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Abstract

Waiting lines are issues faced daily and are undesirable for the majority of the population. In this project the queuing system of a busy and populated area is being analyzed to minimize the time spent waiting in line. The location being analyzed is an A&W at an on-route stop. Due to many travelers needing a pit stop, long lines are formed creating frustration for customers. In order to fix this problem, a redesign of the workplace has to be implemented. In fact, two different types of machines are being added: one for drinks and one for placing orders. Adding these machines will bring less stress to the cashier and overall reduce the lines by increasing the amount of orders in a day. These new changes were simulated and analyzed in Arena and the results were expected. The wait time went down and the numbers of customers being served went up. Thus, our hypothesis was correct and the redesign is more efficient and is more profitable due to its high productivity.

Introduction

On route is a series of rest stops located at certain points along the vast highways of Ontario. The On routes act as a hub, where anyone from truckers to families, can stop, grab a bite to eat, fill up on gas, get directions, withdraw money, or simply use the bathroom. The facilities have been open since the 1960's and have deals with the province to remain open until the year 2060. These facilities serve a large proportion of the 500000 that use the Ontario highways daily, and as a result often cause large wait lines at the restaurants within. The issue our group has chosen to address and simulate is the wait lines at these individual restaurants. In our group's specific case A&W was the restaurant chosen as a focal point. Throughout the year taking a look inside the on route stops a person can see it filled to the brim with people, and if a person is truly in a rush, a simple lunch to go could take as long as an hour during peak times. The group's approach involves simulating the current approach of a customer walking in, waiting in line for the restaurant, making an order, waiting for the cooks to cook and deliver the order, and then pick up the order and leave the A&W process. The group's main plan is to see how affecting the ordering process affects the overall time it takes to successfully get an order accomplished. Our group has planned to test a new method where a touch screen wall is added to the restaurant alongside a drink ordering machine. The ideal scenario would result in the new methods allowing the fast-food restaurant to faster serve the customers in the line, and fill more orders on standard days work. The following report will go over the data, the initial process and then compare the results of the proposed process relative to the initial. The group aims to find a valid cost-effective solution that would better the overall customer time in the system.

Analytical Model Description

On route stops are usually always full, especially during breakfast, lunch or dinner times. This creates long queues due to hungry travelers as there are not many food spots when traveling along the country. A&W is a fastfood place that serves customers burgers and soft drinks and tends to attract a large crowd due to its popularity in North America. The system currently has two types of workers: the ones taking your orders and the ones making them. In fact, we tend to see 2 cashiers that are placed at the front who take your orders and then give them to the 3 workers working at the back by providing them with a receipt with the order information to prepare. The cashier deals with the payment portion and customer relations. The workers in the

back prepare the orders in a sequential matter. The food is prepared with premade ingredients to cut back on time and ease of preparing the food. The cashiers are the ones preparing the drinks which can be time consuming. After preparing the order, a screen displaying the recipients number is flashed on a screen to indicate the order is ready.

In order to fix this problem by minimizing the queues we will be implementing new changes. Two different types of machines will be added. Firstly, there will be machines that dispense a variety of drinks, including coffee, water, soda and tea. In order to be able to get yourself the drink you will have to go pay at the cash register first. This will bring less stress to the worker since they will no longer have to prepare and serve drinks.
The other machine is a self-serve ordering system that has a touchscreen interface to take the customers orders. The orders taken will be for anything on the menu : both drinks and food. The customer completes the transaction by paying with debit, credit card, or cash. After the payment is complete a receipt with the order number is given to the customer. When the customer's number flashes on the screen, the customer can go to the counter to pick up their order.
Due to adding the machines, more orders will come through at once so in order to balance it out more workers will be added at the back to make the food. This requires more workers to attend in the back to prepare the orders. Since the self-serve machines are able to take orders, only one cashier will be needed. It is important to still keep a cashier for customers who might not be able to interact with the machines, such as someone blind or an elderly. Overall, our hypothesis is that these implemented changes will reduce waiting time and provide more efficient customer service.

