptable form, review the scope of input parameter animation.

- *Validation of the model* - compare the performance of the model under known conditions with the performance of the real system, perform statistical tests, assessment simulation studies experienced analysts verify the correctness, completeness and consistency of the model.

- *Creation of documentation* - compiling documentation model for future use, a detailed record of objectives, assumptions, input variables of the simulation model, the number of attempts in the simulation.

- *Selection of the appropriate experiment* - the choice of performance measures, the number of input variables that are likely to affect it and the variability of each entry (number of possible configurations is the product of the number of input variables and levels of each input variable).

- *Determination of initial conditions for the simulation runs* - obtaining accurate information of each run, determine whether the system is stationary (performance measures do not change over time), or non-stationary (power changes over time), verify whether it is appropriate Whether or not the simulation run, the choice of its length, the choice of the appropriate starting conditions, the choice of size sample measured estimates, identification of correlations between output data.

- *Fitting Simulation* - perform simulations using simulation software packages.

- *Interpretation and presentation of results* - numerical calculation of estimates (eg median, confidence intervals) for the required performance measures for each configuration, determine the autocorrelation verification test hypotheses about system performance, design graphical presentation of the output data.

- *It offers a way forward* - recommendations for further action, which could include further experiments to increase accuracy and decrease preload estimates.

The simulation results are approximate but sufficiently accurate solution of the task, finding possible alternatives and appropriate conclusion [5]. The main point of mathematical modeling and computer simulation is that the original system replaces a computer model that can be implemented with the various computer experiments and

their results retrospectively applied to the original system. On the computer you can change the system inputs and system parameters and model can be modified in different places. For these changes to the model reacts to change the output values. To create simulation models currently used specialized software. Methods of computer simulation can be addressed by using the MS Excel and its supplements: Risk Solver,risk, Risk Analyzer, MonteCarlo, Crystal Ball and others.

3 Methods of generating random numbers

In Microsoft Excel simulation models can be constructed in two basic ways:

- using built-in functions,
- using the "Random Number Generation" in Appendix Data Analysis

To generate random numbers you can use command RAND (), we get a random number with uniform distribution in the interval (0,1). To determine the percentage of occurrence of random numbers in the interval function is used COUNTIF (Fig. 2).

	A	B	C	D	E	F	G
1	Experiment	Random number	n=1000	average	0,507641		
2	1	0,195465563					
3	2	0,295041987					
4	3	0,454097066		Intervals		Perc. of occur.	
5	4	0,424401891		0	0,2	0,197	
6	5	0,126242198		0,2	0,4	0,197	
7	6	0,989168335		0,4	0,6	0,202	
8	7	0,745239115		0,6	0,8	0,208	
9	8	0,890169962		0,8	1	0,196	
10	9	0,498856858					
11	10	0,448108615		Intervals		Perc. of occur.	
12	11	0,873974247		0	0,25	0,25	
13	12	0,186481643		0,25	0,5	0,245	
14	13	0,779840583		0,5	0,75	0,253	
15	14	0,743215758		0,75	1	0,252	
16	15	0,249801059					

Figure 2 Generating random numbers, determine the percentage of occurrence

The diameter 1000 of random numbers each time approximates to a value of 0.5 approximately 20% of the results in each of intervals, the distribution of numbers into five intervals, the numbers are distributed to the four intervals is 25% of the results. These results are consistent with the definition of the random number values are generated independently from each other, and of course each other, because the function of the "random" always calculates the numbers generated. The "Random" is also used to generate values for various probability distributions.

Example of generating random inputs for simulation model by using built-in functions is depicted on Fig.3 – Fig.6.

