13th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2009, Hammamet, Tunisia, 16-21 October 2009

MODELING AND OPTIMISATION OF ELECTRIC MOTOR ASSEMBLY SYSTEM

Mirlind Bruqi
Mechanical Engineering Faculty
10000, Prishtina
Kosova

Avdyl Bunjaku
Mechanical Engineering Faculty
10000, Prishtina
Kosova

Lutfi Zharku
Ministry of Trade and Industry
10000, Prishtina
Kosova

Fatos Ukaj
Faculty of Applied Sciences in Business
30000, Peje
Kosova

ABSTRACT
There is a growing need in the industry for decision making which leads to problem resolution and improving of the profit margin of a company. Those problems are often very complicated, and the approach to their solution can be done in different ways. Real life approach to problem resolution is very often achieved by modeling of a problem. This paper discusses the connection between real life model and simulation. Analysis of electric motor model is comprised of, generation and evaluation of alternatives, which in other words can lead to problem resolution, which will in turn be achieved by system optimization.
Keywords: Simulation, Modeling, Optimization.

1. INTRODUCTION
Simulation is a method which deals with research of complex systems, which can not be modeled with regular mathematical methods. The term simulation is derived from the Latin word "simulare" which mean building of a dynamic process, using an abstract model, which works in the same manner like the real model.
This method is applied in all walks of life, from micro-electronics to space flights.
This paper will look at a short but compact form of the entire procedure for simulation of a flexible system for assembly of ATB electric motors. The same algorithm for simulation with few or no modification at all, can always be found in literature.

2. TYPE OF SIMULATION
In the history of simulation, there have been many different approaches to building simulators. These approaches happen concurrently with the development of computer technology. Depending on the speed of data processing there are 3 types of basic simulation forms.

- Discreet simulation;
- Continual simulation and
- Hybrid simulation.

There is also a sub division of simulators according to algorithms they utilize:

- Event simulation;
- Process simulation and
- Activity simulation.

3. BASIC STAGE OF SIMULATION

In this paragraph we will discus the connection between, the real model and the simulation. The boxes colored in blue are the main stages of simulation process, and grey boxes are the names of processes, Figure 1. So to get the results we must go thru these basic stages:

- Modeling;
- Experimentation;
- Interpretation and
- Application.

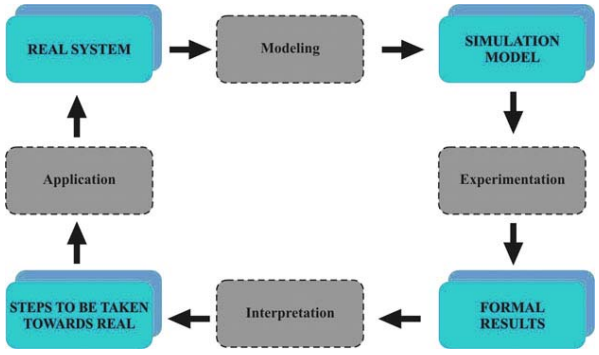

Figure 1. Four basic stages of simulation

4. MAIN SIMULATION ALGORITHM

Execution of the simulation is done by a world known algorithm. It is identical and is applicable in all the literature. The first step of simulation begins with definition of the task. During this step all the parameters are defined and given, the real system is described, the system terms are given, the economic needs of the enterprise are given, the necessary time for experimentation is allocated, and finally the necessary method for experimentation is defined. So, this is the time when the method for experimentation, has still not been selected. In other words, this is the point at which it's decided whether to use simulation, or use other methods, whether they are analytical or heuristic.

Simulation can begin only when these certain terms are evident:

- Analytical model is missing, because the limits of analytical methods have been reached;
- Real system is missing;
- Experimentation with a real system, is impossible because of different circumstances;
- The time limit of experimentation in general;
- Cost factor limit etc.

Certainly, there are other terms, with which the simulation can begin, even if we move from analytical and heuristic methods. Today's programs are developed in such a way that they allow a more simpler way of simulating a system, rather than analyzing it. This has been accomplished by using drag drop modules, which can be positioned in the desired position on the model, the fields then are filled in and the task is done. However the statistical part is the same for both methods.

5. DEFINITION OF SIMULATION GOAL

The first task immediately after definition of experimentation method is the definition of goals which we would like to achieve. It is known that our main goal is to increase the profit. However this is our global goal and it has to be translated into a mathematical language. The main goal is defined as a sum of many sub goals, which in one way or another influence the main goal, Figure 2. Later however using experimentation, it will be identified which sub goal, will have the most influence on the primary goal. But because here we have rules, when it comes to interaction of our system with the outside world, then other sub goals should have some advantage too.

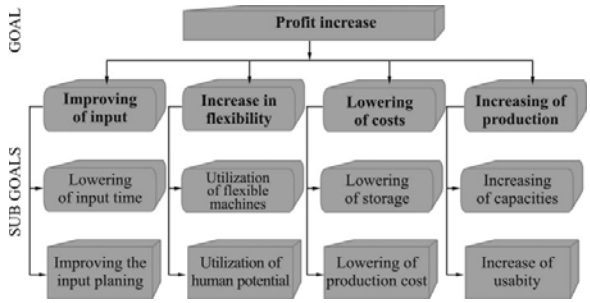

Figure 2. Goals and sub goals of simulation

6. DATA ACTUIQISION AND THEIR PREPARATION

Data which is acquired during the simulation are often called samples. This data can be used or acquired by the following sources.

