Proceedings of the 1991 Winter Simulation Conference
Barry L. Nelson, W. David Kelton, Gordon M. Clark (eds.)

COMPUTER SIMULATION: AN IMPORTANT TOOL IN THE FAST-FOOD INDUSTRY

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ABSTRACT

In 1990, 67% of all restaurant traffic was in quick service units such as Pizza Hut, McDonald's and Burger King. The PepsiCo Restaurant system is the largest fast-food restaurant chain in the world, consisting of Pizza Hut, Kentucky Fried Chicken and Taco Bell. At Pizza Hut productivity and efficiency are very important. Computer simulation plays a key role in solving complex operational problems and improving both productivity and efficiency. Through the use of simulation, production and service aspects of Pizza Hut restaurant and delivery unit operations can be examined relative to staffing levels, equipment layout, workflow, customer service, and capacity. This permits optimization of methods through interactive "what if" analysis on a computer, prior to actually introducing them to the field. This paper discusses the role of computer simulation at Pizza Hut, and describes the characteristics of the simulation models.

1 INTRODUCTION

Customer arrivals and service times are governed by statistical distribution such as exponential, gamma distributions, etc. These distributions provide a relevant range of values and randomness to the system. Therefore, using averages and experimental "Rules of Thumb" can be misleading or disasterous.

Today's restaurants exhibit complex interactions between restaurant equipment, staffing levels, menu selections and customer order mix. Evaluation of how changes will integrate into this complex system often proves to be a challenging task. Small improvements have a significant impact when realized by 6,725 restaurants. One important tool which Pizza Hut uses to evaluate change is computer simulation.

2 THE NEED FOR COMPUTER SIMULATION

Unlike manufacturing systems, fast-food systems are highly labor-intensive. Moreover, the demand is usually intermittent, and not uniform. Most of the sales occur during peak hours. The fast-food business is very competitive and requires that the service and the production facilities be well designed to handle peak demand. Computer simulation provides an accurate way to evaluate changes in the restaurant without disturbing the normal day-to-day operations. By evaluating the impact of changes on the computer, the results of these changes can be defined before they are implemented in the physical restaurant. See Figure (1)

Where Does Simulation Fit in R&D/Operations Development Process?

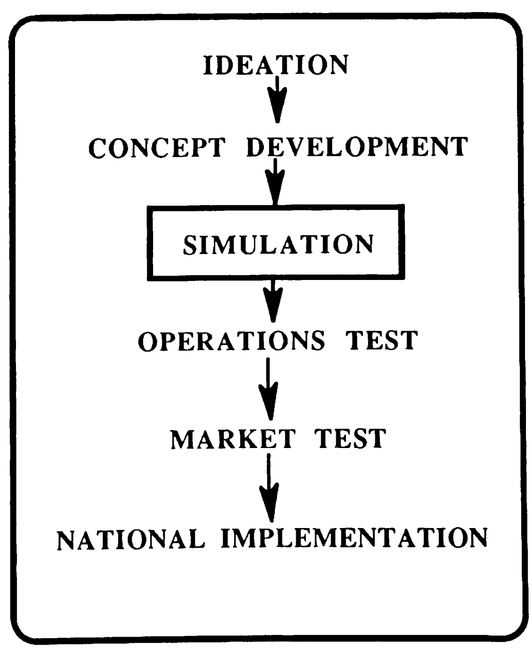

Figure 1. Where simulation fits at Pizza Hut

The results can be used by upper management, equipment designers, architects and other departments to refine the restaurant's design and operation. The simulation system has a strategic impact on positioning restaurants to operate more optimally, since it could be used for the following:

- Detection of system bottlenecks
- Verification of operating standards
- Determining peak performance equipment capacities
- Peak hour capacity requirements
- Customer service times during peak and non-peak times
- Answer "what if" by changing some parameters and determining the impact on the overall system and the customers.

Currently many fast-food restaurants tend to implement their new concepts and ideas and then observe and measure their employees and customers. This process is costly and could abuse both the employees and the customers. Simulation provides an alterative approach to testing. Through computer simulation, the new concept can be simulated and the results will be studied beforehand. Modifications can be made and the simulation is monitored again. After all of the bugs are taken out of the system, the results and recommendations from the computer simulation can be implemented in the field. This will add a sound value to the field test. Figure (2) shows how simulation fits into Pizza Hut.

3 MODEL DEVELOPMENT/ IMPLEMENTATION

3.1 SIMAN Model

A general purpose **SIMAN** simulation model and multiple **CINEMA** animations were developed. The model is flexible enough to accurately model any of the existing restaurant or delivery unit configurations. The model has been developed in such a way that each "module" can be presented in detail or as a simple step in the system. For example, the kitchen is considered a module which can be modeled in detail (maketable, cut table, oven, etc.) or can presented as a simple unit process. The level of detail is important if only one particular part of the restaurant is to be studied and all others only modeled as a "black box." The following five modules have been defined:

Dine-in module - Detailed modeling of dine-in customers requires that the following information be defined - the number and position of table and aisles, customer attributes like smoking vs. non-smoking, number of cars in the party, number of persons in party, number of waitresses and hostesses, zoning for waitresses etc. and all restaurant task assignments.
By modeling the dine-in customers without detail, the only information which is important is the arrival rate and specific items ordered. All other details about dine-

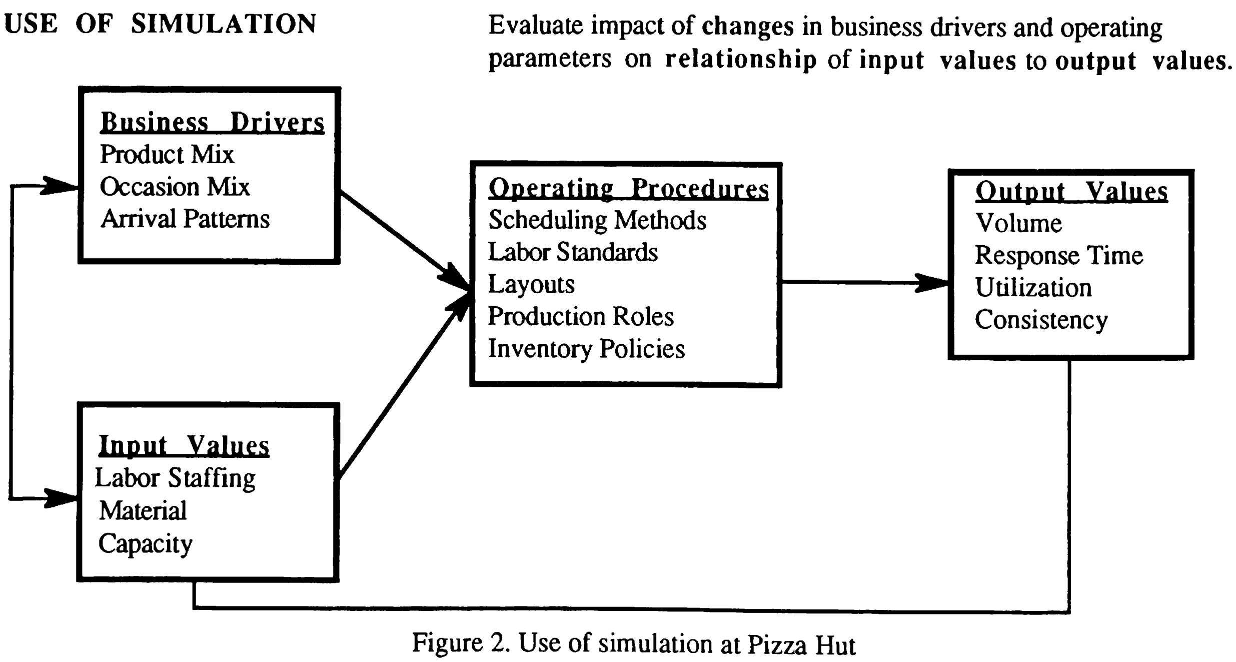

Figure 2. Use of simulation at Pizza Hut

in customers are ignored. This option is useful in evaluating a new kitchen design without a need for defining information on the waitress station or dining room.

Carryout module - Similar to Dine-in module where the Dine-in specific information is replaced with Carryout specific information. Detailed modeling of Carryout customers requires all information be included and accurate. Modeling the Carryout customers without detail simply puts demand on the kitchen based on the carryout arrival rate and specific items ordered.

Delivery module - Similar to the Dine-in module where the Dine-in specific information is replaced with delivery specific information. Detailed modeling of Delivery customers requires all information be included and accurate. Modeling the Delivery customers without detail simply puts a demand on the kitchen based on the delivery phone call arrival rate and specific items ordered.

Kitchen module - The kitchen can be modeled in detail by including all information about staffing levels, task assignments, cut table information, maketable information, oven information, distances between stations, all system delays, etc. The kitchen can also be viewed as a simple delay for each order. This option is useful if a fixed time from the kitchen is known and information about the waitress station, dining room or delivery areas is the only important characteristic.

Oven Module - This model includes very detailed modeling of the pizza ovens. Each square inch of each pizza oven is carefully defined as busy or idle as pizzas move through the oven. A rudimentary packing algorithm is included which loads the ovens by evaluating where a pizza "fits" when it is placed into the oven. The oven can also be viewed as a simple delay and each pizza will assume some time in the oven without actually modeling the ovens in detail. This option is useful if the average oven time is known (including queueing time) and other components of the system are to be evaluated. The kitchen must be modeled in detail, the ovens are part of the single delay for an order in the kitchen. The oven module is a example of capacity determining process.

The analyst prepares a simulation run by completing a data form "configuration file" which is read in by the simulation model to completely configure the system.

3.2 The Configuration File

The configuration file is basically an ASCII file which contains most of the restaurant specific information. This file serves as user interface to the model. The analyst can use a standard text editor such as kedit. The configuration file is an external data file and no compilation is needed to use the file in a given simulation run. The configuration file contains information about the the restaurant type to be modeled, time period to simulate, system level of detail, dining room information, system personnel, task assignments, equipment, product mix, job selection policies, etc.

