Introduction

Benchmark Dry Cleaner and Laundry, Inc. is a dry-cleaning service that both picks up and delivers clothes to and from customers' homes. They service approximately 3000 customers in Carrollton, Irving, Lewisville, Coppell, Flower Mound, McKinney, and Allen. The company utilizes the majority of its 50 employees as manual labor who work four days a week on two shifts of 10 hours a day. The schedules for pick up and delivery is as follows: Drivers run the same route Monday and Wednesday, and another route Tuesday and Thursday. So for the customer, that means that if they leave their clothes out to be picked up on Monday, they get their clothes back on Wednesday. But if they leave their clothes out on Wednesday, they will not be returned until the following Monday. For those customers on the Tuesday-Thursday route, the same principle applies. If they send their clothes out on Tuesday, the clothes will be returned on Thursday. If they leave their clothes out for pick-up on Thursday, they will not receive them until the following Tuesday. Thus, for the customer it would be ideal for them to get the majority of their clothes out on either Monday or Tuesday, depending upon their route assignment.

Description of Problem

The problem for Benchmark is that they are often overwhelmed by work on Mondays and Tuesdays but have an abundance of downtime on Wednesdays and Thursdays because the workload is not as great. The goal of this project is to create a simulation that, when given the number of operators at critical work stations and the pieces of clothing to be processed, will determine the time necessary to send the pieces through the cycle of the laundering process.

The type of information taken into account for this project included the number of machines available now to process the clothing, the number of workers on specific

machines, comparison of laundered to dry-cleaned clothing, and the amount of time needed to go through the different stations. Determining if the ratio of clothes laundered to clothes dry-cleaned affects and will affect the amount of time spent in the cleaning process is an important factor to consider. Other factors that needed to be investigated were whether or not there would need to be a situation where people were moved from the overnight shift to the day shift on Monday and Tuesday to compensate for the overload in clothing.

Process Map

To first gain some background on the project, a thorough description of the dry cleaning and laundering process was needed. The first process undertaken after the clothes are retrieved from the customers' homes is the mark-in. The clothes are sorted into groups that need to be dry-cleaned and groups that need to be laundered. The dry-cleaned clothes are then sorted into dark and light. Laundered clothes are sorted by color (whites, khakis, and darks) and the necessary amount of starch (none, light, and heavy). So in this situation there would be nine groups. A stage between mark-in and cleaning is support, which encompasses marking difficult stains with a special cleaning solution. Two machines were used in the dry-cleaning process, and two machines were used for regular laundry. The amount of clothing to be placed in the laundry washing machines could not exceed 45 pounds and would take 40 minutes to wash. The two dry cleaning machines had different restrictions. Because of the chemicals used, the machines could take a larger amount of clothes. Machine One could take up to 70 pounds per load that would take 75 minutes to process, and Machine Two could process a 55-pound load in 65 minutes. Because the dry cleaned clothes were both washed and dried in the dry cleaning machines, the time in the machines was extended.

The finishing station had a total of four stations. The first station did the pressing for laundered shirts and was actually encompassing two stations that could each handle two operators. This meant that a total of four operators could work on laundered shirts. If one operator was available per station, ideally 50 pieces could be pressed per hour. If there are two operators a total of 90 pieces could be pressed. (The total would be more if not for the space constraints.) Laundered pants were handled by one station with one operator. Pants were pressed at a rate of 60 pieces per hour for two operators. Dry cleaned items were separated into two stations: pants and utility. Utility comprised difficult-to-press items like blouses, pleated skirts, and any clothing that might have had ruffles or external accessories like big buttons or sequins. The pants station with two operators could press 60 pieces per hour. The utility press could accommodate two operators. One operator was able to press 30 pieces per hour and two operators were able to press 50 pieces per hour. This information was important in developing the model regarding the determination of time.

With knowledge of processing times for different types of clothing, the intent was to calculate the time needed to process a set amount of loads for the different routes. This information along with rates of production calculated in pieces per hour could be used to calculate an algorithm utilized in a Visual Basic macro run on a Spreadsheet application. This macro would help management determine based upon the number of pieces of clothing, the types of clothing, dry cleaned or laundered, and the number of operators available what kind of time frame they could estimate for the completion of the work.

