REDUCING CUSTOMER WAIT TIME AND IMPROVING PROCESSES AT ABC's ATV RENTALS

BY

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Abstract

This project serves to explore the system bottlenecks of a small, family owned ATV rental company. The main objective is to reduce the average time a customer spends in the system, focusing on customer wait time as well as other areas that can be improved. This was done by collecting time studies and inputting the values into simulation software, which was run to represent the current system as well as various other possible scenarios encountered by rental companies. While creating the simulation, adaptive techniques were incorporated into the simulation. These techniques aim to increase the durability and reusability of the simulation for future use. An example of incorporating adaptive simulation is through having the simulation software draw values from an Excel spreadsheet. This example of adaptive simulation targets the efficiency of use, as values and formulas are easier to calculate and visualize in Excel than the simulation software. Through the scenarios created in the simulation software, the main system bottleneck was discovered to be the company's trailer fleet size. Several scenarios were then created to further explore the theory and resulted in confirming it. The results of this analysis conclude that to reduce customer wait time in the system, the company should increase its fleet size by one trailer. A secondary, no cost solution is to eliminate ATV load/unload times by moving ATVs to the dunes prior to customer arrival instead of loading them on a customer by customer basis.

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Introduction

Rental companies are a common occurrence in the United States. These companies come in all shapes and forms; from huge corporate owned industrial tool rental companies all the way to privately owned recreation vehicle rental companies. ABC's ATV Rentals in Pismo Beach, CA is one such example of the latter. With a lot size of approximately 8600ft^2, ABC's ATV Rentals surprisingly boasts a fair amount of ATVs and other all-terrain vehicles for rent. However, many of these small businesses aren't running as efficiently as they can, and ABC's ATV Rentals is no exception. There are various snags in the system that cost the company time and money they would otherwise be keeping. Therefore, the main objective of this senior project is to address this issue by

- Reducing customer wait time in the system
- Identifying and addressing bottlenecks in the system

After correction, ABC's ATV Rentals should be operating at a higher level of efficiency, which entails a faster customer flow through the system. The main tool that will be used is ProModel. A simulation of the current processes will be created and analyzed to determine bottlenecks and to find any areas of improvement. After analyzing, several alternative solutions will be suggested, and a second simulation will be made incorporating these suggested changes which will then be compared with the original model to determine if the changes are feasible.

Background

Currently at ABC's ATV Rentals, the typical day has the ATV operators pull out display models from the warehouse (denoted in **Figure 1** below by the number 1) and park them in front of the building as a form of advertisement.

