CONTEST PROBLEM 3

# *IIE/RA Contest Problems*

### Third Annual Contest: Sally Model's SM Pizza Shop

Before I outline my problem, here is a little background information that might help you better understand my specific request. When I was in college, I worked part time at a Mom and Pop pizza parlor. Everything was handmade, so I had the opportunity to learn a lot about making pizzas. After I graduated and started raising a family, I began to experiment with making different kinds of pizza. Over time, I developed a unique pizza product that was a big hit with all our friends. After my children left the nest, I decided to open a pizza shop and expose the public to my new product. The business was an immediate success in terms of customer appreciation, but not from a profit standpoint, so I began to explore better ways to produce my product. With a new set of plans, I opened a second store, revised the plans, then opened a third store, and so on. Over a number of years, I refined my design to where I now have a standard concept that is implemented in all of my stores—currently numbering over 300.

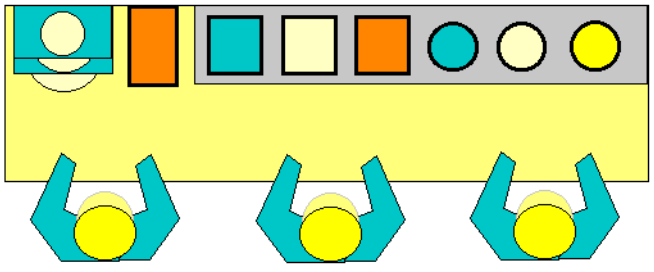
I am about to undertake a major expansion program that I hope will result in the SM Pizza brand becoming a national chain of stores. Although the store design concept is firmly established, the staffing and operational aspects are still a problem. This is the area where I need your recommendations. First, let me describe our expansion philosophy, then our store operation, and finally, my request.

Our new stores will be of the DELCO variety, DELivery and Carry-Out, only. They are designed to be small and cover only a limited delivery area. This allows us to provide a high-quality product in a reasonable time. It also allows us to limit our store hours, which is a distinct advantage since we tend to hire retired individuals to manage and run each store. The limited hours are ideal for these types of employees, and they allow us to confine our sales to the dinnertime crowd. Normally, we locate our stores in suburban areas where we cater to working families who have little time to cook supper. We have found that these individuals are quite happy if we can have carry-out orders ready in 35 minutes or less and have our delivered orders in the customers' hands in 45 minutes or less. If we exceed these times, we start receiving customer complaints and a decrease in sales. Thus, these two performance measures are what we use to determine our customer-satisfaction levels.

Our store operation is really quite simple. It consists of five operations: order taking, pizza making, oven, cut and box, and delivery or carry-out. As I indicated earlier, we have a standard design concept we use in all our stores. It starts with a high-tech phone system that allows us to take the customers' orders (automatically, for many) and display the order at the pizza-making operation. We have no problems with this operation, so it does not need to be considered in your analysis.

This phone system is installed in all our current stores, and we have used it to collect information on customer demand. Although there is some minor variation from store to store, a typical order contains from one to three pizzas. Our data tell us that 64% of the orders are for one pizza; 31%, two pizzas; and 5%, three pizzas. We also have three pizza sizes (large, medium, small) and our data appear to tell us that the pizza size is not dependent on the order size (32%, large; 56%, medium; and 12%, small). We only sell seven different types of pizza: 12%, Veggie; 13%, Fungus; 18%, Red Meat; 15%, Fat Free; 16%, Dairy Delight; 11%, Hot & Spicy; and 15%, The Works.

The pizza-making process is performed at a standard make table with positions for up to three people. A layout of this table is shown below.



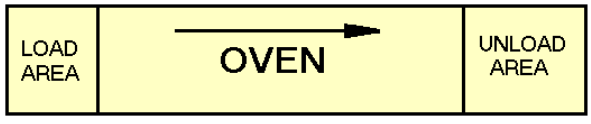
We have divided our pizza-making process into three operation steps or tasks. Some of the pizza-making process is highly confidential; therefore, we will only highlight the three tasks. The first task is the selection of the correct size pizza dough (pre-made) and the saucing of that dough. The second task adds the primary ingredients, and the third task adds the final ingredients. Although each different pizza type requires some different ingredients, we have developed our standard times based on the pizza size and task, independent of the pizza type. Since you will be using simulation for your analysis, I assume that you will need to know something about the variation of our standards. We had a co-op student conduct a preliminary study, which concluded that this variation is best described by a triangular distribution. Thus, the table entries shown next are the parameters for that distribution.

| | Size | | |
|---|---|---|---|
| **Task** | **Large** | **Medium** | **Small** |
| Dough and saucing | 0.5, 0.7, 0.8 | 0.4, 0.6, 0.8 | 0.3, 0.5, 0.7 |
| Primary ingredients | 0.6, 0.8, 1.0 | 0.5, 0.7, 0.9 | 0.4, 0.5, 0.6 |
| Final ingredients | 0.5, 0.6, 0.7 | 0.4, 0.5, 0.6 | 0.3, 0.4, 0.5 |

