SIMULATION FOR ENGINEERING: A PROBLEM-BASED LEARNING

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Abstract

In this work a project on Dynamic, Discrete-change, Stochastic Simulation developed in the Engineering school (UdG) is presented. Each student selects (or is assigned by the professor) one problem. After the student has its particular problem: first, he must understand the system, and clearly define the goals. Next, he must formulate the model representation and translate into modeling software (ARENA©). The "program" must be verified, the model should be validated, and some experiments and runs must be made. Finally, a document with the results must be produced. After one step is finished he must send to the professor its report. The professor evaluates the progress and answers to the student how he could improve its work and how he must advance in the simulation study. The specific material for the simulation study is composed by: summary of the software facilities and detailed description of the system. Both students and professor uses the e-mail and the web site of the UdG for the interactions.

Keywords - Stochastic simulation, Arena, virtual learning.

1 GENERAL SCHEME OF WORK

At the beginning of the course each student selects (or is assigned by the professor) one problem. Examples of these problems are: an "Electronic assembly and test system", a "Small manufacturing system", or "Generic call-center system". After the student has its particular problem he should follow a general scheme of work composed by the follow four steps: first, clearly define the goals; next, translate the model into modeling software (ARENA©); then, verify, validate and run the "program"; finally, produce a report. Approximately, the student can expend a month by step. After one step is finished he must send to the professor its report. The professor evaluates the progress and answers to the student how he could improve its work and how he must advance in the simulation study.

1.1 Step: *define the goals*

The system included in [1] about an "Small manufacturing system" (Fig.1) is a typical example of model to be developed.

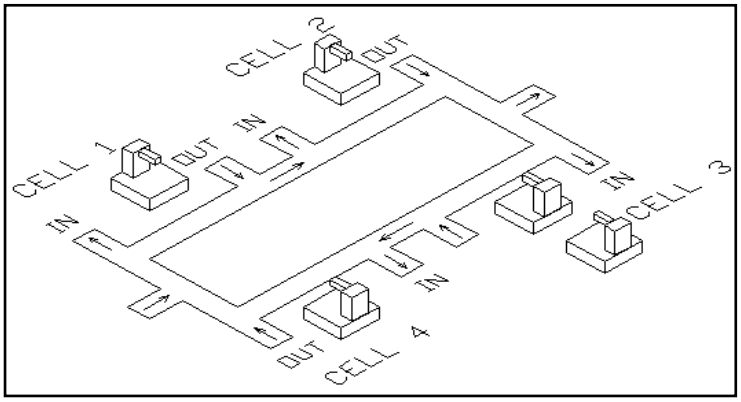

Fig. 1. Example: system to be developed

In this case, the main goal would consist on to analyze the efficiency of the system in relation to the typical measures as: number of parts, waiting time, etc. In addition, the final purpose of the study would be to propose and to analyze an improvement of the system. Of course, the efficiency of the

improved model must be compared with the initial one. After the short report of this step, the professor revises and evaluates the definition of the goals and suggests improvements or other ideas.

1.2 Step: *translate into Arena*

In this step the student has to implement the model into Arena. He must to identify and apply all the modules, distribution of probability functions, and the transfer method of the entities through the system. This step ends when (Fig. 2) the system is fully implemented and properly runs without errors.

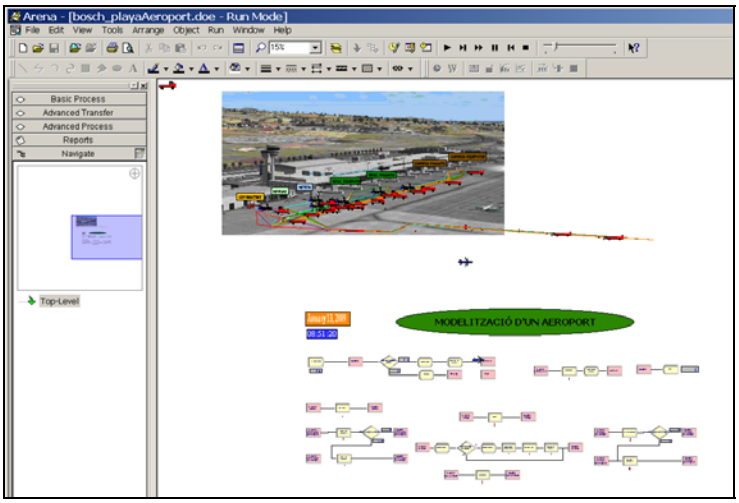

Fig. 2. System implemented into Arena.

The answer of the professor about the short report of this step consists on evaluate if the Arena model fully reflects the initial system and if it is properly animated.

1.3 Step: *analyze the program*

This step is the more statistical one. Here the student has to analyze in detail the existence or not of a warm-up period and suitable number of replications. After this, he has to describe in detail de efficiency of the system. To do this, he has to produce the reports from the outputs of Arena (Fig. 3) and to explain the behavior of the measures of efficiency: length of queues, waiting times, transfer times, etc.