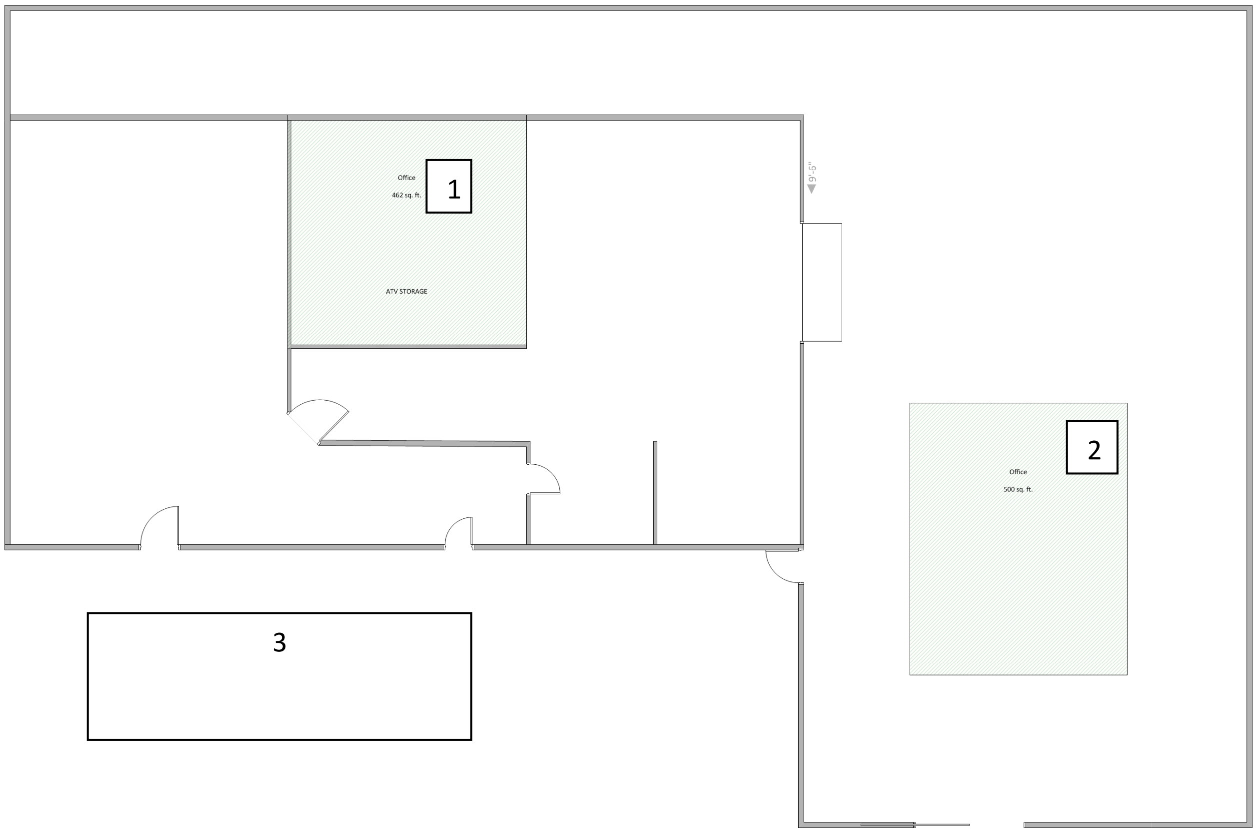


Figure 1: Facility Layout

After moving the display vehicles, the operators then proceed to pull out an amount of vehicles to the staging area (denoted by the number 2 in **Figure** 1) that is dependent on the forecast created by the manager. This number varies drastically because of time of year, weather, and holidays. Depending on the type of vehicle, checking oil will take longer. At this point, depending on whether or not the day has been forecasted as busy or not, there are two different methods of approach. If the day is forecasted as "busy", all the ATVs will be pulled out and

prepared. During this preparation stage, ATVs that have completed preparations are then trucked down to the dunes (driving ATVs are forbidden on the beach) by one of two trailers to a designated plot of land reserved for ABC's ATV Rentals for this very purpose. The reason behind this is to save time loading up the truck when customers arrive. However, if the day has been forecasted as not busy, then ATVs are loaded onto trucks after customers arrive to rent. The policy for the ATVs are that if it was pulled out, regardless of whether it was used or not, it has to be washed and serviced before put away at closing. This leads to the problem of finding the optimal fleet size to pull out in the morning.

Moving to customer arrivals, customers arrive in groups anywhere between 2 and 30 at complete random. After signing a waiver, they are required to watch an eleven minute safety movie before being allowed to go to the dunes. Upon completion of the safety movie the customer is then driven to the dunes by an operator who then proceeds to instruct them how to properly operate their respective vehicles. The problem with larger parties is that each trailer can only take 8 passengers at a time each.

Upon completing instructing the customers, the operator drives back to ABC's to pick up new customers and the previous customers go ahead and ride on the dunes until their allotted time is up and are picked up by an operator in the same area. At closing, all vehicles that were pulled out are washed, serviced, and stored back in the warehouse for the next day's use.

Simulation is often used for modeling and designing manufacturing systems like factories, flexible manufacturing systems, assembly lines, warehouses, and supply chains. Many other applications exist, including hospitals, military operations, traffic, airports, computer systems, telecommunication networks, and in this case, ATV rental companies. The importance of being

able to reuse simulations or be able to quickly tweak simulations to meet fluctuations in variables is vital. For this to happen, simulations must be easily adjusted – meaning the simulation has to be able to be modified while reducing the risk of errors or bugs. The ability to respond effectively to changing circumstances is called *flexibility* [16]. There are various types of flexibility. The following table explains each type:

Table 1: Types of Flexibility

Type	Definition	Example
Action Flexibility	the capacity for taking new action to meet new circumstances	planning without knowing the future as in plant expansion
State Flexibility	the capacity to continue functioning effectively despite change	built-in robustness, absorbency, and tolerance to change
Job Flexibility	the ability of the system to cope with changes in the jobs to be processed by the system.	being able to process a variety of jobs
Machine Flexibility	the ability of the system to cope with changes/disturbances at machines/workstations	the capability of a machine to do a large variety of operations

Furthermore, adaptive simulations must be able to incorporate changes such as [16]:

- Requirements changes or changes in the answers to be provided by the simulation model
- Internal and external changes in the production environment. Internal changes are changes in the process and material handling equipment and the interconnections among them. External changes are changes to the products to be made and the production quantities, for example, which are not changes in the physical manufacturing system.

