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OPPORTUNITIES FOR SIMULATION IN AMUSEMENT PARKS

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ABSTRACT

This paper discusses eight projects that were conducted by students over a one-month period at a large amusement park. Many of the findings of the students resulted from their insights having worked in a specific area for a short time and having collected data intensively over a one-week period. The base case simulation models were validated by comparison to actual data, and one or more alternatives were considered.

1 INTRODUCTION

Students from Instituto Technologico y de Estudios Superiores de Monterrey (ITESM or Monterrey Tech) have been visiting Georgia Tech each Summer for several years. They have been taking an accelerated set of two courses over a one month period and receiving the credit at Monterrey Tech. The courses have always included discrete-event simulation at the undergraduate level.

In the Summer of 1994, the students were given the option of taking two courses, as in the past, or taking Advanced Simulation and Projects in Simulation. Some 44 students signed up for the Summer Program with 33 electing the new option.

The new option included advanced study in simulation language and animation software, introduction to distribution fitting software, and introduction to output analysis software. The project site was a very large amusement park, Six Flags Over Georgia, called the Park in this paper, located near Atlanta.

The students were given a two-hour introduction to the Park on their second day in the Summer Program. After the introduction, they were told to spend the balance of the day in the Park so that they could understand what it is like to be a visitor there, and to begin to get the desire to partake of the thrills out of their system.

On the very next day, the students went to costuming, received training in a specific area and worked in the Park for eight hours. This on-the-job experience lasted for two days. The students had been divided up into teams of four persons each, except for one team that had five persons. The work days were Friday afternoon and the following Monday afternoon. Over the weekend, the students began data collection activities.

2 STUDY AREAS

Large amusement parks usually have some five or so major attractions for which the demand is very high. For proprietary reasons, the data given in this paper is fictitious, but the essence will not be lost. On a very busy day, there may be 36,000 guests in the Park. Some 50% of the guests would like to participate in the main attraction, a thriller ride of the coaster variety. Another class of ride is the floater, and these may also be major attractions. (Floaters are rides on water, in boats, or rafts.) The capacity of the top attraction may be 12,000 persons per day. Thus, 6,000 people may be unable to ride on the major attraction on the busiest day. To increase the capacity of the major attraction to 18,000 persons per day is probably unsound from an economical standpoint.

Even though the capacity of the major attraction is nominally 12,000 per day, only 10,000 guests might be served for several reasons including the following:

1. Failure to fill the ride on each use.
2. Unplanned down time to insure ride safety.
3. Cycle time not at its minimum value.

The cycle time can be broken down further into loading time, ride time, and unloading time. Each of these three components has some opportunity for cycle time reduction.

There are other areas of interest in a Park than the rides. For instance, guests are served during the car parking process, at the gates where they purchase their tickets, and so on. Each of these service areas is an opportunity for improvement.

The specific study areas (shown in bold) are introduced by a trip to the Park. The first sight is the **parking lot**. Trams ride through the lot on a continuous basis. If the main lot fills up, there is an overflow dirt parking area. After walking from the car, or riding the tram, we arrive at the **gates**. There are lots of possibilities for entering the park. We may have bought our tickets in advance, perhaps we have a coupon that entitles us to a reduced fee, there is a self-service machine that accepts major credit cards, we may even pay the regular admission fare with cash. After walking into the Park, we may decide to visit those major attractions. We could go to the exciting roller coaster the **Scream Machine**. Another exciting roller coaster is the **Georgia Cyclone**. It seems like everyone wants to take these two rides. Now, it's time for lunch at **DeeJay's Diner**. It's really a fast food restaurant serving hamburgers, French fries, and so on. It's a good idea to come before noon or after 1:00 PM. After lunch, some in our party want to visit the **lady's rest room**. It does get crowded here. If people only knew that there were other facilities available, things would go much faster. Now, its back out into the Park for the **Thunder River** ride. Everybody manages to get splashed (maybe they can't avoid it), even soaking wet, here. It was worth the wait. We certainly don't want to leave the Park without some souvenirs, T-shirts, and so on. These come from the **warehouse** area initially, then they are sold in the many retail areas. Another fun day at the Park!

