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APPLICATIONS IN LOGISTICS USING SIMULATION WITH PROMODEL

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ABSTRACT

This paper shows the importance of the use of animated simulation tools in Engineering Education. Simulation is a fictitious reproduction of the behavior for real events of dynamic systems made in order to evaluate and improve systems performance. Nowadays, analysis and improvement of complex dynamic systems like logistics networks can be done by using animated simulation due to the extended capacity in memory and processing of modern computers. *ProModel*®, is an animated simulation software, specially designed to model productive and logistics processes. Some applications frequently used in dynamic logistics systems by means of animated simulation are: layout improvements; simulation of collecting and picking operations; simulation of dock operations, rapid interchanges or crossdocking; choosing of better alternatives between a set of possible paths, to simulate the flow of raw materials, human resources, physical resources, in load, unload and transportation operations; simulation of information flows of client orders, well known as call centers and simulation of integrated dynamic logistic system in order to see the totality of information flows, transportation routes, and operation control along the supply chain and to obtain more profitable alternatives.

KEYWORDS

Simulation, animated simulation.

1. INTRODUCTION

The Globalization of markets, the exponential development in transport, communications and computer systems have been generated changes around the world in definition and core concepts of *Logistics*. *Web* net links are around the World. Suppliers, warehouses, distribution centers, production facilities, client homes, are now connected by *Internet*. Logistics systems are in business twenty four hours a day during all days in a year, every where in the planet.

The main objective of Logistics is to deliver goods and services in the place where needed, at the right time, in the exact quantities, with quality requirements that satisfy client needs and expectations. Also, Logistics is now the natural link between suppliers, producers and clients, no matters where they are placed or the hourly differences.

Operations programmers of dynamic logistic systems deal with huge data bases that require fast responses, great capacities of memory and processing. On the other hand, these systems also require complex, efficient, effective communications systems, moreover, they require application of Operations Research models and the use of costly and complex software packages like *DRP (Distribution Resources Planning)* y and *ERP (Enterprise Resources Planning).*

In such conditions, simulation of Logistics operations is a tremendous tool because it allows the experimentation of solution alternatives and improvement in real systems or subsystems without costly tries.

1.1 THE MODERN CONCEPT OF LOGISTICS

Logistics concept and *Globalization* have been evolved simultaneously. Demand and expectations of customers and users are now the trigger of supply chain system. Client orders could travel to suppliers or producers and return as products or services.

Through the supply chain system flows information, by one side, and materials for the other side. The physical row materials flow starts in suppliers facilities. Materials are transformed in products or services in producer facilities, then are delivered, until they reach final users. Information flow starts in clients or users as commercial orders, goes to production facilities where check if there are existences in inventory. If there are products in inventory, these are delivered to final users. If not, a new order is sent to suppliers as a part of information flow. The physical flow of raw material goes through production to final users. Information and physical flows bring together suppliers, producers and users.
The Council of Logistics Management (CLM) offers the following definition: "*Logistics* is the process of planning, implementing and controlling the efficient, cost effective flow and storage of raw materials, in-process inventory, finished goods and related information from point of origin to point of consumption for the purpose of conforming to customer requirements" [1]

Logistics is related with strategic management of purchases, shipping, storage of materials and parts, transformation in goods, storage of end products, on time deliver to customers, by one side, management information of commercial orders, goods requests, invoices, bill statements, situation and location of orders, packages and shipments across marketing channels, by the other side, with objectives as customers satisfaction, invoice payments, profit returns, maximization of profits.

1.2. SIMULATION ADVANTAGES

Simulation allows users to simplify complexity in dynamic logistics systems. "The power of simulation lies in the fact that it provides a method of analysis that is not only formal and predictive, but is capable of accurately evaluating the performance of even the most complex systems"[2]. Users may design simplified models of logistic subsystems from complex real world systems, experiment with them, analyze, and predict its performance, increase complexity, experiment, analyze and so on. They can also test solution alternatives to well defined problems.

Simulation can be seen as an experimental laboratory where it is possible to test particular relationships related with subsystems of the real world, because those proofs are impossible to realize in real conditions

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[1] Benjamín Blanchard, *Logistics Engineering and Management,* 4a. ed. New Jersey, USA, Prentice Hall, 1.999,p.3.