- Updated data provided by related information systems such as process planning and shop floor control.

Adaptability measures the ease of changing a simulation model. Building a simulation model is a time consuming and also sometimes difficult task. If at all possible, decision makers will try to reuse an existing simulation model, modify it with the corresponding changes, and run it to solve a different problem. In the figure below, I have come up with several criteria which make a simulation "adaptive" in my opinion and have evaluated them of necessity in three different applications; factory layout, rental company, military depot. The number scale ranges from 1-5, 1 being least prioritized while 5 being most prioritized.

Table 2: Adaptive Design Criteria

Criteria	Definition	**Factory**	**Rental**	**Military**
Effort	A simulation cannot take large amounts of time to create; therefore the amount of effort needed to create the model should be kept as low as possible.	3	3	3
Effectiveness	This measures how accurately the simulation reflects reality. For the simulation to be effective, it needs to be valid to real life scenarios.	4	4	4
Robust	The simulation's ability to be modified to meet any changes in the system. This means the simulation must be able to take into account many different variables without being completely changed.	3	4	5
Modification	The simulation must be able to be modified to meet changing scenarios. The simulation must be able to be transformed to meet continuous improvement implementations.	2	4	5

Effort

The priorities for effort are the same values for all three applications. Effort is given medium priority because time should be taken to create a good simulation. By rushing simulations, the risk for bugs and errors increase, meaning the simulation might take even longer. By taking a good amount of time to create a proper simulation, all three applications can enjoy a more robust program.

Effectiveness

There is no point in creating a model that does not apply to the situation at hand. Therefore, all three applications have been ranked with a 4. The key to a good simulation model is how accurately it represents the scenarios it was made to simulate.

Robust

We start seeing variations between the three applications in robustness. While it is beneficial for models to be robust, we start seeing that the different applications have different priorities. For a Factory, things should remain relatively constant. Material arrives by trucks, which is then unloaded and sent through each work station. Ideally each workstation completes task with consistent times. Basically, there should be very little variability in the process of a factory.

For an ATV Rental Company however, there is a huge variation. The most prominent factor affecting ATV Rental Companies is the weather; the effects of which is most paramount during the winter and spring months. People don't want to ride ATVs in the rain or if it is too cold, therefore, ATV Rental simulations should be able to incorporate the resulting flux in

customer arrival. Another big fluctuation is vehicle damage. A lot of customers are riding ATVs for the first time and do not necessarily know the limitations of the vehicles. This means that ATVs being damaged and taken out of commission for a couple days is a potential risk to business that needs to be factored into the simulation.

Lastly, for a military depot, factors such as troop deployment and rearming are very important. In this case, sudden spikes in demand can arise from new deployment, meaning the military depot must be able to simulate what happens in those scenarios and were potential bottlenecks will occur. This was rated a 5 because it is imperative that military personnel are fully equipped and battle ready in short notice, meaning military depots cannot be late with their shipments.

Modification

The reason why the factory received such a low rating is attributed to the consistency at which it operates. Even though factories may receive demand spikes, the process for the most part remains the same. The most common way to meet a demand spike is to increase the number of operator hours, meaning a night shift. This does not change any building processes, therefore models created for factories remain relatively the same without major repercussion.

For an ATV Rental Company, however, simulations must be easily modified. Reasons for this are customer arrival rates, what kind of day it is, and how many ATVs are operational that day. Failure to incorporate these factors can lead to the company not being able to keep up with customer demand, or pulling out more ATVs then were necessary.

Lastly, a military depot needs to be able to modify its simulation with ease. Not only does the depot have to respond to troop deployment, but it needs to keep its inventory up to date

with the newest technology, which may require different handling or different spot placement. Factors such as a busy day and a slow day all are factors that must be taken into account.

