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SIMULATION SUCCESS STORIES: BUSINESS PROCESS REENGINEERING

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ABSTRACT

In this rapidly changing economy, businesses are constantly seeking newer, simpler methods which will help them remain competitive. In this quest, they have discovered that simulation provides a structured environment in which they can better understand, analyze, and improve their processes.

We're going to look at three businesses that have found simulation instrumental in their pursuit of perfection: the US Postal Service, National Cash Register, and a diversified energy corporation.

1 INTRODUCTION

Business process reengineering is the analysis and redesign of business processes. It requires companies to look at their fundamental processes from a cross-functional perspective and ask "Why?" and "What if?" It requires the use of tools and techniques, combined with enabling technologies, to make changes throughout an organization. The objective is to simplify workflow so that the functions within each process are optimized.

Simulation has proven to be an effective tool in just about all facets of the reengineering process. It allows BPR practitioners to determine which processes should be reengineered and if proposed changes will have a productive impact.

The three businesses we're looking at use simulation for close examination of different aspects of their business process: vehicle allocation, proof of concept phase in product development, and reengineering of strategic operations.

2 ANALYSIS OF US POSTAL SERVICE VEHICLE MAINTENANCE FACILITIES

The United States Postal Service (USPS) is currently investigating options to evaluate service center locations within service areas to increase efficiency and reduce costs. They enlisted CAPI to develop a simulation to determine the staff required and costs to maintain postal owned vehicles in a user defined area. The goal of the simulation is to determine how best to allocate vehicles to Vehicle Maintenance Facilities (VMF) and to optimize the use of staff.

2.1 Model Building Issues

The model developer had a number of issues to take into account while building the simulation. First, the definition of each user defined area had to be reexamined. Each area is broken into "zones". Originally, a zone was based on mileage from a VMF. As the model building progressed, it was determined that the zone concept would work better if a zone was based on driving time. Although a postal unit might only be 5 miles from a VMF, the driving time could be as long as one hour if there were traffic delays. This new "driving time" definition was then adopted by USPS.

Then, there was the issue of who the end-user of the simuation would be. The simulation had to be developed so that it could be used by casual users; i.e., users not familiar with simulation. To facilitate ease of use, CAPI developed a graphical user interface which prompts users for information in an easy to understand manner.

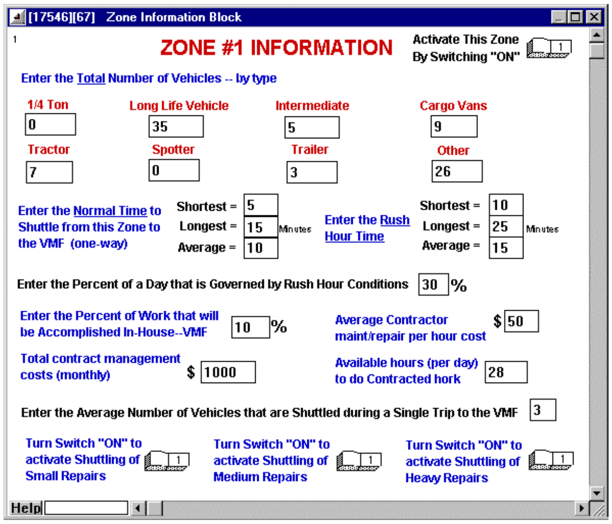

Figure 1: Interface Window

This interface offers a number of inputs to the user:

- The number of vehicles, by type, contained in a zone.
- The frequency of scheduled maintenance and emergency repairs by vehicle type.
- The division of repairs into major, medium, and minor categories.
- The time required to perform the scheduled maintenance and repairs by type of vehicle and type of repair.
- Number of bays in a VMF.

2.2 Simulation Results

Some of the output from this simulation is shown below (information shown is for presentation purposes only):

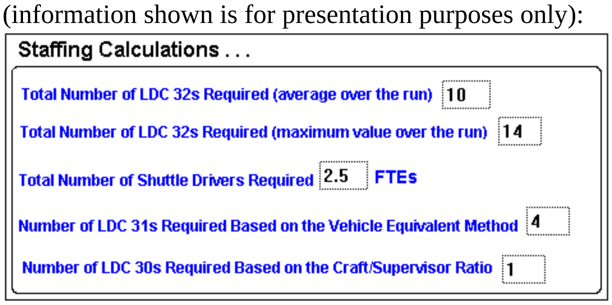

Figure 2: Simulation Output

There are currently ten copies of this simulation in use by USPS personnel. They are using it to determine the best mix of staff, operating hours for a VMF, and to determine if further enhancements are required.