Analysis of the Situation

The process map provided insight into a way to forecast the amount of time necessary to clean the clothes based upon number of operators and how the products were "finished." Using Window's Excel program to initially calculate the amount of time spent per load of clothing, it was discovered that a macro coded in Visual Basic could be created to simulate the time it would take to process the clothes. We felt that this program would work best in our situation because the program assumes that the load per wash is fixed. An assumption that needed to be made in calculating the time included claiming that turnaround time between the loads of clothing would be zero. For example, because the two dry cleaning machines varied in washing time by 10 minutes (machine one finishes in 65 minutes and the machine two in 75), we assume that if both machines start at the same time, that in the case of machine one, the subsequent load begins washing in the 66^{th} minute.

Technical Description of the Model

The model used was conducted in Microsoft Excel with the assistance of Visual Basic macros and ANSI C. The formulas used in Excel can be seen in Figure 1. The formulas for the VB macros and ANSI C are attached in the appendix. The model is interactive, and requires a user's input of relevant data on Sheet 1 of the Excel Workbook in order to receive a solution

. This will allow for the simulation to quickly compute the data that we need. The variables explained are the user-inputted variables. They included number of pieces and the number of operators per station in the Finishing section.

The model works as follows:

- The user will input the required variables

- The model will take the total pieces and compute the product mix
- The laundry section of the product mix is then broken down as follows: no starch, light starch, and heavy starch with sub sections of whites, khaki, and dark colors.
- The number of pieces for each section and subsection are used to find the total number of hours it takes for the laundry to be washed
- This same process is used to find the breakdown of the dry cleaning except that it is broken into the two different machines and not by starch or colors. This is due to the fact that the light and dark colors make up 50 percent of the total pieces each of the dry cleaned laundry.
- Since the two dry cleaning machines have different variables in the time taken to wash and the number of pieces per load, we created a VB macro to do another simulation.
- This simulation conducts a series of loops over time and determines how many loads each machine will wash most effectively.
- The Finishing process is broken down into laundered shirts, laundered pants, utility press, and pant press.
- Three of the four sections will allow for the user-inputted variables of the number of operators.
- In the laundered shirt section, an ANSI C program is used to help calculate the total time to clean and press.
- The ANSI C program allows the user to enter in the number of operators and the pieces per hour that they can do and returns the total time taken.
- The laundered pants total time was conducted by hand since only one operator is able to work at that station.
- The utility press and pant press sections were broken down and calculated by hand for each of the possible number of operators.

- The entire time the laundry process can take can be calculated and displayed to the user.

Analysis

Because of the pressure on the workers to finish an inordinate amount of work in a technically impossible amount of time, this program, when implemented, can assist in showing what can be done in an ideal situation. It will provide management a frame of reference in determining what is achievable by workers. While the data can assist in helping the workers improve when they know there is a specific goal ahead of them, the program can also provide reason for investigation into work habits if forecasted goals are not reached. What was determined is that without investment in more machinery, distributing demand evenly over the work-week will be very difficult. The customers likely get the majority of their pieces out on Monday and Tuesday because of the turnaround time. If it would be possible to invest in enough machines and transportation in order to implement a one-day turnaround, demand would distribute more evenly because, excluding Thursday, there would be no inclination on the part of the customers to get clothes out on only Monday or Tuesday if they knew they could get them back the next day. With the way the work week is calculated right now there is no possible way to get a completely even distribution of pieces of clothing per week.

Conclusion

Utilizing the macro can be useful to management in determining staffing needs, equipment needs, and assisting in forecasting how many pieces of clothing can be sent through the cleaning process. Due to the complexity of the dry cleaning process, the study was done to examine the aggregate amount of time spent on the processing of the pieces of clothing, not on the time per station, which is ultimately

dependent upon the pieces of clothing to come through the station. This is one limitation that with more time, attention could be given to. The constantly shifting variables within the process of cleaning itself contributed to the immense difficulty of this project. With Benchmark's expansion in the coming millennium, it will be interesting to see how the simulation can be used in dealing with the hiring of new employees and the purchasing of new equipment.