Application of a decision support system in an industrial enterprise

To cite this article: S N Medvedev *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **709** 044026

IOP Conf. Series: Materials Science and Engineering **709** (2020) 044026 doi:10.1088/1757-899X/709/4/044026

Application of a decision support system in an industrial enterprise

S N Medvedev[1,*], K A Aksyonov[2] and O P Aksyonova[3]

[1]Institute of Radioelectronics and Information Technologies Ural Federal University, Ekaterinburg, Russia, stefanmedvedev@mail.ru
[2]Institute of Radioelectronics and Information Technologies Ural Federal University, Ekaterinburg, Russia, wiper99@mail.ru
[3]Institute of Radioelectronics and Information Technologies Ural Federal University, Ekaterinburg, Russia

* stefanmedvedev@mail.ru

Abstract.Work at an industrial enterprise is associated with the constant adoption of management decisions at all levels, on which both the timeliness of order fulfilment and the efficiency of production capacity depend. The use of modern information technologies based on mathematical methods, allow you to make a decision knowing what should happen.

1. Introduction

The use of modern technology in a machine-building enterprise is not only a means to increase the productivity of personnel, but also to increase the efficiency of the entire enterprise. Modern technologies include not only various mechanized means, but also information systems of various levels, allowing managers to receive timely and relevant information on the basis of which to make the right management decisions. Execution of production orders is a priority for the manager, managing the production process at the enterprise. Efficiently distributing orders and completing tasks on time will not only make a profit, but also maintain existing reputation. If there are divisions at the enterprise, which are a kind of "doublers" it allows to distribute the produced nomenclature between them in various proportions. Determining the optimal distribution of orders between divisions, as well as modeling the process of manufacturing a nomenclature, will make it possible to lose the situation before making a decision. Simulation modeling [1-3] and multi agent approach [4-6] allows you to see how the process will work in its implementation, without spending a lot of resources and time.

2. Formulation of the problem

The industrial enterprise [7] under consideration consists of metallurgical and assembly plants, the production cycle begins from raw materials and ends with the output of the finished product. Metallurgical production consists of five workshops, which form a single technological chain for the production and delivery of it to the assembly production.

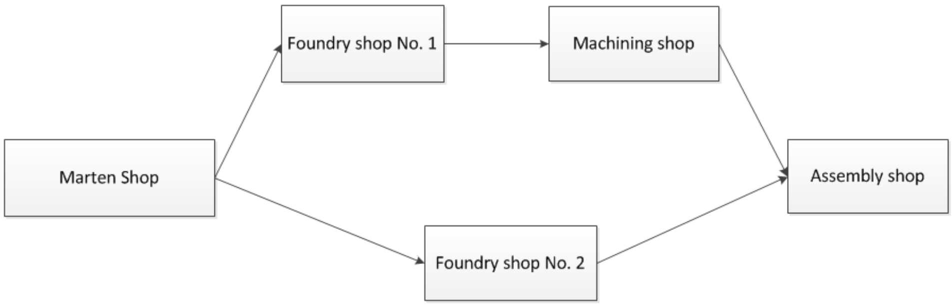


Figure 1. Production flow chart

The information from workshops comes from different enterprise information systems [8-9]. In the scheme under consideration, the production of parts is carried out on two production branches having different production capacities, but allowing to produce the same nomenclature. The distribution of the nomenclature between the two threads is not an easy task, which must take into account both the time of manufacture and the profit, which is formed in the shop on the basis of the costs incurred. One of the solutions to the problem may be the use of software tools that will solve the problem.

3. Theory

To solve the problem under consideration and to find the most efficient plan for distributing orders among the divisions, the BpSim.DSS dynamic situation simulation system was applied. In this system, a model was created with a sequence of actions to take when finding a solution that includes the laboriousness of manufacturing based on the technological processes of manufacturing parts in each structural unit, the permissible amount of products deviating from the central department in each direction, the schedule of units. The target indicator was taken to maximize revenue, which should be obtained from the enterprise.