PROCESS SIMULATION AND METHODS OF GENERATING RANDOM NUMBERS

Gabriela Ižariková

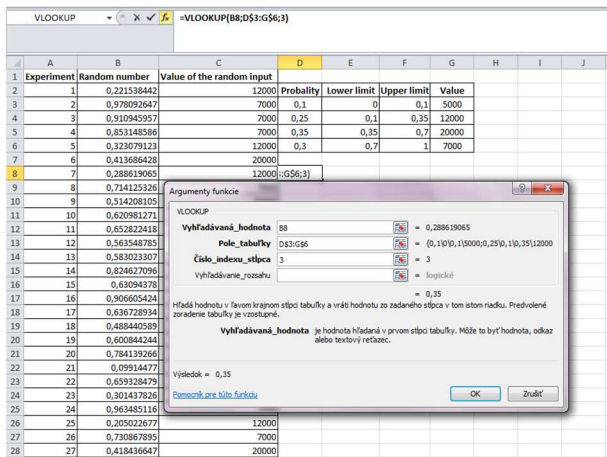


Figure 3 Discrete distribution

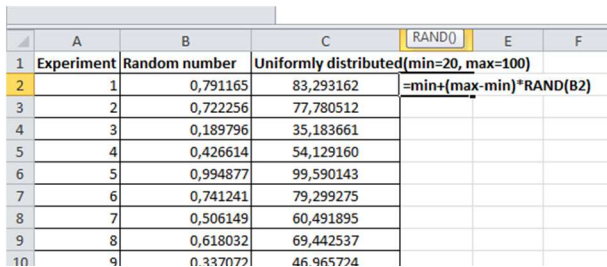


Figure 4 Uniformly distribution

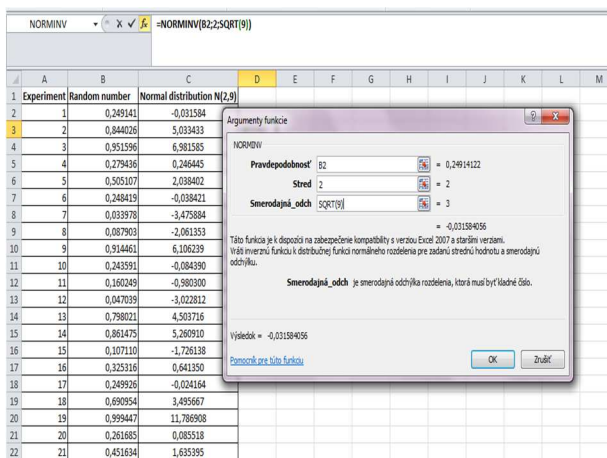


Figure 5 Normal distribution

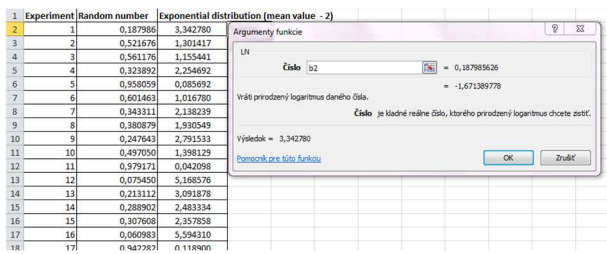


Figure 6 Exponential distribution

located in Data Analysis, example of generating 1000 random variables (normal distribution - $N(2,9)$, uniform distribution - $R(20,100)$) is on Fig.7.

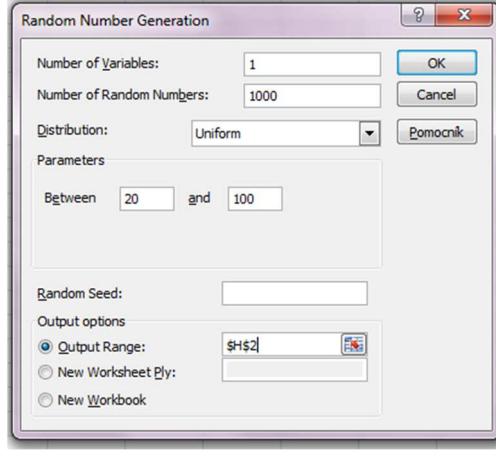
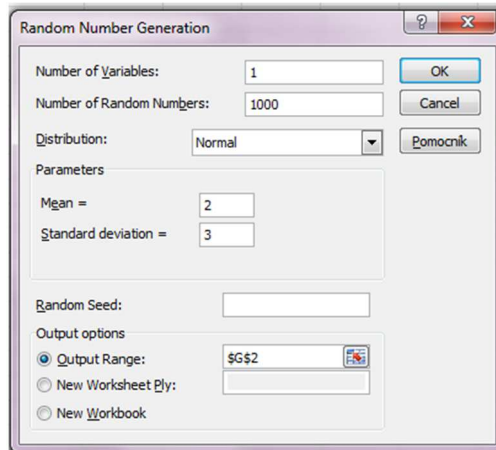


Figure 7 Random Number Generation

In the following part is used simulation software Risk, suitable mainly for simulations in the tabular processor Microsoft Excel. @RISK performs risk analysis using Monte Carlo simulation to show how many possible outcomes in a spreadsheet model exist and tells how the likelihood they might occur is. It mathematically and objectively tracks many different possible future scenarios and assess the probabilities and risks associated with each different one. This means that it gives an assessment which risks to take and which ones to avoid, allowing for the best decision making under uncertainty. Random inputs of model are generated by using add-on @Risk in the top menu in folder "Define Distribution", in option for discrete (Fig. 8) and continuous probability distribution Fig. 9. The second possibility is generating of random inputs is to write function directly into a cell – for normal distribution it is "RiskNormal (mean value, standard deviation)".