To create an effective simulation, the creator must incorporate many types of flexibility. There are many different reasons to justify this. For example, if a machine has a tendency to break down, one must take that fact into account when creating the simulation. Likewise, the simulation software must be able to incorporate this event. If a simulator is not able to add in vital events because the software is unable to do so, then the software is bad. The simulation must accurately portray the flow of material through the warehouse. One of the greatest problems of applying simulation models is the time-variant feature of the modeled processes. Even if the simulation starts with exact parameters from the real modeled system, and the model is accurate, if some features of the material flow system change, the modeling error increases over time.

Adaptive simulation ideals must be considered from the very start of creating a model. In the case of Angello's ATV Rentals, I divided the entire action into three different processes. The first process is customer arrival, which includes the arrival itself, number of people in the group, and type of ATV requested. After that is all accounted for the customer is sent to a customer wait zone to receive their ATVs.

The second part of this process is the Bike Runner receiving the order and pulling appropriate ATVs to meet each order. This part of the program must react to the previous part of the program. The most challenging aspect was the alignment of which customer receives which bike while taking into account grouping each batch of customers.

The third and last part is the actual dropping off and picking up of customers on the dunes. This calls for the truck resource to manually take each group of customers to the dunes and pick up any customers that are ready to go. In the grouping aspect, ProModel is more of a hindrance. Each resource is only able to take one entity at a time, which causes the modeler to batch a group of customers into a single entity and then ungroup then later. Simio does not have that limitation, as its resources can take any number of entities at one time to a destination.

The actual formation of a complex adaptive simulation requires simple models being built and combined at the very end. Each simple model must be able to incorporate variable fluctuations as well as having the capacity to be modified to cope with new processes. The benefit of creating simple adaptable models is that bugs can be identified early and eliminated. Furthermore, since the model is simple, there are not many areas in which things can go wrong in a simulation, making debugging faster and more straightforward.

Literature Review

In this section, I will go over various articles that I discovered that talk about different instances of where simulations was used to improve processes. These articles include not only scenarios in which simulation was used in a rental situation, but other instances as well, such as using simulation to improve processes at a hospital. In addition to articles on various cases of using simulation to improve processes, also researched were various articles on fleet sizing and dynamic scheduling for rental vehicles.

Simulation-based framework to improve patient experience in an emergency department

This article describes how simulation is used to improve processes at a hospital. The global economic crisis has a significant impact on healthcare resource provision worldwide. The management of limited healthcare resources is further challenged by the high level of uncertainty in demand, which can lead to unbalanced utilization of the available resources and a potential deterioration of patient satisfaction in terms of longer waiting times and perceived reduced quality of services. Therefore, healthcare managers require timely and accurate tools to optimize resource utility in a complex and ever-changing patient care process. Complexity and different levels of variability within the process are incorporated into the process modeling phase, followed by developing a simulation model to examine the impact of potential alternatives. The goal of this project was to create and develop an interactive simulation-based decision support framework to improve planning and efficiency of healthcare processes. This study has similar traits to Angello's ATV Rentals in that customer arrival rates drastically affect processes.

Different times of the year equate to different customer flows. For example, more people will use health facilities during flu system just like people are more likely to rent ATVs during Spring and Summer because of good weather. A sudden spike in customer arrival can clog up and tie down many processes by sheer numbers alone. Added to the issue is each customer’s specific needs [1].

Using Simulation to Choose Between Rental Car Lot Layouts

This resource presents a flexible, rental car lot simulation model. This data-driven model serves as a template that can be used to easily test configurations and options used in the real system. In the rental car industry, the number of cars that are waiting for or currently in the process of being cleaned directly translates into unrealized potential income. Although the actual time spent preparing a car for rental (e.g., cleaning, servicing, and fueling) cannot be significantly reduced without affecting quality, the number of cars being prepared at a time can be modified. This report claims that front the point of view of a rental car company, there exists three essential processes, “The first process details how the customer is handled during the time spent checking out a vehicle. The second process is what happens while a customer checks in the vehicle. The third operation, which is hidden from the customer, is what happens to a vehicle between being parked in the check-in area by a customer and being checked out by another customer.” Just like rental cars, ATVs also need to be serviced and maintained. The difference between this project and Angello’s ATV Rentals is the customer doesn’t physically return the vehicle. For Angello’s, the customer is brought back with the rented ATV, unloaded back at the establishment, and is free to go. ATV operators are responsible for unloading and servicing the ATV from that point on. On busy days, this means having to hurriedly unload, service, and load the ATV as quickly as possible back onto the trailer to meet customer demands [2].