Most of the information which changes between restaurants is included in the configuration file as well as in the experiment frame. When the model begins execution, the configuration file is immediately read and all the information is written to the experimental frame. All information which appear in the configuration file will replace the information already existing in the experimental frame. See Figure (3)

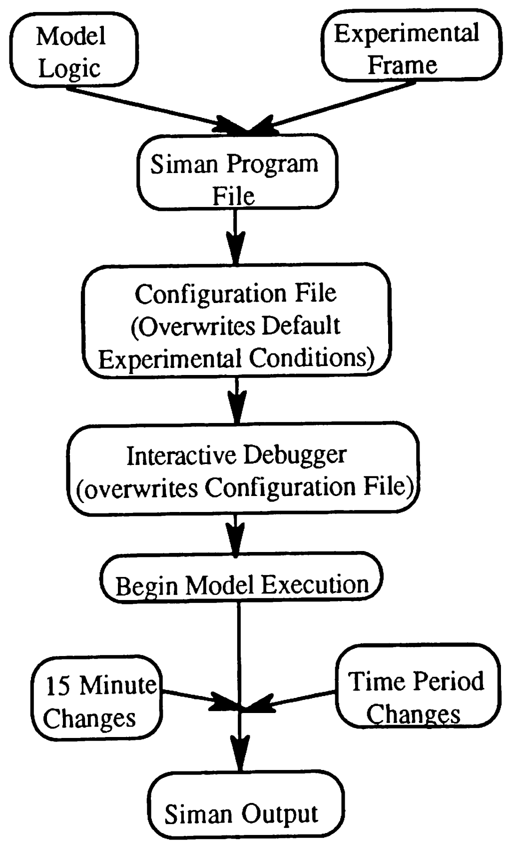

Figure 3. Model Execution Flow Chart

3.3 FORTRAN Code

Throughout the model, events and user functions are called to execute FORTRAN subroutines. These subroutines make determinations such as:

- find a resource to perform a task
- which job to do next
- find a table for a given party
- calculate specific food items for dine-in, carryout, and delivery customers
- which resource to use

This use of events and user function in the model makes the model very flexible and easy to modify and update.

3.4 User Menus

In addition to the configuration file, a user-friendly menu-driven system was developed which allows the user to change parameters of the restaurant in a user-friendly environment. The user menus include much of the same information as in the configuration files such as the three different customer types, capacity of all resources, job assignment, product mix, and arrival rates by 15 minute increments. The user menu will allow non-programmers to be able to utilize the simulation models.

3.5 Animation

Multiple CINEMA animations (screens) were developed to be able to view the entire restaurant. The animations were used primarily for these purposes:

- As vital tools in debugging and validating the simulation model and understanding the true dynamics between the different restaurant modules.

- As an important tool for upper management to view the models. Animation allows management and other individuals to see the restaurants in action. Animation has been used in all simulation presentations

Six different layouts have been developed:

- Dining Room
- Carryout Counter
- Delivery/Dispatch Area
- Delco Layout
- 2-D Oven Layout
- 3-D Perspective Kitchen View

3.6 Data Requirement

Obtaining the necessary data to feed the simulation model is a huge task in and of itself. We believe that to obtain an accurate simulation output, correct and precise input data must be used. The data necessary for the simulation model was voluminous and was obtained from two main sources:

1)Main Frame Data Base

Much of the required data was obtained through internal sources.

2)Time and Motion Study

Time studies were performed in different parts of the country to collect production and service times for every activity "Task" that takes place in the restaurant such as "Greet Dine-In Customers."

The Unifit software by Averill Law is used to fit probability distribution to the observed data.

4 MODEL VERIFICATION/VALIDATION

The validation process requires many steps and it could be costly and time consuming. However, Pizza Hut considers this process as an essential step and enough time must be spent on it to ensure model credibility. Therefore, the following steps were taken to verify and validate the simulation models:

1- The SIMAN code along with all the FORTRAN codes were reviewed against the real system to ensure accuracy. Two Pizza Hut engineers walked through the code line by line.

2- Initial simulation runs were used to review the model output to point out any concerns or unreal output.

3- Key performance measures of the system were defined. These measures were time in the system, waiting time to be seated, service time, etc.

4- Both time study sheets and video cameras were used to collect the actual observation from a specific restaurant. This data was then entered into the simulation model and the simulation run was replicated a number of times to obtain independent identically distributed data points. Confidence intervals were calculated around these key performance measures. The outcome was very satisfactory when compared to the actual restaurant performance.

5- Finally, the animation has added a great value to the validation process and to the credibility of the model. We feel that the models accurately represent Pizza Hut restaurants.

5 SUMMARY

As the fast-food business grows more competitive, it is essential to have a sophisticated, highly flexible, powerful analytical tools available so that they can be used by engineers and analysts. Computer simulation helps us get better answers, faster at lower cost.

ACKNOWLEDGMENTS

The auther extends his thanks and gratitude to Richard H. Rosenbloom, Sr. Director, Productivity Engineering, Pizza Hut, Inc. and John P. Meszaros, Project Engineer, Systems Modeling Corporation for their help and assistance with this article.