A SIMULATION OF OPERATIONS OF A QUICK-SERVICE STEAK HOUSE RESTAURANT

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ABSTRACT

Operations of a steak-house restaurant in St. Ann, Missouri is simulated using GPSS (General Purpose Simulation System). Objective is to eliminate the long waiting lines. Two models are developed to simulate the actual situation and the proposed change to the restaurant. It is found that the change in facilities greatly improved the efficiency of the restaurant and increased profits by eliminating the problem of loss of customers over waiting time.

INTRODUCTION

In this paper we studied the operations of a steak-house restaurant in St. Ann, Missouri. Because of the long waiting lines, the owner was having a lot of difficulties in serving the people in his cafeteria type establishment. Although he appreciated the good business, he was concerned that he will eventually lose his customers if he did not improve his operation.

PRESENT OPERATION

The present operation of the restaurant consisted of a series of service areas where customers picked up different parts of their dinner as they moved toward a cash register. A diagram of this operation is given in Figure 1 under Model #1.

Customers first entered a queue (#1) and waited for their turn for someone to take their order (facility #1). In addition, in this area the steak was cooked and potato and bread was put on a plate. This entire process took about 95 seconds with a variance of 15 seconds.

Customers next entered another queue (#2), the salad bar (facility #2). There was only one person serving both the salad bar and the cold drink fountain (facility #3) and consequently both of these areas were not in operation at the same time. About 80% of the customers preferred cold drinks while the other 20% wanted to have a hot drink (facility #4) with their meal. After receiving a salad and a drink, customers next moved on to the cash register and paid for their food. On the average, it took each customer 17 ∓ 5 seconds to get a salad, 10 ∓ 5 seconds a cold drink, 18 ∓ 2 seconds a hot drink, 27 ∓ 10 seconds to pay for the meal, depending on the change.

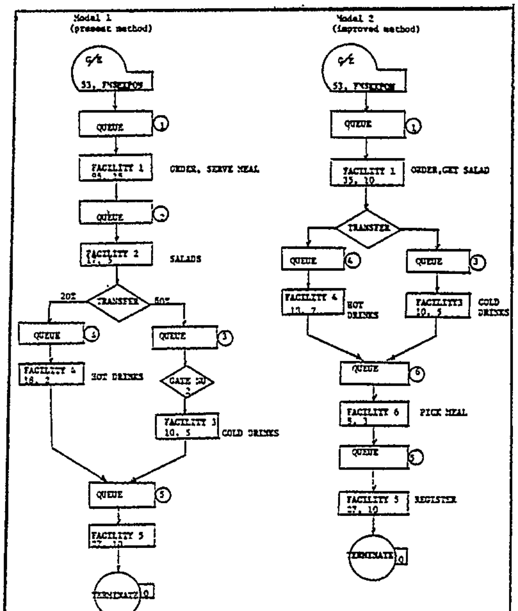

FIGURE 1. Flow Diagram of the Present and Improved Operation.

MODEL DEVELOPMENT

We developed two models to simulate the actual situation and the proposed change to the restaurant. Our first effort was directed toward getting a model that we could validate as being very close to the real-life situation. After we were satisfied with this, we had the basics to develop a second model which was our proposed solution to the problem.

In the development of the first model, we were very careful to only select the peak times because the other times would tend to smooth out our analysis of the waiting lines associated with the restaurant. We, therefore, selected 11 AM - 1 PM and 5 PM - 7 PM for the times to test our model. We gathered statistical data on these times and selected several of the busiest days of the week to run our model against. (see Table 1)

TABLE 1 Arrival Rate of Customers

TIME	SUN	MON	TUE	WED	THUR	FRI	SAT
10:30-11:30 AM	50	20	25	25	30	30	30
11:30-12:30	150	80	80	85	90	100	120
12:30- 1:30 PM	60	30	35	40	50	70	90
1:30- 2:30	40	20	20	25	30	50	60
2:30- 3:30	40	15	15	10	20	10	10
3:30- 4:30	60	5	5	10	10	20	20
4:30- 5:30	35	30	35	40	50	50	30
5:30- 6:30	55	50	60	65	75	80	90
6:30- 7:30	55	50	55	55	65	85	95
7:30- 8:30	20	20	30	35	40	55	65
8:30- 9:30	0	0	0	0	0	35	40
9:30-10:30	0	0	0	0	0	20	25