Discrete Time Simulation of an Equipment Rental Business

This project focuses on reporting the results of a discrete time simulation model developed for an equipment rental business to study the impact of business decisions. By utilizing the simulation, cost/benefit analyses were applied the results, which identified profitable investment alternatives for the business. Also measured were asset populations in terms of profitability and were then quantified in relation between utilization, repair times, and responsiveness to the customers. These same concepts can be also applied to an ATV Rental Company. Often customers will roll over an ATV, which almost always results in damaging the handlebars. However, more complex machinery can require longer fix times, especially in the cases of internal damages. A concept worth exploring is determining whether or not some models of ATVs are worth keeping as available to rent [3].

Fleet-sizing and service availability for a vehicle rental system via closed queuing networks

In this paper, the authors address the problem of determining the optimal fleet size for a vehicle rental company and derive analytical results for its relationship to vehicle availability at each rental station in the company's network of locations. In this system, customers will arrive to rental stations, use a vehicle for some amount of time, and then return the vehicle to any station of their choosing. These systems are quite large, with some rental programs consisting of 2000 bicycles spread across approximately 1500 locations. The fundamental problem facing such a system is determining the optimal fleet size. This entails balancing between the revenue obtained from satisfied customers and the cost of maintaining the fleet. Although Angello's ATV Rentals does not have more than one return location, key concepts of fleet size can still be applied. Every ATV that is pulled out and prepped in the morning is required to be serviced and

maintained at the close of the day, regardless of whether it was rented out or not. However, not having enough ATVs out and prepped can lead to severe bottlenecks and clogs if the company is hit with a large group of customers unexpectedly, causing a decrease in quality as ATVs are rushed out [4].

Dynamic scheduling of recreational rental vehicles with revenue management extensions

This paper reports on a study of rental operations in which vehicles of different types are made available for hire from several depots to retail customers. Already established in this company's rental policies is a fleet schedule, which is a plan for the deployment of each vehicle in the fleet so as to meet all reserved rentals while also accounting for vehicle maintenance activities and changes in fleet composition. The main target points of this study are to minimize the costs associated with substitutions and relocations. A substitution is a case where a rental is planned with a vehicle type different to the one requested by the customer. A relocation shifts a vehicle from one location to another in order to satisfy a planned rental pickup at the destination. The approaches used were an Assignment Approach, where an assignment model that fully addresses the rental-fleet scheduling problem is used, and a Network-Flow Approach. The method that will be used on Angello's ATV Rental will be more similar to a Network-Flow Approach. The current scope is aimed to identify and reduce causes of customer wait time [5].

A synthesis of tactical fleet planning models for the car rental industry

One of the primary functions of revenue management for a car rental company is to determine the optimal mixture and size of the vehicle fleet that should be available for rent at each location on a daily basis. This article is about determining optimal fleet size as well as optimal fleet

spread. Using stochastic and price sensitive daily demand, pool managers must address two main questions: (1) how to spread the available pool fleet among the various locations to satisfy demand and generate maximum revenue and (2) how to geographically redistribute the vehicles in response to shifts in the daily demand of the pool's locations. To do this, pool managers must review forecasts, try to stimulate demand a few days prior to rental, and to have control over the daily inventory of vehicles. The model presented is a one-stage model that captures the daily decisions made by the pool manager. The pool manager first observes the available inventory of the entire pool at the end of the day and then decides on the quantities of vehicles to allocate to each location the next day based on the forecasted demands. Operations Research is used to determine the type of spread for rental vehicles between the different rental locations. Although I plan to incorporate operations research into my study, the extent will be very limited in the scope of the project. The main objective in my project is to reduce customer wait time; however, my secondary objective is to improve the processes of Angello's ATV Rentals wherever I can. All rental companies share the problem of finding the balance between customers satisfied and cost of maintaining the vehicle fleet [6].