[2] Harrell Charles, Ghosh Biman, Bowden Royce, *SIMULATION USING PROMODEL*, McGraw Hill, Boston, USA, 2000, p.7.

or are very costly.[3] While testing, experimenters are allowed to change parameters, conditions, relationships any times as necessary, in order to get intuition or to learn about the model and afterwards about the real system.

There is a lot of enterprises in the field of logistic operations with known evidences that simulation is a very useful tool to gather innovative ideas and to test them. Without that help, nobody even treats to attempt new solution alternatives. Once, conditions are proved in the model, people come up with feasible solutions these are tested until to meet best or good alternatives, then savings are gained . In most of the cases, savings are greater than investments in software, people and computer time.[4]

ProModel®, a short way of *Production Modeler*, is an animated software specially made to simulate production and logistic models and systems. The operative system *Windows* offers graphical advantages and friendly users tools. Moreover, simulation and programmer experts have conceived *ProModel®* in such a way that includes statistical concepts, as the most known distributions (normal, poisson, exponential, binomial,...) for raw material arrivals, operations times, downtimes for machines and operators, and logical definitions, that allows to include variability, always present in logistic models, without any trouble.

ProModel®, includes another options such as cost analysis, different scenarios, multiple replications, automatic choosing of better alternatives and distributions with best fit to data, also very useful graphical reports.

THE MORE FREQUENTLY APPLICATIONS IN LOGISTIC SYSTEMS BY USING SIMULATION WITH PROMODEL*

1. IMPROVING DISTRIBUTION IN INDUSTRIAL FACILITIES LAYOUT.

It's a fact that distribution of machines, equipment, stores, transports and work stations, by one side, and assignment of people to operations or workstations, by the other side, have a strong influence in production parameters as cycle times, throughput , work in process and logistic operation costs.

By using simulation with *ProModel®*, people can insert reduced layout plans from *AutoCad* designs or make a drawings using graphical tools available in that software. Afterward layout has been drawn according with plan specifications, *ProModel®* has useful graphic libraries of machines, transportation media as conveyors, cranes, lift trucks, etc., very used in manufacturing enterprises. This software provides automatic graphic aids that calculate distance between locations.

The program has options to change scales, also automatic help to locate and provide cartesian coordinates of any point in the plane. Besides, *ProModel®* make calculations of path distances. Once defined the layout, it is possible to experiment different alternatives of material handling as following: a) use operators, b) use conveyors, c) use fork lift trucks and pallets, d) use cranes, and e) all type of combinations of before alternatives.

a) Use of operators for handling materials.

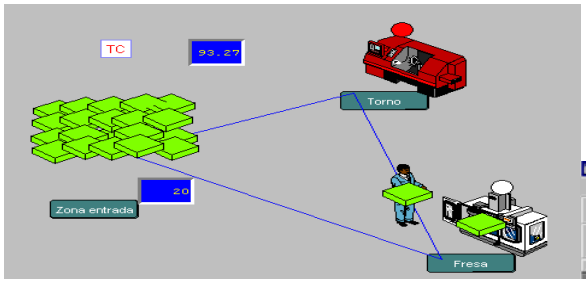
Each operator or resource must have defined a moving path network. Routing paths may have multiple segments as resources need to stop. It is possible to define work places for operators, load or unload transportation times, waiting and operation times. Simulation allows calculate Operation and handling

[3] Blanco-Rivero Luis Ernesto & Fajardo-Piedrahita Iván Dario, *SIMULACION CON PROMODEL Casos de Producción y Logística*, Editorial Escuela Colombiana de Ingeniería, Bogotá, Colombia, segunda edición 2003, p.4.
[4] Ibidem, p.4.

costs, optimal number of operators, materials and resources moving times, and production *throughput* . See graphic 1.

As *ProModel*® has the powerful graphical tools of *Windows*, in order to change distribution layouts, people only need to drag and drop locations, run the program and see results. Also, users can define variables to gather cycle handling times and motion time between locations.

By using *Simrunner* or scenarios, the analyst is able to find the better alternative in number of operators, or layout distribution. See graphic 2.



Graphic 1. Operator handles materials. **Graphic 2. Operator times report.**

b) Use Conveyors.

Users are able to utilize conveyors instead of using operators for handling materials. *ProModel*® has suitable adjustable icons in order to build conveyors or queues. There are also options to define accumulating conveyors where if the lead entity is unable to exit the conveyor, trailing entities queue up, or no accumulating conveyors where if the lead entity comes to a stop, the conveyor and all other entities stop. As before, it is possible to calculate times, distances and costs.

c) Use fork lift trucks and pallets.