In the second model we assumed we could change the order of the facilities in the restaurant by changing the direction of the movement of the line. We also assumed that we could add an extra employee during the peak hours to resolve some of the waiting time problems. Under this new system service of the steak, potatoes and toast we put at the end of the line (see Model 2 in Figure 1) because it had the longest waiting time. The extra employee was added to the soda fountain so that the other employee was free to take the orders, and give them over a microphone to the cooks at the far end of the line while serving the salads. (This new process took about 25 to 45 seconds.)

RESULTS

We used GPSS (General Purpose Simulation System) language to simulate each system corresponding to two hours of actual operation time. Our basic assumptions were that the customers arrived, on the average of every 53 seconds, according to a Poisson process (exponential inter-arrival times).

The results of the first model was that everything revolved around the first queue and facility. We found that there was an average wait of 30 minutes in this queue (see Table 2). At certain periods after the first hour and during the customer peaks, we found that the waiting times could get up to an hour. Although these times seem to be excessive, they conform to what was actually experienced in the restaurant. The total time through the system during these peak periods was about 45 minutes. This time would be totally unacceptable to customers and you can well imagine why a number were lost. This was even more acute problem for the people who had a 30 minute lunch period and even with an hour it would be very rushed. The maximum number of the people in the order queue was sixty four. All other queues did not experience backup because of the magnitude of waiting time in the first queue.

In the second model we switched the facilities around and let the cooking time of the steak go on as the people moved through the line, serving them at the end of the line. We found that this cut the service time of the first queue down extensively and it was physcially impossible for a person to go through the other facilities and reach the steak serving facility in more time than it took to cook the steak. We also found that we could serve more people in the two hour period than we could with Model 1. In Model 1 we were able to serve seventy five people while in Model 2 we served one hundred and sixty two people through the line. The average contents of the first queue dropped from thirty five people to less than two waiting in line. This is a much more optimal way to run this operation. We found that the total time through the system was also greatly reduced in that it took an average of about five minutes to go through the complete line.

TABLE 2: Comparison of Selected Statistics

FACILITY STATISTICS COMPARISON

FACILITY	NUMBER ENTRIES Model 1	Model 2	Comparison (percent increase)
1	76	163	114%
2	75		
3	57	137	140%
4	18	25	39%
5	75	162	116%
6		162	

QUEUE STATISTICS COMPARISON

QUEUE	Model 1	Model 2	Comparison (percent decrease)
		Maximum Contents	
1	64	7	89%
		Average Contents	
1	35	2	94%
		Average Waiting (minutes)	
1	30	1.4	95%
		Standard Deviation (minutes)	
1	18	1.1	94%

CONCLUSIONS

The change in facilities greatly improved the efficiency of the model of the steak house restaurant. Although the waiting time advantages are obvious another benefit was that the steak was not getting cold as it went through the line and was hot as possible since it was served at the last facility. Since the entire business was based on a volume operation, one of the reasons for unprofitability was a loss of customers over waiting time. It should also be stated that increased competition added to this unprofitable situation. The new arrangement suggested in Model 2 was tried subsequently and found to be a viable alternative to the first model. The real life situation of Model 2 works very closely to the simulated one and this restaurant is now making a good profit.

REFERENCES

1. General Purpose Simulation System V OS/DOS User's Manual No. SH20-0851, International Business Machines Corporation, White Plains, New York, 1973.
2. Greenberg, S., GPSS Primer, Wiley, New York, 1972.
3. Gordon, G., The Application of GPSS V to Discrete System Simulation, Prentice-Hall, Englewood Cliffs, New Jersey, 1975.
4. Naylor, T. and Finger, J.M., "Verification of Computer Simulation Models", Management Science, Vol. 4, p. 92-101, October 1967.