Wait-Time Predictors for Customer Service Systems with Time-Varying Demand and Capacity

This article is dedicated to creating improved real-time delay predictors for many-server service systems with a time-varying arrival rate, a time-varying number of servers, and customer abandonment. The authors investigate alternative ways to predict, in real time, the delay of an arriving customer in a service system such as a hospital emergency department or a customer contact center. The authors model such a service system by a queuing model with a time-varying

arrival rate, a time-varying number of servers, and customer abandonment. Also explored was the effect that delay announcements had on customers. The article then goes into depth on how each predictor is calculated. This can be incorporated into my simulation in several cases. Many times people will enter only to buy a flag or other piece of merchandise. Other times, customers only come to compare prices. On a very busy day when all ATVs are rented out, Angello's may have to give out a delay announcement because they do not have any more ATVs on hand to rent out. A factor that can possibly contribute to customer abandonment would be the weather. Should the weather not meet customer preference, the customer may just decide to leave instead of proceeding to rent an ATV [7].

Quantifying Service Quality

Quality, and the concept of total quality management, is becoming more prominent concerns for service businesses in the United States. The reason for this a "natural consequence of the broadened definition of quality which focuses on customer needs and desires rather than solely on product attributes." Three primary sources of customer input for a rental company are: (1) direct interaction with customers, (2) customer comments or problems reported by employees, and (3) customer evaluations. Industries that serve travelers and tourists are highly competitive, which also includes the rental field. ATV rental companies, for the most part, maintain similar inventories of ATV models available for rent. The thing that separates an ATV rental company from its competitors may just boil down to service quality. The article mentions the advantages that can be gained by issuing surveys pertaining to what aspects of renting were most important to them [8].

Car Rental Logistics Problem: A Review of Literature

This focuses on decision making that pertains to achieving a high degree of customer satisfaction and optimizes vehicle fleet utilization. To do this, logistics managers adopt three main decision-making steps: pool segmentation, strategic fleet planning, and tactical fleet planning. The demand forecasts are forecasted at two levels: length-of-rent, which determines the time of car returned, and on-rent, which refers to the number of cars in use on a specific date. All demand forecasting is based on a combination of long-term and short-term forecasting. Strategic Fleet Planning and Tactical Fleet Planning are core problems. Vehicle fleeting decisions impact the rental company's revenues highly. If the amount of fleet that is assigned is smaller than the needs in a pool, the result is supply insufficiency, which equates to lost customers. On the contrary, assigning too large a fleet size will result in overstock, which wastes resources. While on a much smaller scale, Angello's ATV Rentals will also experience these things. On forecasted busy days, ATVs are prepped and driven down to the drop-off point in the dunes so there will be a larger stock of ATVs already at the dunes ready to be ridden. However, if the forecast is too aggressive, then the same amount of ATVs that would have saved time now waste time being retrieved, cleaned, and stored [9].

Rental price and rental duration under retail competition

This article focuses on trying to determine optimal rental duration and the appropriate rental rate that goes along with it. Key things that are taken into account are (1) limited supply, (2) regulatory requirement, and (3) asset utilization. Given those three items, and given the rental duration, the article asks what is the optimal number of rental units that the rental store should stock. The answer to the question is in the trade-off between rental duration and rental price.

Also brought forth is the competition between rival companies, the difference between getting business or having your business going to your competitor depends on rental price and rental duration. The company who can offer the most combinations of rental price and rental duration is more likely to have a combination that the customer prefers. It should also be noted that the combinations of rental price and rental duration don't always have to be official. It is common for a rental company to slash prices and give customers a deal if it has been a slow day, or if the customer regularly rents from them. Incorporating all the different combinations of rental price and rental duration into a simulation, however, will require a lot of logic programming. Not only is group size taken into account, but now on top of that fluctuating prices are added which are dependent on many different inputs [10].

Analysis and Simulation of Passenger Flows in an Airport Terminal

As the title implies, this article is a study of the flow of passengers through an airport terminal. This article describes a project concerning the analysis and redesign of passenger handling at an airport. In this situation, dynamic modeling played a major role. Simulation was applied to gain insights into the relations between the processes, the presence of bottlenecks, and their causes. By doing this, critical aspects in the passenger flow through the airport terminal have been explored and studied. Main points to address in this project were to make sure customers had short connection times between the individual flights as well as give the customer enough time to shop in between flights. The search for logistic bottlenecks in the passenger handling included a study of both passenger flow and congestion in the buildings. The first step in the project was to understand and describe the current situation completely for the sake of model validation. This meant all processes involved with passenger handling had to be analyzed and the number of

resources estimated. All times (such as wait, process, queue, etc.) were measured and compared to the information supplied by airport experts. My ATV simulation is very similar to this article. The airport model includes a lot more variables, as well as being a more complex system. However, the airport model does not account for or measure airplane storage or taxing. My model must include the movement and storage of ATVs being used by customers [11].