Simulation Model

The simulation constructed has a few parts to it. First, the initial system has a few made assumptions. The customer is busy and therefore already has an idea of what they want. So there is no decision module needed. The restaurant is also fully stocked every morning so no shortages of food supply. In addition the workers are constantly working, and anyone off for a break or off shift is covered for by someone else.

The initial module focuses purely on the system currently. One cashier, and the service staff behind him. The customer comes in, waits in line if necessary, places an order, then waits for the order to be completed, collects the order and leaves the line.

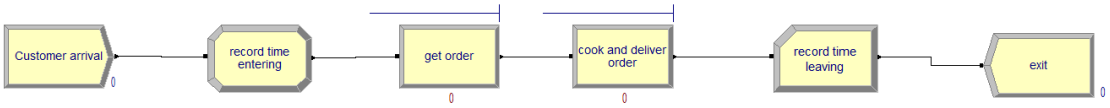

Figure 1: Arena file for original design

The model shown in figure 1 has a customer enter the system uniformly with mean 5 minutes between arrival of each customer. The get order process takes place once the customer gets the cash register, and takes anywhere from 2-3 minutes. Once complete the second process module takes over, where the kitchen staff performs their tasks and takes from 2-3 minutes to cook and deliver the order. The customer is then recorded leaving and then exits the restaurant.

The second module is the new changes proposed. This includes a designated drink station/ ordering machine, a tablet ordering system, and the original cashier.

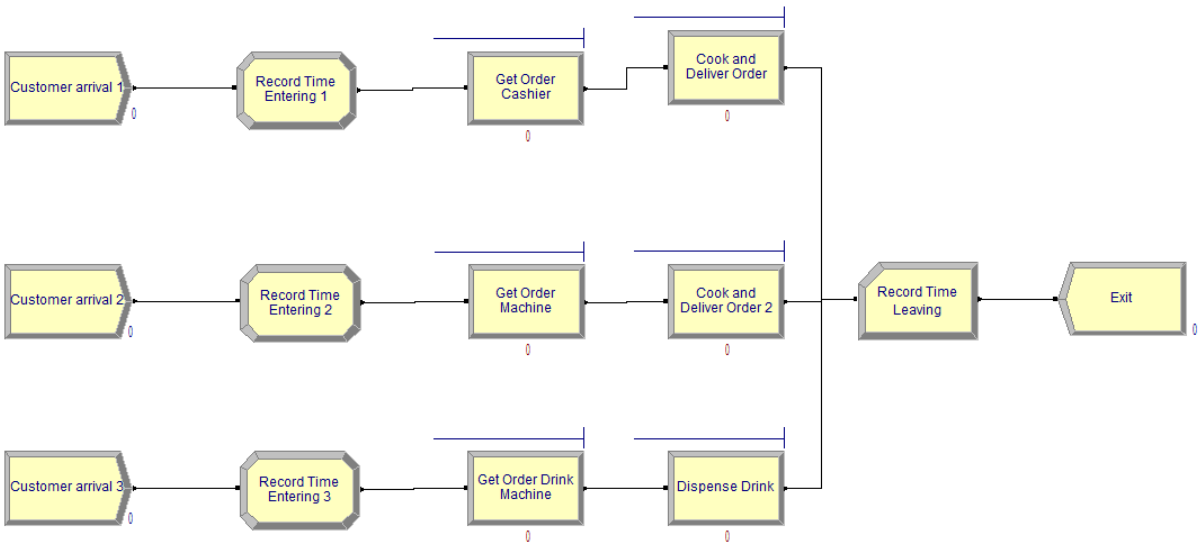

Figure 2: Arena file for redesign

The model shown in figure 2 has 3 independent customer arrival lines. Each with an interval of 5 minutes, One line leads to the standard cashier which has the same values as the original process. The second line leads to a tablet wall, with an order time of 30 seconds to 2 minutes, then the cook and delivery process which is shorter now due to increased staff and thus has a value of 1-3 minutes. Finally the third line is exclusively for customers who want drinks. The speediest of all 3 lines, the order process takes 30 seconds to 1.5 minutes, which has an equal time to the drink dispensing system.