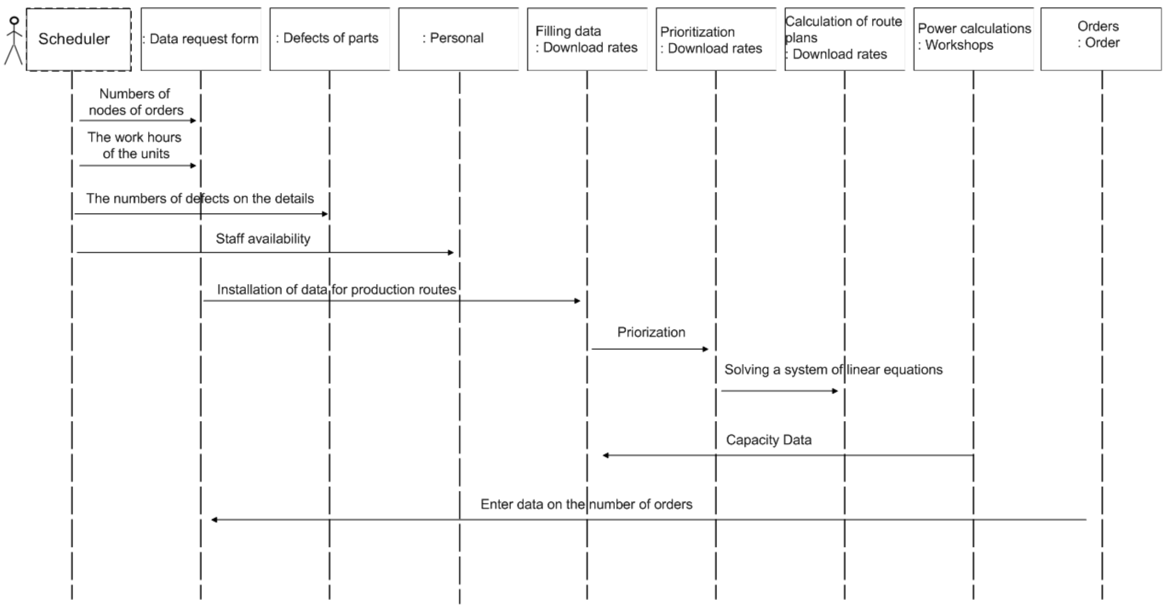


Figure 2. Solutions Chart

The calculation of the distribution plan between departments was carried out after receiving the input parameters, on the basis of which a system of linear equations was built and a solution was found. The resulting solution is optimal and serves as a guideline for further calculations. To obtain a plan for distributing orders between divisions, a model was built using the “over-inspecting” method of orders in the simulation system BpSim.MAS, where technology was developed for each of the routes, the used equipment was taken into account, the level of defective products was reflected, software agents were engaged applications within structural subdivisions, since the nomenclature positions have different production routes inside the workshop.

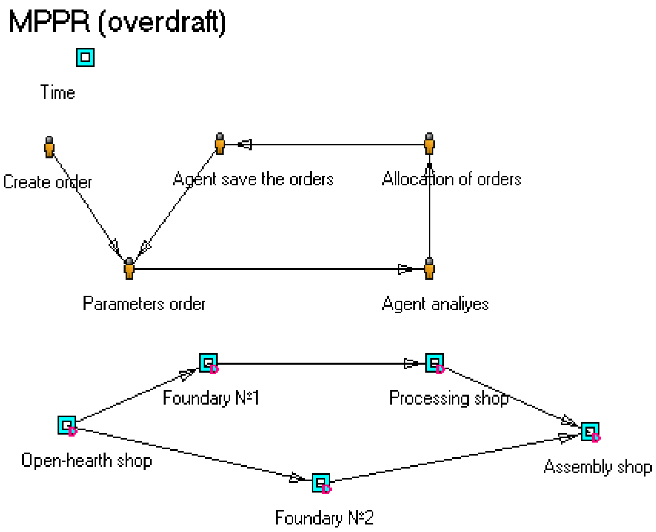
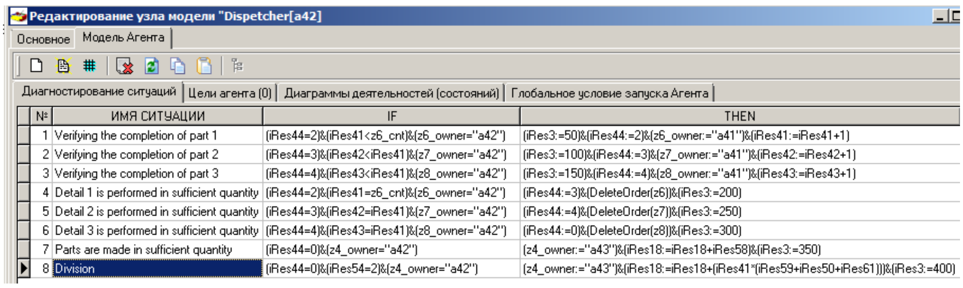


Figure 3. The upper level of the model MPPR (overdraft)

The implementation of the distribution of various nomenclature between technological equipment is carried out using software agents, which describe the rules.



№	ИМЯ СИТУАЦИИ	IF	THEN
1	Verifying the completion of part 1	(iRes44=2)&(iRes41<z6_cnt)&(z6_owner="a42")	(iRes3:=50)&(iRes44:=2)&(z6_owner:="a41")&(iRes41:=iRes41+1)
2	Verifying the completion of part 2	(iRes44=3)&(iRes42<iRes41)&(z7_owner="a42")	(iRes3:=100)&(iRes44:=3)&(z7_owner:="a41")&(iRes42:=iRes42+1)
3	Verifying the completion of part 3	(iRes44=4)&(iRes43<iRes41)&(z8_owner="a42")	(iRes3:=150)&(iRes44:=4)&(z8_owner:="a41")&(iRes43:=iRes43+1)
4	Detail 1 is performed in sufficient quantity	(iRes44=2)&(iRes41=z6_cnt)&(z6_owner="a42")	(iRes44:=3)&(DeleteOrder(z6))&(iRes3:=200)
5	Detail 2 is performed in sufficient quantity	(iRes44=3)&(iRes42=iRes41)&(z7_owner="a42")	(iRes44:=4)&(DeleteOrder(z7))&(iRes3:=250)
6	Detail 3 is performed in sufficient quantity	(iRes44=4)&(iRes43=iRes41)&(z8_owner="a42")	(iRes44:=0)&(DeleteOrder(z8))&(iRes3:=300)
7	Parts are made in sufficient quantity	(iRes44=0)&(z4_owner="a42")	(z4_owner:="a43")&(iRes18:=iRes18+iRes58)&(iRes3:=350)
8	Division	(iRes44=0)&(iRes54=2)&(z4_owner="a42")	(z4_owner:="a43")&(iRes18:=iRes18+(iRes41*(iRes59+iRes50+iRes61)))&(iRes3:=400)