APPENDIX-PROGRAM LISTING

MODEL 1

```
BLOCK
NUMBER  *LOC   OPERATION  A,B,C,D,E,F,G,H,I,J        COMMENTS

                SIMULATE
   1      EXPON FUNCTION   RN1,C24
   1      0,0/.1,.104/.2,.222/.3,.355/.4,.509/.5,.69/.6,.915/.7,1.2/.75,1.38/
   1      .8,1.6/.84,1.83/.88,2.12/.9,2.3/.92,2.52/.94,2.81/.95,2.99/.96,3.2/
   1      .97,3.5/.98,3.9/.99,4.6/.995,5.3/.998,6.2/.999,7/.9997,8
       1        GENERATE   53,FN$EXPON
       2        QUEUE      1
       3        SEIZE      1
       4        DEPART     1
       5        ADVANCE    95,15
       6        RELEASE    1
       7        QUEUE      2
       8        SEIZE      2
       9        DEPART     2
      10        ADVANCE    17,5
      11        RELEASE    2
      12   TRAN TRANSFER   .2,COLD,HOT
      13   COLD QUEUE      3
      14        SEIZE      3
      15        GATE NU    2
      16        DEPART     3
      17        ADVANCE    10,5
      18        RELEASE    3
      19        TRANSFER   ,REGIS
      20    HOT QUEUE      4
      21        SEIZE      4
      22        DEPART     4
      23        ADVANCE    18,2
      24        RELEASE    4
      25  REGIS QUEUE      5
      26        SEIZE      5
      27        DEPART     5
      28        ADVANCE    27,10
      29        RELEASE    5
      30        TABULATE   7
      31        TERMINATE
   7          7 TABLE      M1,150,100,100
   1          1 QTABLE     1,80,20,40
   2          2 QTABLE     2,100,2,40
   3          3 QTABLE     3,15,1,40
   4          4 QTABLE     4,15,1,40
   5          5 QTABLE     5,15,5,40
      32        GENERATE   7200
      33        TERMINATE  1
                START      1
```

MODEL 2

```
BLOCK
NUMBER  *LOC   OPERATION  A,B,C,D,E,F,G,H,I,J        COMMENTS

                SIMULATE
   1      EXPON FUNCTION   RN1,C24
   1      0,0/.1,.104/.2,.222/.3,.355/.4,.509/.5,.69/.6,.915/.7,1.2/.75,1.39
   1      .8,1.6/.84,1.83/.88,2.12/.9,2.3/.92,2.52/.94,2.81/.95,2.99/.96,3.2
   1      .97,3.5/.98,3.9/.99,4.6/.995,5.3/.998,6.2/.999,7/.9997,8
       1        GENERATE   53,FN$EXPON
       2        QUEUE      1
       3        SEIZE      1
       4        DEPART     1
       5        ADVANCE    35,10
       6        RELEASE    1
       7   TRAN TRANSFER   .2,COLD,HOT
       8   COLD QUEUE      3
       9        SEIZE      3
      10        DEPART     3
      11        ADVANCE    10,5
      12        RELEASE    3
      13        TRANSFER   ,PICNL
      14    HOT QUEUE      4
      15        SEIZE      4
      16        DEPART     4
      17        ADVANCE    19,2
      18        RELEASE    4
      19  PICNL QUEUE      6
      20        SEIZE      6
      21        DEPART     6
      22        ADVANCE    8,3
      23        RELEASE    6
      24  REGIS QUEUE      5
      25        SEIZE      5
      26        DEPART     5
      27        ADVANCE    27,10
      28        RELEASE    5
      29        TABULATE   7
      30        TERMINATE
   7          7 TABLE      M1,150,100,100
   1          1 QTABLE     1,80,20,40
   3          3 QTABLE     3,15,1,40
   4          4 QTABLE     4,15,1,40
   5          5 QTABLE     5,15,5,40
   6          6 QTABLE     6,15,1,40
      31        GENERATE   7200
      32        TERMINATE  1
                START      1
```