In addition to these productivity improvements, this model is being used to develop a strategy for more effective use of facilities, to explore cost reductions through outsourcing opportunities, and to assist other government agencies by accepting vehicle maintenance work from those agencies, thereby increasing the return on investment made in the VMF itself. Results of these models provide information to VMF managers that allow them to accomplish these goals and more.

3 SIMULATION IN THE PRODUCT DEVELOPMENT CYCLE

This discussion describes how simulation modeling was used at National Cash Register (NCR) during the early phases of a product development cycle. One goal was to validate the general design of a potential product by running simulated "runs" of a similar product already in use. A second goal was to uncover process bottlenecks and inefficiencies by "stressing" the system. The successes and challenges associated with simulation modeling during the early stages of product development will also be discussed.

A previously developed simulation model designed to simulate the front-end operations of a retail grocery store was modified to simulate the behavior of an existing retail product that was similar to NCRs prototype product. Based on the performance of the simulated retail product, design recommendations for NCRs prototype product were made to avoid design inefficiencies.

3.1 The Simulation Model

The simulation model was designed to represent the entire front-end checkout process; from the point at which a customer enters a queue, to collecting the receipt, then departing the front-end area. At the highest level, the simulation network represented five major task categories:

- Customer Wait (time in the queue)
- Unloading (customer/cashier unloads items)
- Itemization (entering merchandise UPCs, voids, price modifications)
- Finalization (tendering cash, check, credit, debit payment)
- Bagging (preparing, filling, and moving bags).

Within each major task category, several discrete task events were specified, ranging from the scanning and handling of each piece of merchandise to preparing tender, waiting for change, and receiving a receipt. Both cashier and customer activities were modeled and a total of 299 discrete tasks were contained within the model.

The model was also designed to account for a variety of front-end checkout scenarios involving solely cashier checkout, customer checkout, or a combination cashier/customer checkout. A total of 37 different checkout scenarios were possible. In addition, the model was designed to accommodate several input parameters which characterize the retail environment. Individual store information, for example, allowed for the number of lanes in the store to be specified, hours of store operation, and the number of days to simulate, to name a few. The model was also designed to allow the input of tendering, labor, and merchandise purchased distributions, as well as task time distributions for each of the 299 discrete tasks mentioned above.

3.2 Model Validation

Discrete task time distribution data taken from field studies and input parameters based on store report data were input into the model. The simulation was run for a period of two 24 hour days and the overall major task category totals were examined (Itemization, Finalization, Bagging, and Miscellaneous). The average task times for each of these categories were within one standard deviation of the values obtained during field studies, suggesting that the model was operating as expected.

3.3 Stressing the Model

The model was configured to simulate a 13 lane store containing 5 regular lanes, 2 express lanes, and 5 prototype system lanes. The regular and express lanes were configured to operate in a normal mode; i.e. all processes to occur at one checkout lane. Because the prototype system involved a two staged checkout process (itemization at one location and finalization at a second location), it was configured to operate with 4 itemization lanes and only one finalization lane. By restricting the operation to a single finalization lane, the system was stressed in that all customers using the prototype lanes were forced to pass through the single finalization lane. The model was configured to simulate 24 hours of store operation per day for a two day period.

The regular and express lane performance was found to correlate highly with NCRs retail front-end database values. A marked increase in customer wait time was experienced at the prototype lanes both prior to entering the lane (in the queue) and at the finalization station. These bottlenecks were observed during the field study and the simulation model output confirmed this occurrence. Because customers were forced to pass through a single finalization lane, total transaction times were nearly twice as large as those experienced at the regular/express lanes. For some retail settings, this scenario represents the best case given the difficulty of acquiring and maintaining a strong labor force.

3.4 Results

Simulation modeling was successfully used to enhance known performance data of a prototype retail product. By stressing the system, a suspected bottleneck in the process was validated. Other suspected problems areas related to customer task performance were validated which supported additional design recommendations for NCRs product. The results were used to confirm the overall design direction of NCRs retail product in the hopes of avoiding similar process bottlenecks. NCR is looking at the use of similar simulation models for future product development phases of this retail product.