Material Handling Simulation: Minimizing Bottlenecks and Improving Product Flow Using Lotus 1-2-3

The subject of this article is a glass bottle manufacturer that manufactures bottles for the beverage industry. Bottles coming from the production lines are automatically packed in corrugated containers and transported by a conveyor system to an automatic palletizing area where six palletizers are used to stack containers in wooden pallets for storage. Cased bottles can also be fed directly to filling lines for packaging and distribution. This article deals with several bottlenecks in the conveyor system and how those problems were analyzed in order to improve material flow and reduce product damage. The method used was to break down the conveyor system into measureable sections then using Lotus 1-2-3 as a simulation technique to identify and quantify bottlenecks. As a result, they were able to recommend production scheduling alternatives as well as minor equipment changes to eliminate bottlenecks. The first step to the process was to first develop a material flow diagram to define the system capabilities. Once the material flow is determined, each piece of equipment is studied to determine maximum capacities and effective capacities. While outdated, this method of approach is still valuable to create a good foundation. Creating a material flow diagram to define the system capabilities is a good first step to understanding the system as a whole. However, with the creation of ProModel,

Lotus 1-2-3 is even less of a tool choice. With ProModel, the entire system can be laid out in picture form while also including animations to help with visual cues [12].

Characteristics of Waiting Line Models – the Indicators of the Customer Flow Management Systems Efficiency

This article focuses on the presentation of single-channel waiting line systems with Poisson arrivals and exponential service times. According to the article, one of the factors influencing consumers' perception on service quality is the efficiency of waiting systems. However, the waiting time is inevitable in the case of random requests. Thus, capacity for a sufficient service is needed, although it comes at a cost. This is the premise from which the queuing theory start in designing service systems. Customer flow management includes customer flow handling as well as their experiences from the first contact with the company until the delivery of goods/services. The steps of customer flow are as follows: (1) pre-reception – involves using programming in advance, i.e., a reservation. This results in a shorter waiting time. (2) reception – customer flow management opting to place customers in different waiting lines, depending on their needs. (3) waiting – wait time can be minimized by improving staff planning and increasing processes flexibility. (4) service – performed once the customers are waiting in a line. (5) post-service – the waiting and proceeding times after a customer is served. (6) administration – records that can be used to the current processes assessment. By breaking down the customer flow process, we can exactly where in the process bottlenecks arise, and what causes the bottleneck(s). Currently, Angello's ATV Rentals does not take reservations because in the case of cancellation, the risk of turning away a customer because of a reservation is not desired. However, on slower

periods of the year (i.e. Winter) where renting out every single ATV is unlikely, it would benefit the company to get a general idea on how many ATVs to prep if they took reservations [13].

Using turndowns to estimate the latent demand in a car rental unconstrained demand forecast

This study focuses on a situation where recorded turndowns successfully predicted the latent demand in a car rental unconstrained demand forecast. In this study, a decomposition method that identifies the actual latent demand from the actual latent demand from the total recorded turndowns is developed. In the 1990s, major car rental companies in the United States started using yield management as a competitive tool for improving operational performance. However, forecasting the unconstrained demand is one of the most difficult problems in yield management practice. In this case, adding latent demand to the historical censored data helped to forecast the unconstrained rental demand because "unconstrained" data was used. The key to success was to detect, isolate, and remove the components that were not part of the latent demand. The separation of turndowns and rate denials in the data source makes the decomposition method workable. While it is highly unlikely Angello's ATV Rentals will implement something so advanced, this article can come in handy should Angello's ATV Rentals adopt a reservation system [14].

