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Improvement of an Industrial Process by Applying Process Simulation

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Abstract: The purpose of this project is to improve the industrial process by applying process simulation, for which the ProModel® software was used in its student version. The methodology García, García, & Cárdenas (2006) was used to carry out the research. A confidence interval of 90% and a maximum permissible error margin of 10% were used. The results obtained helped to increase productivity by 37.1%.
Keywords: Simulation, Improvement, Increase, Industrial Process and Productivity.

INTRODUCTION

In Mexico, industrial manufacturing processes have a high content of work in each product to be processed, so these processes have a large number of variables to consider when modeling them; In addition, unexpected events or events occur, and the variability and interdependencies between subprocesses are high [1].

Coss [2] mentions that simulation is the process of designing and developing a computerized model of a system or process and conducting experiments with this model in order to understand the behavior of the system or evaluate several strategies with which the system can be operated. Blanco & Fajardo [2] mention in their work that simulation is a fictitious representation of a real situation, which is experienced through models that are abstractions of reality; the knowledge acquired in the simulation is applied in the real world. In the general sense, simulation deals with the study of dynamic systems over time [3].

Garcia, García & Cárdenas [4] mentioned in his book refers to a large set of methods and applications that seek to imitate the behavior of real systems, usually by means of a computer with appropriate software. For their part, Jiménez & Gómez [5] mention that simulation is an ideal tool to study complex systems, evaluating different alternatives with their respective sensitivity analysis at a relatively lower cost than other techniques, being able to make the best decision without having to alter the system previously. Likewise, Rodríguez & Correa [6] point out that in recent years simulation has played an important role in decision-making in activities related to logistics, this has become a tool that has been developed and that has had different applications in many areas of knowledge.

SIMULATORS

Within the study of process simulation, there is a range of specialized programs for the study of this area, among which are:

- GASP IV. It is a collection of FORTRAN subroutines, designed to facilitate the simulation of sequence of events [7].
- SIMAN. Rodríguez, Márquez, Morales and Sanromán [8] model a discrete system using process orientation; that is, in a particular system model, the entities that move through the system are studied.
- Sand Simulation. It is software for the simulation of discrete events for the optimization of complex processes [9].

- ProModel. It is a simulator with animation for personal computers. It is software used to recreate real-life operations. Its name comes from the short form of writing in English Production Modeler; therefore, this tool is designed specifically to analyze production systems [10].
- Flexsim. It is an analysis tool that helps engineers and planners make intelligent decisions in the design and operation of a system. With Flexsim, a 3-dimensional computer model of a real life system can be developed [11].
- Simio. Simio is a modeling software designed from its bases to support the paradigm of object modeling [12]; however, it also supports the use of other multiple paradigms including process orientation and event orientation [1].

APPLICATIONS

Banks, Carson II, Nelson, & Nicol [13] point out that in the field of applications of simulation models can be developed: manufacturing processes, queuing systems, inventory systems, investment projects, flight simulations and aerodynamic tests , driving simulations and car crashes, natural disasters, defense strategies, plant distribution, chemical reactions, etc. On the other hand Jiménez [14] in his thesis work, he developed a project where he simulated 4 production and logistics workshops, having success in the implementation of specialized software ProModel in the 4 cases. Arroyo, Burgos & Burgos [15] implemented the simulation in an industrial company, the results of the study helped to obtain information of great importance for decision-making.

MATERIALS AND METHODS

The methodology used was the one proposed by García, García & Cárdenas [16] who proposed the following steps in their book:

Definition of the system under study. ASEDESTO Empresarial [17,18] proposes the following formula:

$$n = \frac{z^2 * p * q}{e^2}$$

Where:
z = is the confidence interval to use
e = maximum permissible error
p = probability of success that one wishes to obtain. When it is not known, it is left with value 0.5.
q = probability of error that you want to obtain. When it is not known, it is left with value 0.5.

For the present investigation, a confidence interval of 90% (variable z) and a maximum permissible error percentage of 10% (variable e) were used. The variables p and q with a value of 0.5 were left with the same value. 68 observations were taken in the specified area.

Generation of the base simulation model

With the observations of the previous step, the model of the process to be evaluated was performed. The specialized software ProModel® was used in its student version for the development of the project. Figure 1 represents the base model made in the specialized software ProModel®.

Fig-1: Specialized software ProModel® student version

Collection and analysis of data

In this stage, the necessary times were collected for each of the activities that make up the model. 68 times were collected per activity. These times were analyzed in their correct shot, in order to avoid errors in stage. The following format was used for the collection of times.

Fecha:		Analisita								
Area:		Operador								
	OBSERVACIONES									
ACTIVIDAD	1	2	3	4	5	6	7	8	9	10

Fig-2: Data collection format

Generation of the preliminary model

In this phase, the first model of the process to be analyzed was built, using the commands: locations, entities, process and arrivals of the specialized ProModel® software. Figure 3 represents the preliminary model.