- System historical data;
- Data which is monitored;
- Data from identical systems;
- Data from employees etc.

What is defined as data?

- Data about the production system layout, respectively how are the machines laid out throughout the production system;
- Data regarding every production operation, and the time it takes to finish;
- Data regarding the machine breakdown, and how long it lasts;
- Data regarding machine buffers and workstations;
- Data regarding transportation and means of transportation, and entire logistical concept;
- Data regarding time shifts;
- Data regarding system timeouts etc.
- Statistical data processing is the immediate step taken after the data has been acquired.

7. SYSTEMS SIMULATION

After the model verification phase, the next in turn is Simulation, Figure 3. After all the previous phases have been completed, there is a possibility for the experimentation to begin. The beginning of simulation means that the physical system has been modeled with precision, and every test performed on the simulated model would give the same results like the real life system.

Every result acquired from this simulation, is valuable, and can be implemented in the real life system. Before we begin the simulation we should check, if all the necessary options are available, also check if all the necessary options for statistics are enabled. During simulation we have the option to select other options in regard to animation such as:

- When we are working with complex or large models, there is an option for displaying of a simplified layout of elements of the model during simulation;
- Selection of the simulation method with animation or without it - “batching”. In conclusion, with using the “batching” method, the program will be executed much faster in comparison with the animation method;
- Utilization of the “full screen” method, which allows the user to have a more complete view of the program on a small monitor

Table 1 show the utilization of resources, respectively the utilization of assembly stations of a flexible system. Simulation has been performed for only 5760 seconds, with initial material flow rate of 1 piece per second. The images show how Arena is displaying the scheme in the so called Reports module.

Replica 1	Begin simulation (Start Time):	250,00 [seconds]
	End simulation (Stop Time):	5760,00 [seconds]
	Time unit: Seconds	
	Resource Utilization	

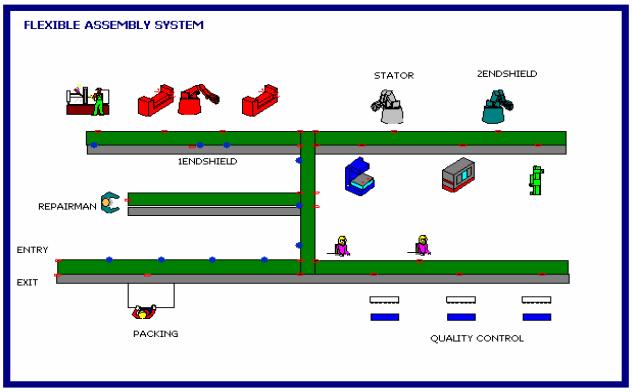

Figure 3. System animation during simulation

Table 1. Resource utilization during simulation.

	System Resources	Instantaneously Utilization	Number Busy	Number Scheduled	Number Seized	Schedule Utilization
1	Resource 01	1	1	1	1.102,00	1
2	Resource 02	1	1	1	552	1
…	…	…	…	…	…	…
16	Resource 16	0,79	0,79	1	215	0,79

8. CONCLUSIONS

Like in other methodologies, simulation lasso has its advantages and disadvantages. Main advantages are:

- Fast and simple calculation of system parameters, even on cases where no real system exists;
- Simulation is a practical tool for finding bottlenecks which often affect the systems reliability. This has been made possible by 2D and 3D graphical interpretation of simulation results;
- Research costs using simulation are far more lower in relation to total costs of planning (1:10);
- Simulation can be used in cases where all other analytical methods have failed;
- Long-time planning can be simulated for a short amount of time;

Integration with other CIM environment enables fast data exchange, even when there is a large amount of it.

9. DISADVANTAGES

Longer time for producing of modeling data, when systems without automatic withdrawal (using a computer);

- When high security systems are used, the operator has to have a wide experience;
- Often practical problems will require that the researcher have a interdisciplinary knowledge, rather than only be familiar with the program used.

10. REFERENCES

[1] Bruçi M., Stopper M., Bunjaku A., Stuja K., Kubat A.: Optimisation of Flexible Assembly System for Electrical Motors using Optquest for Arena, DAAAM International pp. 071-072, Vienna, Austria 2003.,

[2] Bruçi M., Bunjaku A., Stuja K., Buza Sh.: Optimizing of Flexible Palletizing Lines Using Simulation Tools". TMT 2005, pp. 693-696. Antalya, Turkey, 2005.,

[3] Stuja K., Stopper M., Bunjaku A., Bruçi A.: A concept for scheduling of flexible assembly for electrical motors. DAAAM International Scientific Book 2003, pp. 591-598, ISBN 3-901509-36-4, ISSN 1726-9687, Vienna, Austria, 2003.

[4] Bruçi M., Bunjaku A., Lika R.: Application Of The Modern Simulation Methods At The Flexible Systems Of Electromotor's Assembling, TMT 2005, pp. 373-376, Istanbul, Turkey, 2008.