Pallets are flat wooden or plastic structures onto which heavy goods are loaded so can they be moved using fork lift trucks. They are mostly used in order to facilitate storage and transportation. The graphical environment of *ProModel*® permits the use of fork lift trucks as resources and pallets as entities. It is achievable to define path moving routes for trucks.

d) Use cranes.

In such a kind of industries as metallurgy, steel mills or those that have heavy metals or pieces as raw materials (steel molds, dies, stones) it is mandatory to use cranes, rail way tracks, fork lift trucks for handling and transportation. *ProModel*® make possible to simulate cranes, define its paths, calculate the number of trips, distance traveled, times of operation and operational costs.

1. PICKING UP OPERATIONS.

Identification, localization and picking up are typical operations in searching and handling processes for raw materials, in process products, end parts or products, packages, letters, spare parts, etc. These operations are generally realized in store rooms, warehouses, supermarkets, inventory zones or temporary storage.

ProModel®, permits delimitation of inventory zones in the layout of store rooms, also allows graphical representation of magazines, exhibition facilities, and so on. Inside store rooms designs, it is possible to build paths or routes of picking up, to be used by operator or fork lift trucks. Animated simulation of picking up operations in store facilities is feasible by using that software. Also, it is possible to calculate traveled distances, picking up times, optimal number of resources and alternatives costs.

2. CROSSDOCKING.

Crossdocking is a logistic system used in supply chain design by great supermarkets chains. In this system products are delivered to warehouses on a continual basis where they are sorted, repacked, and distributed to stores without sitting in inventory. Goods from suppliers travel to distribution centers, then to stores with a minimum of handling and without storage, in order to minimize inventory costs and delivery times. The central idea of *crossdocking* is to transfer directly loads from incoming vehicles to departing vehicles without store products.

By means of animated *ProModel®*, it is achievable to simulate *crossdocking* operations in distribution centers, to define packing zones and to see arrivals of trucks, unloading, picking up, loading operations, departs of distribution vehicles by using operators, pallets and fork lift trucks.

Users may define variables in order to calculate operational indicators as number of used resources, spent times, travel distances and operations costs.

3. DISTRIBUTION ROUTES.

Combined use of Geographical Information Systems (GIS) and animated simulation software as *ProModel®*, allows the use of digital maps with accurate localization of facilities, streets, avenues, highways in order to design optimal routes for vehicles and calculate travel distances and delivery costs. See graphic 3.

Graphic 3. Map of the north zone of Bogota –Colombia with distribution routes for vehicles.

4. LOAD AND UNLOAD OPERATIONS.

This type of applications is similar to those in improving layout distribution of industrial facilities, commented before. It is possible to simulate different alternatives for load and unload trucks, including operators, conveyors, pallets and fork lift trucks. For each alternative, users may calculate number and type of resources, in such a way that minimize load and unload times.

Moreover, users can simulate incoming and departing vehicles to inventory zones for loading or unloading operations. Also, they can simulate motion of resources such as operators, fork lift trucks, conveyors between areas of sorting and storage, and calculate alternatives costs in order to select the most suitable.

5. CALL CENTERS OPERATIONS.

The arrival of calls to a calling center, definition of answer times, duration times variability of callings, queues length of incoming calls when the system is busy, optimal number of operators are among others parameters and variables that can be simulated with this type of application.

ProModel®, provides graphic libraries that allows animated simulation of call centers.

6. SUPPLY CHAIN INTEGRAL OPERATION.

Each one of the subsystems in a supply chain can be model and simulated isolated from the rest of subsystems, nevertheless, *ProModel*® has a powerful tool: *merge command* that allows to integrate subsystems without start all over. All variables and indicators are enabled to function in the integrated system. See graphic 4.

Graphic 4. Integrated supply chain. Subsystems: control and call center, load and unload zones, distribution routes.

SUMMARY

Applications in logistics with *Promodel*® are multiple and varied, only limited by users imagination.

Our contribution has been oriented to help students to understand most of the relationships and parameters in a supply chain or in logistics systems with animated simulation.

As *Promodel*® is a not very expensive product, and is easy to program, it can be a powerful tool for engineers and managers in order to improve their logistics systems.

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