3 PRESENTATIONS

The Park saw opportunities for improvement. During preliminary meetings these opportunities were discussed with the authors. Initially, very brief descriptions of each area were developed. A second meeting was held, and more definition was given to the areas of interest. When the students arrived, they were assigned specific areas. They were given only one week to develop a problem formulation, and present it to the Park in 10 minutes. At the problem formulation, the supervisor for each of the areas, and others from the Park were in attendance to give their suggested revisions, comment on data requirements, discuss the alternatives that were being examined, and provide input on the projected timetable.

The second presentation by the students was the interim report. This was given with little more than a week left in the Summer Program. At this time their progress was described. The purpose was to determine if any changes in direction were needed prior to the final push. Each group was given 20 minutes to make their presentation.

The final presentations lasted 30 minutes each. They were given over a two-day period. Completing all of the data collection, simulation, animation, output analysis, and reporting in a one-month period was a real challenge, and the students worked long hours to reach their goal. The presentations were all made using graphics software. Copies of the final report were given to the instructors and to the supervisor in the project area within the Park.

4 SOLUTION IN THE FORMULATION

The real purpose of the courses was learning advanced simulation and applying the knowledge gained to a real situation. The Park made this possible in a very effective and efficient manner. The people at the Park were willing to let the students practice their skills, they cooperated fully with the student teams, and provided information upon request.

Although the solutions were thought to be in the simulations, that was not always the case. Many of the "solutions" came from observation, from seeing things differently. Examples are as follows:

1. Parking lot
   a. Pay for parking in the Park eating facilities.
   b. Work with the Rapid Transit Authority to increase bus service to the Park.

2. Gates
   a. Provide signs for the guests indicating the appropriate booth for their transaction.
   b. Make the self service credit card machine more visible.

3. Scream Machine
   a. Provide information to riders concerning remaining seats.
   b. Provide information that describes layout of

cars comprising the train.

c. Provide overhead mirrors so that riders can fully spot available seats.

4. Georgia Cyclone
   a. Have an alarm that signals the operators that a train should be released.
   b. Have signs that explain the ride seating to the guests.

5. DeeJay's Diner
   a. Provide goals for production.
   b. Let guests dispense their own drinks.

6. Lady's Rest Room
   a. Have electronic signs to indicate a vacancy in a stall.
   b. Have signs to indicate direction and walking time to other facilities.

7. Thunder River
   a. Install pumps to move boats that are temporarily stalled.
   b. Have staff work very hard in meeting the release time for boats.

8. Warehouse
   a. Implement a program for maintenance of the stock.
   b. Insure that workers are using safety equipment properly.

These suggestions are all low in cost. This was appreciated by the Park, and the low cost increases the probability of implementation.

5 SIMULATIONS CONDUCTED

Rather than present all of the simulation models that were constructed, several of the models will be described in this section.

5.1 DeeJay's Diner

The intent of the solution was the examination of several alternatives that would decrease the time in system for guests. The assumptions are that there are three general periods during the day, i.e., lunch from noon to 2:00 PM, dinner from 5:00 PM to 7:30 PM, and snack time otherwise. It was also assumed that there were four groupings of work days, i.e., Monday-Wednesday-Friday, Saturday, Sunday, and Tuesday-Thursday. Alternative scenarios included varying the number and mix of workers. Evaluation criteria included the average time in line, the maximum number in line, the time in system, personnel costs, and number of reneges. The simulation was conducted numerous times for the base case and confidence intervals for maximum people in line and average time waiting were constructed. The real system performance measures were compared to the measures from the simulation indicating a validated model. Then the alternatives were simulated. For example, the current system has 7 cashiers throughout the day. An alternative is to use the number of cashiers, and possibly expediters, appropriate to the system demand. Multiple replications were simulated. The results indicated much lower personnel costs, and greatly reduced waiting for the alternative scenarios. For the busiest day of the week, the new personnel costs would only be approximately 60% of the current personnel costs.