Although there are three logical positions, we do not always allocate three individuals to the pizza-making process because the staffing cost is estimated at $6.15 per hour. The number allocated to this process should be dependent upon the demand. However, if there are three people assigned to this process, the first person performs the first task and

passes the product to the second person. If the second person is busy, the product is placed between them to wait for the second person. If three people are assigned to the make table, there is only room for one product between task stations. Thus, the line will sometimes back up because the person has nowhere to place the pizza they just finished. If there is only one person assigned to this process, all three tasks are performed by that person before work starts on the next pizza. If two people are assigned to the line, they are allowed to determine the best way to share the work. We eventually would like to develop a standard assignment policy for this condition, but have not accomplished this to date. If time permits, we would appreciate your input on this matter.

The assembled pizza is then sent to the oven. We use the Magic Baker line of ovens in all our stores. These ovens are fairly standard for the industry. They are basically a simple conveyor with an enclosure of the central part of the unit, which contains the oven. The pizzas are placed on the load area of the conveyor at the left (see diagram below). They travel through the oven tunnel and emerge at the right completely cooked.




We initially had some problems with this setup when pizzas started to back up during our peak production time. The utilization of the oven is very dependent on how the pizzas are loaded, and the limited load area does not allow a place to put the back up of finished, but uncooked pizzas. We contacted Magic Baker and jointly developed a solution to this problem. This solution is confidential, but you can think of it as a slide that buffers the area between the make table and the oven. This slide has the added advantage of arranging the pizzas to make optimal use (more or less) of the oven space. We have conducted some studies on this setup in order to develop a means of estimating the capacity of specific ovens. This information should be helpful to you in developing your simulation.

When a pizza is ready to be baked and arrives at the load area, it waits until there are a known number of square inches of the load area available. It then enters the load area, and is conveyed into the oven. It is assumed to enter the oven 1.9 minutes after it enters the load area. Of course, different pizza sizes require a different number of square inches. That information is as follows:

| | |
|---|---|
| Large | 250 square inches |
| Medium | 175 square inches |
| Small | 115 square inches |

There are currently three different sizes of ovens available from Magic Baker (Series I, II, or III). The load-area sizes for these three ovens are as follows:

| | |
|---|---|
| Series I | 435 square inches |
| Series II | 520 square inches |
| Series III | 605 square inches |

Basically, the increased capacity is achieved by making the ovens wider. It takes 7.5 minutes for a pizza to emerge from the oven and enter the unload area.

At the unload area, the pizza is removed by a single worker ($5.90 per hour), cut, and placed in a box. This worker also accumulates the pizzas into the original customer order. When an order is complete, it is sent to the delivery area (40%) or the carry-out area (60%). We do not have a standard for this operation as it is normally not a problem. However, I did manage to find a data file (`IIE_SM_3.dat`) containing some time observations. I have not had the time to look over these data, so they may contain some bad data points. I assume you can take care of this potential problem if it occurs. The worker is also required to assemble additional pizza boxes, taking about 12 seconds each, if the supply is low and time permits. If the supply gets extremely low, drivers will often assemble boxes during their idle time.

The orders sent to the carry-out area are immediately available for customer pickup. The delivery orders wait for an available driver. Currently, our drivers take only one order at a time, as it lessens the probability of a late delivery. Obviously, the delivery time is highly dependent upon the store's location. But, since we limit our delivery area, we have been able to develop reasonable data on the delivery process. You can assume that the drive-time from our store to the customer's door follows a triangular distribution with parameters 3, 5, 12. Our delivery costs are included in the estimated per-hour cost for our delivery staff ($7.15).

At this point, you should have a good understanding of our process. Now you need to understand that we staff our stores for the peak sale time, which covers about three hours. Actually, the peak demand normally occurs only for 15 to 45 minutes of these three hours. However, there tends to be a relatively high demand during the entire three-hour time period. During most of this time, all our staff is devoted to producing and delivering pizzas. The time before and after this peak is devoted to preparing for the peak and cleaning up after the peak. Remember that we only open our stores for a short period of time. So far, we have found that staffing to the peak provides just about the ideal for the before and after operations. Our marketing staff has become very good at estimating the demand, in orders per peak hour, for new stores. We will begin opening our new stores in June of next year, with the one basic problem to resolve first. Given an expected peak demand, how should we staff our make table and delivery operations and what size oven should we install?

What I would like is a table that I can reference that will tell me the following:

- Number of people at make table
- Oven size—Series I, II, or III
- Number of delivery people

You can assume that our peak demand ranges from 20 to 60 orders per hour. I would like this tool to give me the most economical option based on achieving a 90% to 95% customer satisfaction! This is important because the ovens are a major capital expense. There is an incremental capital cost of $35,000 if we use a Series II (instead of a I), and an additional $30,000 increment for using a Series III (instead of a II).

Estimates of the accuracy of the recommended configurations should be included in the report. Also, I would appreciate any other recommendations on our general operations.