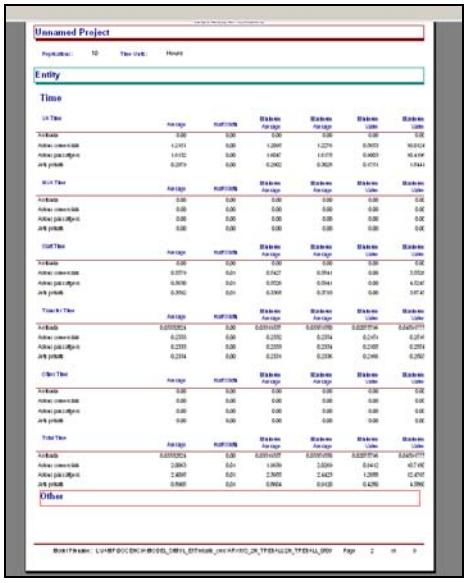

Fig. 3. *Category overview* report from Arena.

From these results the student has to propose a change into the system in order to improve its efficiency. For example, some change in the priorities of the queues, or a change the method of transference of the entities, or another different way of sharing the resources (servers, transporters, machines, etc.). Then he has to analyze the new organization and contrast (Fig. 4) that the new system really improves the initial one.

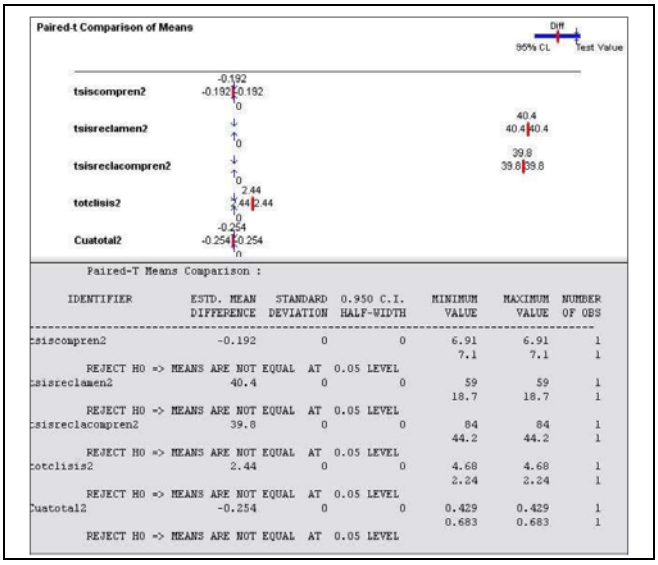

Fig. 4. On contrasting with *Output Analyzer* the improvement of the efficiency.

The Output Analyzer program of Arena gives the possibility to easily make contrasts of means in order to confirm if a change in a system improves the efficiency in relation to one particular measure.

After the short report form this step, the professor evaluates if the analysis is suitable for the initial goals. Also informs to the student if the proposed change of the system is a suitable modification.

1.4 Step: *the report*

Finally, a document with the all the information about the simulation study must be produced. Note that all those above instructions and communications between the student and professor are virtually done. Both students and professor uses the e-mail and the web site of the UdG for the interactions. Furthermore, in this web site there is a forum space where the student can discus about its difficulties and progress.

The specific material for the simulation study is composed by: summary of the software facilities and detailed description of the system. The rest of the material of the subject is composed by: slides for the theoretical background, examples, exercises, and case-studies. All these material are provided by the web site of the UdG. Usually, this subject is followed by 25 students each semester. In parallel they attend in-person to classes where they learn theoretical concepts related to simulation techniques and queue systems. In the final report the theoretical concepts should be related with the practical study. For example (Fig.5), the student should to apply its knowledge about fitting a distribution model to a sample data. This analysis is done in the program Input Analyzer of Arena. The professor gives to the student a sample data for a random aspect of the system (e.g. time between arrivals, resource time, etc.) and he should to analyze which (it exists) probability distribution better fits the sample data.

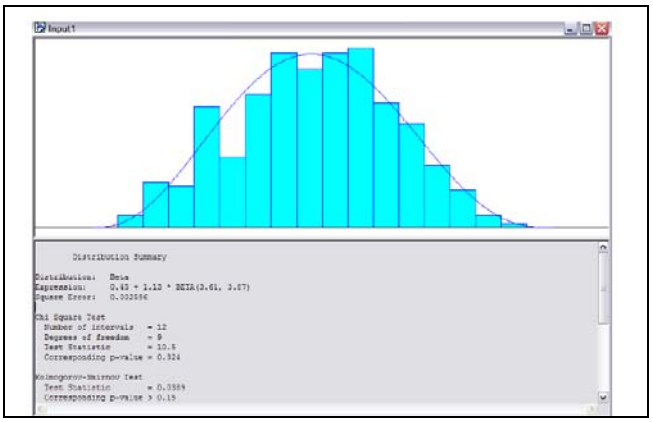

Fig. 5. On adjusting a probability distribution function: *Input Analyzer.*

The professor produces the qualification mark of this study taking into account all the process and the final report.

References

[1] Kelton, W. D., Sadowski, R. P., Sturrock, D. T. (2007). Simulation with Arena, McGraw-Hill Higher Education, Boston, 630 p.