Figure 4. The rules of the agent "Determination of parameters of opportunity"

The description of various situations in the rules of agents allows to increase the adequacy of the simulation model, which increases the reliability of the data obtained.

In contrast to the simple model of order fulfillment in the enterprise, where the distribution of orders occurs entirely and order division is impossible, and the calculation of getting maximum profit when executing the received order is not carried out.

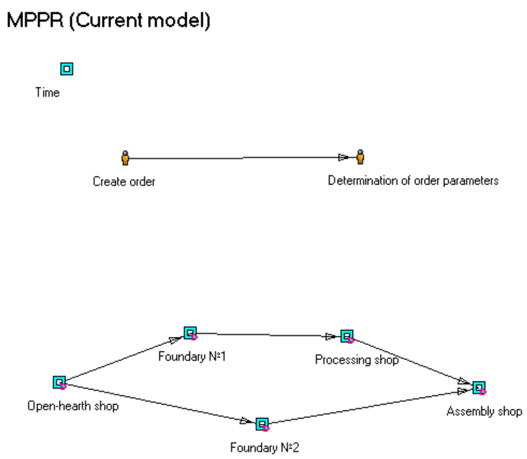


Figure 5. Upper level of the MPPR model (current model)

The constructed models are a simplified model for manufacturing products in the shops of a metallurgical enterprise. Further experiments were carried out on these models.

4. Experimental results

In the course of the experiments on the "run" of the model of the current implementation of orders and the model of the MPPR (overwork), the following results were obtained.

Table 1. Comparison of models

Characteristic	Current model	MPPR (overdraft)
Total number of items collected	91	142
% order completion 1	43,75	51,5625
% order completion 2	24,13793	37,24138
% order completion 3	0	13,924

5. Conclusion

The results obtained during the experiments demonstrate the advantages of using the model with the “over-insulating” method over the current production model. The number of assembled products in the MPPR model (over-protection) increased 1.56 times in comparison with the current model.

Using the system of dynamic simulation of situations BpSim.DSS together with the simulation system BpSim.MAS together form a decision support system for obtaining an optimal result and confirming it in conditions close to real in an industrial enterprise.

Acknowledgments

This work is supported by Act 211 Government of the Russian Federation, contract № 02.A03.21.0006.

References

[1] Solovyeva I Sokolov B and Ivanov D 2015 *Analysis of position optimization method applicability in supply chain management problem Proc. Int. Conf. Stability and Control Processes* pp 498-500

[2] Devyatkov V Vlasov S and Devyatkov T 2013 *Cloud Technology in Simulation Studies: GPSS Cloud Project Proc. of the 7th IFAC Conf. on Manufacturing Modeling, Management, and Control* (Russia: Saint Petersburg) vol 7 pp 637-641

IOP Conf. Series: Materials Science and Engineering **709** (2020) 044026 doi:10.1088/1757-899X/709/4/044026

[3] Klebanov B Antropov T and Riabkina E 2016 *Bases of imitation model of artificial society construction accounting of the agents' needs recursion 16th Int. Conf. SGEM* vol 1, pp 101-108

[4] Yudin E and Yudina M 2017 *Calculation of number of motifs on three nodes using random sampling of frames in networks with directed links Proc. Siberian Symp. on Data Science and Engineering* pp 23–26

[5] Aksyonov K Bykov E and Aksyonova O 2012 *Application of Multi-agent Simulation for Decision Support in a Construction Corporation and its Comparison with Critical Path Method Proc. Int. Conf. on Mechatronics and Control Engineering* pp 2244-2247

[6] Wittich V and Skobelev P 2003 *Multi-agent interaction models for the design of the nets of requirements and capabilities in open systems Automatics and telemechanics vol 1* pp 177-185

[7] Kondratiev A Aksenov K Antonova A Medvedev S 2015 *Investigation of the work of the processing shop with the help of a multiagent model of resource conversion processes* pp 17-25

[8] Borodin A Kiselev Y Mirvoda S and Porshnev S 2015 *On design of domain-specific query language for the metallurgical industry Proc. Int. Conf. BDAS* pp 505–515

[9] Borodin A Mirvoda S Kulikov I and Porshnev S 2017 Optimization of memory operations in generalized search trees of PostgreSQL Proc. Int. Conf. *BDAS* pp 224–23