For generating random inputs of simulation inputs is possible to use a function "Random Number Generation"

PROCESS SIMULATION AND METHODS OF GENERATING RANDOM NUMBERS

Gabriela Ižaríková

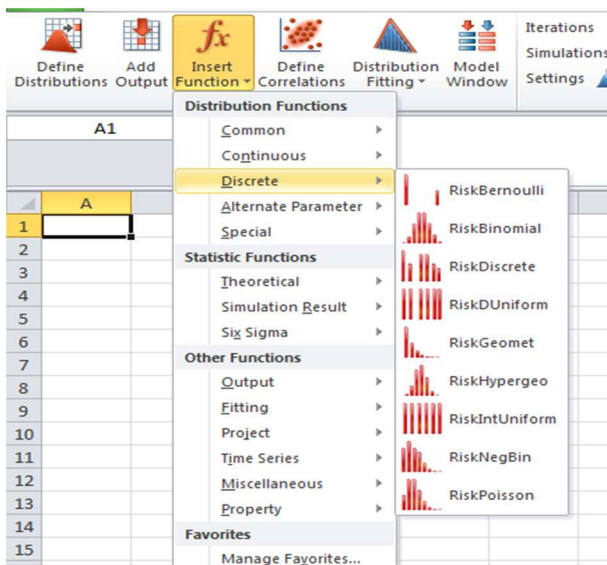


Figure 8 Discrete probability distribution

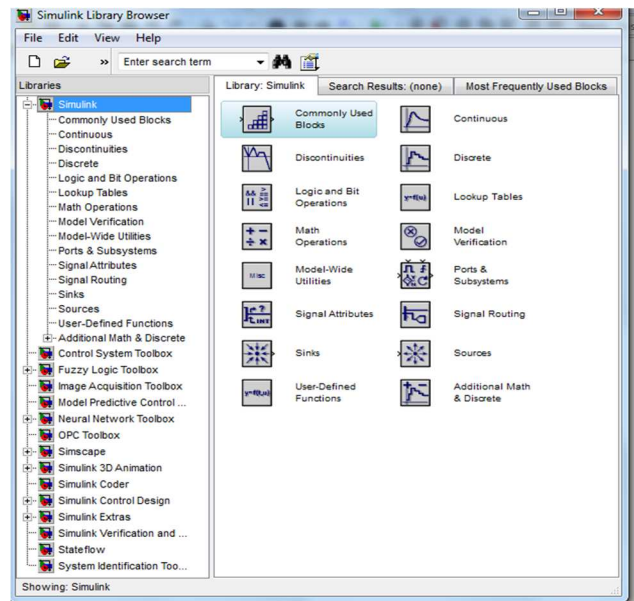


Figure 10 Window with the basic libraries of Simulink

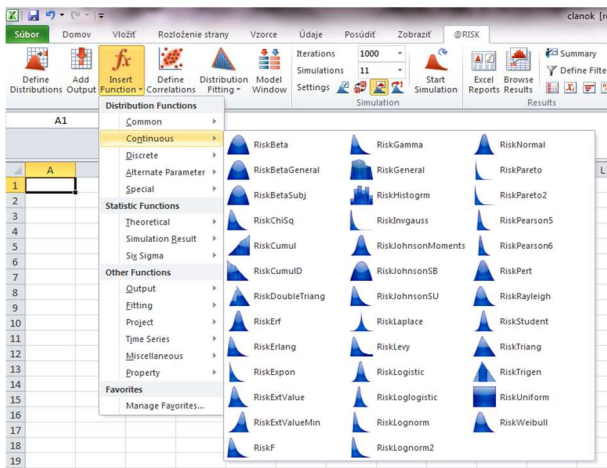


Figure 9 Continuous probability distribution

To create simulation models can also be used programming system messy, which produces models at different levels of difficulty. Models are created in Simulink (SIMulation and LINK), is a software product that allows the modeling, simulation and analysis system that inputs will change over time. Simulink starts from the basic MATLAB command "Simulink", or from the tool panel window with the basic libraries available blocks, divided into groups according to areas of application are to Fig.10. Simulation of dynamical systems consists of two steps:

- creation of using Simulink block diagram, making a connection between blocks and setting any necessary adjustment between inputs and outputs,
- setting time parameters simulation, running the simulation model created.

Conclusion

The article is an example of using the software simulation designed for simulation in Microsoft Excel spreadsheet and Matlab, demonstrated the possibility of its usage in order to show a universal method for problem solving. A simulation is an important and has a stable place in the production process and also in business practice. It is not a tool to solve all the problems, but could be used to quickly optimize and improve.

Acknowledgement

This article was created by implementation of the grant project KEGA 004TUKE-4/2013 "Intensification of modelling in teaching II. and III. degree in the field of study 5.2.52 Industrial Engineering".

References

- [1] NELSON, B. L.: Stochastic Modeling: Analysis and Simulation, McGraw-Hill, 1995.
- [2] PEKÁR, J.: Softvérová podpora rozhodovania v prostredí Microsoft Excel, EKONOM Bratislava, 2010. (original in Slovak)
- [3] TREBUŇA, P. a kol.: Modelovanie v priemyselnom inžinierstve, TUKE, p.195, 2015. (original in Slovak)
- [4] STRAKA, M.: Diskrétna a spojitá simulácia v simulačnom jazyku EXTEND [online], Košice: TU FBERG, Edičné stredisko/AMS. 2007. (original in Slovak)
- [5] SZABO, S., FERENCZ, V., PUCIHAR, A.: Trust, Innovation and Prosperity. In: Quality Innovation Prosperity, Kvalita Inovácia Prosperita, Vol. XVII, No. 2, pp. 1-8, 2013.

Review process

Single-blind peer reviewed process by two reviewers.