Proceedings of the 2012 Winter Simulation Conference
C. Laroque, J. Himmelspach, R. Pasupathy, O. Rose, and A.M. Uhrmacher, eds

APPLICATION OF SIMULATION-BASED DECISION SUPPORT SYSTEMS TO OPTIMIZATION OF CONSTRUCTION CORPORATION PROCESSES

Konstantin Aksyonov, Eugene Bykov, Wang Kai, Olga Aksyonova

Ural Federal University
Mira, 19
Ekaterinburg, Russia

ABSTRACT

The poster focuses on development and application of a decision support system BPsim.DSS, which greatly simplifies analysts work and allows them make their job more efficiently and allows prediction of consequences of taken decisions. The poster gives an example of the system deployment in production environment, a construction company and presents achieved results.

THEORETICAL BASIS FOR BOTTLENECKS ANALYSIS AND SYNTHESIS OF MULTI-AGENT MODEL

In our work, multi-agent resource conversion processes (MRCP) approach (Aksyonov 2011, Kononova 2008) is used for research of business processes, offering integration of methods of simulation, expert, situational and multi-agent modeling.

A set of multi-agent model elements includes: *MRCP={ Goal, Res, Mech, Order, Op, Agent }*,where *Goal* – set of model goals; *Res* – resources; *Mech* – tools; *Order* – transacts; *Op* – model operations; *Agent* – model agents that include *AgentGoal* (agent goals) and *AgentSolution* (knowledge base).

Model of a multi-agent resource conversion process was represented in form of a multi-channel queuing system in (Kononova 2008). Bottlenecks analysis method is based on operational analysis of probability networks (Aleksandrov 2009, Litvin et al.1984). The following multi-agent model parameters are analyzed during bottlenecks identification:

1. Load ratio of operations U_{Op_cp}, tools U_{Mech_cp}, agents U_{Agent_cp};
2. Average wait time for the transact in a queue to operation, agent;
3. Operation delay due to missing tools P_{MechOp} or missing input resources P_{ResOp};

Average transact queue to operations Q_{Op_cp} and agents Q_{Ag_cp} is also analyzed to estimate dynamics of operation *Op* and agent *Agent* work. Similarly average resource state is estimated.

Algorithm for re-engineering of the multi-agent resource conversion processes model (model analysis and structural synthesis) has been developed. Application of operation analysis of probability networks to a multi-agent model allows reducing the number of experiments with the model by building a queuing system model on the basis of experiments with multi-agent model, focusing on fast detection of average number of working devices.

APPLICATION OF RE-ENGINEERING AGENT

Simulation model of construction corporation “China Wan Bao Engineering Corp.” has been designed with BPsim tools. The model consists of 128 operations, 90 resources, 11 agents for construction of 11 buildings. The model makes use of distribution agents for own and sub-contract works. The models and re-engineering process in detail are discussed in works of the authors that have not yet been published.

978-1-4673-4781-5/12/$31.00 ©2012 IEEE

Financial analysis of profiles for various models indicated, that the most efficient is the modified subcontract model with revenue of 16 billion yuans.

APPLICATION OF OPERATION ANALYSIS OF PROBABILITY NETWORKS AND SIMULATION MODELING TO ANALYSIS OF TRUCK LOADING PROBLEM, BASED ON MULTI-AGENT MODEL

Construction model is represented in form of multi-channel queuing system for the purpose of bottlenecks analysis:

1. Requirements flows are put to service channels that model operation of various vehicles. Trucks are the key service devices here;
2. Requirements (transacts) contain information on volume of work and necessary quantities of vehicles.

One specific feature of the current system is that frequency of tasks for trucks is various on different stages of building construction. Early stages of construction feature significant growth in truck demand. At these stages there is a shortage of trucks, and a queue is generated. During the remaining stages the trucks is mostly idle.

Initial data for the current simulation model of the queuing system included statistical chronometry of previous works of the corporation together with multi-agent model simulation results.

Results of simulation experiments of construction model in form of a multi-agent resource conversion system, implemented in BPsim.MAS, are highly close to real situation.

Application of intelligent re-engineering agent and BPsim system provided analysis of bottlenecks and convolution/de-convolution of multi-agent processes. Application of queuing system model and operation analysis allowed decreasing the number of experiments with multi-agent model, that target search of average truck count. Re-engineering of the multi-agent model of construction corporation allowed decreasing average node wait time. Method application resulted in construction completion time decrease by 42% (1.6 yrs / 580 days) and allowed to improve the load of tools, compared to purchase of new trucks. Deployment effect is estimated by 4.6 billion yuans.

CONCLUSION

Application of discrete-event modeling and multi-agent modeling together with operation analysis of probability networks allows identification of system bottlenecks and lets the analysts be sure that decisions are made correctly. Comprehensive use of multi-agent model of resource conversion processes, queuing systems and operation analysis allows reducing of the number of experiments with simulation model that focus on search of average number of technical tools. Proposed methods offer a simpler solution than experiment designs and allow reasonable precision in many applications.

ACKNOWLEDGMENTS

Research is supported by RFBR grant №12-07-31045.

REFERENCES

Aksyonov, K.A. 2011. *Theory and practice of decision support tools*, Germany, Saarbrucken: LAP LAMBERT Academic Publishing GmbH & Co. KG. ISBN 978-3-8465-0782-7.

Aleksandrov, D.V. 2009. *Methodology of modeling distributed systems of managing business processes of macro-enterprises*, DPhil research paper, Vladimir.

Kononova, E.P. 2008. *Methodology of business processes re-engineering based on integration of structural analysis, expert systems and formal grammar*, DPhil research paper, Moscow.

Litvin, V.G., V.P.Aldyshev, and A.I.Vinnichenko. 1984. *Analysis of performance of multi-program computers*, Moscow, Finance and statistics.