5.2 Gates

The simulation included the analysis of two alternatives; maintaining the current system of forming separate lines behind the two windows in each ticket selling booth or use one line only. For an M/M/2 queueing system, this problem can be examined with queueing theory. However, in the existing system, there are many kinds of transactions, each taking a different action time, and there are frequent interruptions of the cashiers that must be considered. Thus, a simulation was warranted. During a necessarily short time span, a vast amount of data was collected and analyzed concerning the arrival patterns and service times. (Nearly 600 observation were made for interarrival times to the back gate on a Saturday morning.) This led to several assumptions. There are three types of arrival patterns classified as Monday-Wednesday-Friday-Sunday, Tuesday-Thursday, and Saturday. The busiest part of the day is from 10:00 AM to 12:30 PM. All of the cashiers work at the same speed. The criterion were waiting time in line, the time that guests spend in the system and server utilization. Ten replications of the simulation were conducted and the performance measures were compared to those of the real system with no statistically significant difference. Then, ten replications of the alternative, one line per booth, were conducted. There was a significant difference between the means, a reduction of waiting time by a factor of 1/3rd. It was noted that adopting this alternative was relatively inexpensive.

5.3 Georgia Cyclone

Since this ride is so highly demanded, the time in line is the issue of concern. The highest demand day is Saturday, and that is the day that was modeled. It is assumed that there can only be two trains, each carrying 24 passengers, in operation at one time. The ride's operation time is 140 seconds. It is assumed, further, that 10% of those entering the queue do renege. Several of the rides considered the alternative of having a line for those riding alone. This will reduce the number of idle seats on each ride and increase the daily capacity in a rather easy manner, i.e., filling in empty seats. The team simulated the base system and compared it to the real system with very favorable results. They assumed that all seats could be filled using the added line, and the simulation, of course, confirmed how wonderful this would work on the criterion, the average time in line. Adding another line is relatively inexpensive.

5.4 Female Rest Room Queueing

There are ample rest room facilities throughout the Park. One of these rest rooms is located in a very popular area and is highly demanded by the guests during the busiest times. If guests knew the location of other rest rooms, the demand on this rest room could be reduced. The current system was modeled, with validation accomplished by comparison to the real system. The alternative scenario suggested increasing the number of stalls from seven to ten; adding signs that indicate whether the stall is vacant, occupied, or being maintained; and indicating nearby locations of other rest room facilities. These measures would reduce waiting time drastically by 75%. It was estimated that the cost would be approximately $15,000.

6 PARK REACTION

The Park was an excellent client. They were much involved in the investigations from the two initialization meetings through the final presentations (after which a celebration was provided by the Park with refreshments and mementos). The Park also realized the benefits of analysis and was willing to consider making changes that would improve service to the guests.

Two weeks after the students had departed, the major contact at the Park had the following paraphrased comments: "We are reviewing the recommendations. Some of the recommendations are easy to implement and we have done so already. For example, the students recommended having a person at the front of the queue before the Georgia Cyclone to direct guests. We are doing that today. For 95% of the recommendations, however, it will be next year before implementation can occur because the changes have to be included in the budget. Some of the suggestions that look particularly attractive are adding one or more trams in the parking area and adjusting staff size throughout the day in DeeJay's Diner. There are other suggestions, that are more expensive, but are being closely examined. An example is the redesign and addition to the warehouse. All of us at the Park are pleased that we had the students here. They provided fresh views in many areas."

7 CONCLUSION

This paper discussed eight projects that were conducted by students over a one-month period at a large amusement park. Many of the findings of the students resulted from their insights having worked in a specific area for a short time and having collected data intensively over a one-week period. The base case simulation models were validated by comparison to actual data, and one or more alternatives were considered. The reaction of the Park to the students was very enthusiastic. They were particularly interested in recommendations that were relatively inexpensive to implement, and most of the recommendations were of this order.

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JERRY BANKS is a Professor in the School of Industrial and Systems Engineering at the Georgia Institute of Technology, Atlanta, Georgia, USA. He received the Ph.D. degree from the Oklahoma State University. He teaches discrete-event simulation, quality control, and creativity/innovation for engineers. He is the author, co-author, or co-editor of nine texts, several chapters in texts, and numerous technical papers. Recent titles include the co-authored text **Forecasting and Management of Technology** published in 1991 and the single-authored text **Principles of Quality Control** published in 1989, both by John Wiley, New York. He is also the co-author of **Discrete-Event Systems**

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