Both processes are working for 7 replications, with a length of 5000 minutes as the replication length, for 24 hours a day.

Simulation Results and Discussion

For 7 replications the following results are as follows:

Table 1: Total time per customer and wait time for each design

Original Design			
	Average	Minimum	Maximum
Total time per customer (minutes)	6.0952	3.0453	21.3527
Wait time (minutes)	1.6208	0	18.3198
New Design			
	Average	Minimum	Maximum
Total time per customer (minutes)	3.9950	1.0101	15.2182
Wait time (minutes)	0.7455	0	10.5779

The total time per customer and the wait time is represented in the table above for each design: original vs redesign. A few observations can be noted. Firstly, the total time of each customer spent in the store decreased with the redesign. It was originally 6.0952 minutes on

average and went down to 3.9950 minutes. These results are positive since it indicates that the new redesign is 65.5% more efficient and thus will be able to serve more customers. As well, decreasing the wait time was one of the goals for the redesign. It was originally 1.6208 minutes and went down to 0.7455 minutes. When the redesign was simulated into Arena the resultant output proved that the goal was achieved.

Table 2: Average time and Wait time per process

Original		
	Average Time (minutes)	Wait Time (minutes)
Cook and Deliver	2.05	0.06
Get Order	4.05	1.56
New Design		
	Average Time (minutes)	Wait Time (minutes)
Cook and Deliver 1	2.06	0.05
Cook and Deliver 1	2.55	0.58
Dispense Drink	1.04	0.05
Get Order Cashier	3.64	1.13
Get Order Drink	1.15	0.15
Get Order Machine	1.51	0.27

In the original design the cook and deliver time took 2.05 minutes and getting the order took 4.05 minutes. These were the two steps that affected the overall time of the interaction. In the new design there are two cook and delivery times that can happen simultaneously, one with an average time of 2.06 minutes and the other with average wait time of 2.55 minutes. The dispense drink takes an average time of 1.04 minutes. In the redesign you could order through

cashier, drink machine for only drinks, and machine for all orders. The cashier interaction takes an average of 3.64 minutes, drink takes 1.15 minutes, and machine takes 1.51 minutes.

Overall, these results show that the redesign is a better alternative since it decreased the wait time, decreased the time it would take to interact with customers and increased the total numbers of customers that the store can serve. Before the number of customers in and out was 1014, and then with the redesign it increased to 2995 customers. Thus, this proves that the redesign is better and our hypothesis was correct since it reduced the waiting time and provided more efficient customer service, the desired state was accomplished.

Conclusions

To conclude, the overall process by which the group examined the Onroute A&W restaurant, accounted for data, and developed possible solutions was a thorough example of what some industrial engineers around the world tackle daily. Students were able to look at an already functioning process, examine it and then recreate the steps within, using industry grade software to try different methods in which one could improve the system. The project allowed the students to apply simulation techniques learned in class to a real-world situation, and witness how different solutions, and altercations can change the overall process. The students were able to see the benefits, and downfalls of using simulation, to effectively confirm the validity of their designs. The conclusion drawn from this study indicates that the proposed solutions does in fact offer a substantial amount of productivity to the A&W restaurant. The addition of the touch screen, and exclusive drink machine ordering system alongside the cashier offers the visitor the ability to make orders quicker and the staff deliver the products faster. The process has increased its productivity in terms of time, and customer output, proving that the new system is indeed better. Understanding that A&W is a business, keeping the bottom lines looking healthy is a huge incentive to not make any changes. However after analyzing the results of the Arena files the data proves that over time the costs of implementing the drink ordering system, and the touchscreen wall is quite beneficial as these two changes help process customers at a rate almost triple the original. This proves that over time this investment will greatly improve profits, and customer turnover. As prospective engineers, knowledge in simulation is a major asset in a world where change is always happening. IND600 as a course proved to students that it is indeed a very

valuable piece of technology in a wide array of fields, and this project greatly improved the students comfort levels in using software such as Arena to provide quantifiable, and reliable data.