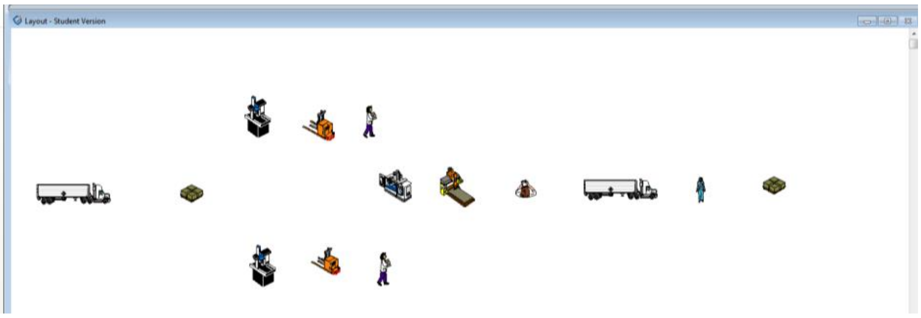

Fig-3: Preliminary model of the process

Verification of the model

In this stage, the activities and times were verified, in order to know if all meet 68 times. They went reviewing activity by activity to corroborate that they were correctly. The same format used in the data collection and analysis phase was used.

Validation of the model

In this phase, the times of each operation were validated. Likewise, the dispersion of the data was corroborated, taking care that all the samples complied with a minimum deviation.

Generation of the final model

In this stage, the final model was built. The name and counters were added to all locations. Figure 4 represents the final model of the process.

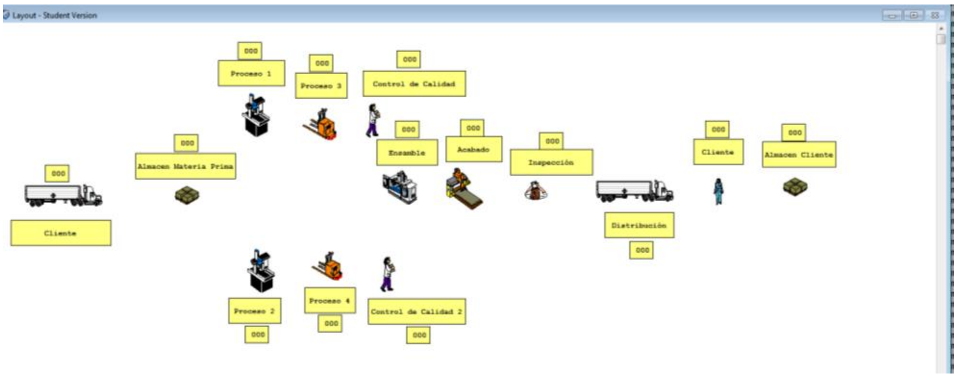

Fig-4: Final model of the process

Documentation of the model

In this phase of the project, the final model was kept in order to leave the progress to the immediate boss for future investigations.

RESULTS

In this section, the results obtained in the simulation of the process are presented. Table 1 represents the variables: parts with successful outputs, parts in the system and failed parts. It is worth mentioning that the demand was 1000 pieces per day.

Table-1: Initial Results

Variable	Quantity
Parts with successful output	424
Parts in the system	0
Failed Parts	576

As can be seen in table 1, productivity is very low. Because the expected demand for products is 1000 pieces, only 424 pieces manage to successfully exit. The production of this process has areas of opportunity. The calculation of productivity is calculated as follows:

$$productivity = \frac{\text{Parts with successful output}}{\text{Parts with successful output} + \text{Parts in the system} + \text{Failed Parts}} * 100\%$$

For the case of the problem, the formula will be as follows:

$$productivity = \frac{424}{424 + 0 + 576} * 100\% = 42.4\%$$

The result of productivity shows that there are areas for improvement in the process.

INTERVENTION

As an improvement proposal, it was decided to analyze the activities and activities that do not add value were eliminated in order to make the process faster.

Table 2 represents the variables: pieces with successful exits, pieces in the system and failed pieces once the activities that did not add value were eliminated.

Table-2: Results with the improvement proposal

Variable	Quantity
Parts with successful output	795
Parts in the system	0
Failed Parts	205

As can be seen in table 2, productivity improved markedly. Due to the fact that the expected demand for products is 1000 pieces, they have already managed to successfully exit 795. The production of this process has improved by 37.1%. For the case of the problem, the formula will be as follows:

$$\text{productivity} = \frac{795}{795 + 0 + 205} * 100\% = 79.5\%$$

CONCLUSIONS

Currently companies seek to be competitive in a global environment, for this, they must reduce their costs, in order to be able to offer quality products. The simulation of processes is a very important tool that helps to study and evaluate an approximate result of what reality is. Likewise, the simulation takes into account the elements that relate to each other to achieve a specific purpose, which have an input and output in the processes. The present project helped to visualize study and evaluate an industrial process, the objective of the project was achieved, since the productivity of the process was improved in the first instance.

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