4 REENGINEERING AN OFFSHORE PIPE-LAYING OPERATION

The offshore oil industry requires large capital expenditures during every aspect of the operation to find and produce oil products. Pipelaying is just one of the many expensive parts of the offshore oil production process. Following years of exploration, test drilling, production equipment design and installation, pipe must be laid on the sea floor to transport oil products from a production facility to shore.

4.1 Building the Model

A pipelaying barge which may be as long as 500 feet and can lay up to 60 inch diameter pipe is used to weld pipe sections together and lay the pipe into a trench dug by a towed plow. The pipe comes in 40-foot sections called joints, which are coated with concrete for added weight and then delivered to the lay barge from the coating yard via cargo barges being towed by tugboats. The lay barge itself costs over $100,000 per day to operate with the cargo barges and tugs needed to supply the pipe costing as much as $5000 per day.

The company responsible for laying the pipe saw many opportunities to reengineer this process and minimize the costs of the total operation. To assist in this reengineering process, they decided to build a simulation of the pipelaying operation to look at the scheduling aspects of the pipe coating yard, the tugs, cargo barges, and the lay barge. The model the company would develop must be capable of being used to model any pipelaying operation anywhere in the world. This required that the model be very flexible as to the type of resources, routes, and schedules which could be input in the model. The simulation would need to be able to determine the following for any pipelaying operation:

- The minimum number of barges and tugboats necessary to support the lay barge operation without shutting it down.
- The cost and total duration of the operations.
- The required loading rate and operating hours of the coating yard.
- The initial date as well as the total duration required for the equipment to be engaged to the project.
- The preferred route to take.

There are a number of constraints associated with the pipelaying operation which must be taken into account in the simulation in order to produce an accurate model. Some of the typical pipelaying constraints are as follows:

- The cargo barge capacity throughout the project can change as the pipelaying proceeds.
- Estimated laying rates are assumed for a lay barge and it always has an initial stock of joints to lay if none are available from shore; this initial stock is always replenished from the next barge.
- Estimated coating and loading rates are assumed for a coating yard (which can add shifts or run overtime if necessary); also, multiple coating yards can be used.
- Costs of each operation vary according to equipment used.
- There can be multiple transportation routes for the pipe from the coating yard to the lay barge.

The company chose to produce their model in Extend™, by Imagine That, Inc., San Jose, CA.

4.2 Simulation Results

After the simulation was completed, it was used to analyze a specific pipelaying operation in two different steps. The first part of the analysis was to use an input table of estimated laying rates to determine the best route (of three) to be used by the tugs and cargo barges based on minimizing the risk of shutting down the lay barge. This analysis showed that one route requires a slightly shorter time of the lay barge operations, however the cost of transportation is slightly higher compared to a second route. The analysis shows that a third route is the most expensive. The first route was recommended because of the shorter operating time of the lay barge and the lighter overall traffic experienced along the route.

The second part of the analysis was conducted once the pipelaying operation was underway. Actual laying rates from the first half of the operation are used in the simulation to determine if the coating and loading schedules of the coating yard need to be adjusted. Several different cases of adding shifts or overtime at the coating yard were analyzed with the goal of minimizing the risk of shutting down the lay barge during the last half of the operation. The best scenario found that running the coating yard around the clock for the remainder of the operation would minimize the risk of shutting down the lay barge. The scenario also minimized the total cost to the customer which includes the cost of the coating yard, the cost of transportation, and the cost of the lay barge operation.

The simulation model has proven to be invaluable to the company in the reengineering of their pipelaying operations. The company can now use the simulation to offer quotations to their customers before a pipelaying operation ever begins. Then they can use the tool to decide the best route for their cargo barges and tug boats to take to the lay barge. And finally the tool can be used during the operation to predict if major problems of shutting down the lay barge might occur and what can be done proactively with the coating yard and transportation resources to prevent such a costly shutdown.

5 CONCLUSION

Simulation is an effective tool in the analysis and redesign of business processes. It has assisted numerous corporations, government agencies, and universities to realize their goals and gain a better understanding of the way things work. Whether you’re designing a product, improving productivity, or reengineering your entire business operations, simulation can be an crucial tool in your reengineering efforts.

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