An Adaptive Scheduling Scheme for Dynamic Service Time Allocation on a Shared Resource

This article presents a scheduling scheme that allows a number of customers to share a common resource in an efficient and fair way. Each customer is permitted to use the resource for an allotted amount of time that cannot exceed a certain limit. After expiration of the service time

allotted, if more service is still wanted or required, the customer has to re-enter the request queue and issue a new service request. The basic idea of this new scheme is that every customer is initially allowed to use the resource for a limited period of time that does not exceed a certain quota. Admittedly, at first glance, this idea seems to be a step backward for rental services. For Angello's ATV Rentals, it doesn't matter who is renting the ATV so long as it is being rented out. However, by having a set maximum time on allows for the possibility that a new customer can rent out the ATV, expanding the customer base. Another benefit for implementing service time allocation is for control purposes. Currently, customers can indefinitely extend the rental duration, giving the manager less control over inventory because he/she cannot say for sure that the ATV will be back at a certain time. After implementing STA, the manager will be able to say for sure when he will have a stock of ATVs at any given time in case of customers walking in during a stock out [15].

Design

The design of experiment I performed follows a set of steps that are depicted below.

The scope is defined as follows:

Table 3: Scope

Scope
Obtain Data on the System
Model the System
Create One "As-is" Model
Create 1 "To-Be" Model
Analyze Models and Data
Make Recommendations

The scope, as shown above, is to use adaptive simulation to model the current system to identify bottlenecks and propose solutions. Thus the requirements of this project are to gather data from time studies, incorporate those numbers into valid simulations, and to make decisions based on the output. A limiting factor is that being a small family-owned business, ABC ATV Rentals does not have the money, manpower, or time to make facility changes. Therefore, all alternative changes suggested must have a relatively low cost and cannot create any downtimes for the company.

The overall approach of this project is graphically displayed on the next page.

After defining the objective, scope, and requirements, the next step was to collect data to analyze. This was achieved predominantly by performing on-site time studies. Items included in the time studies are process times as well as customer arrival times. Process times are defined as various steps in the rental process that involve the flow of ATVs through the system. Examples for this

are pull times, load/unload times, gas times, etc. Customer arrival times were measured by recording the time and number of customers arriving. As stated before, the main method of data gathering was on-site time studies conducted by myself. Restrictions on availability due to class greatly reduced sample sizes, as I was only able to make it to the facility for a few hours a week. To complicate matters, most of the on-site time studies occurred during Winter Quarter 2013. This meant weather became a factor when collecting data. People are reluctant to go ATVing when the weather is cold or rainy, and as a result, many visits to the facility yielded no customer data.

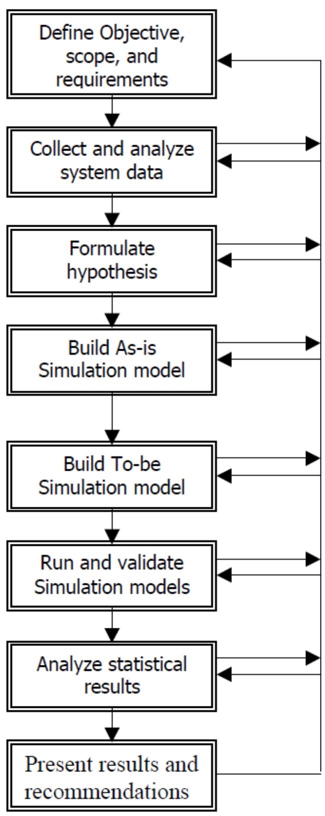


Figure 2: Overall Project Approach

Figure 2 is taken from Arvin Haddadazdeh and Natalie Flint from their Cal Poly Health Center simulation report under methodology. I do not claim any rights or ownership.

This lack of customer arrival prevented larger sample sizes for the customer flow through each station in the system. This meant that customer flow through the system had to be estimated with the available sample data. Fortunately, ATV pull times, oil times, and gas times were not affected by the lack of customers. Although less ATVs were pulled and serviced less frequently because of the lack of customers, I was able to gather enough data for an acceptable sample size. Furthermore, even though there was a low customer arrival rate, ABC's ATV Rentals did possess a number of old customer arrival sheets which included time of arrival, number of customers in the group, and ATVs rented. This was particularly useful when trying to create an expression for customer arrival times as well as group sizes that can be used in the simulation. The only drawback to the sheets was they did not record time spent at each station by the customer. After as much data as possible was collected, the numbers were compiled on Excel and averages were made to use in the simulation.

Methods

The main method of discovering bottlenecks in this project was through simulation, with the software used being ProModel. The first step of using simulation was to simulate the current layout and process that ABC's ATV Rentals were running at the current time.

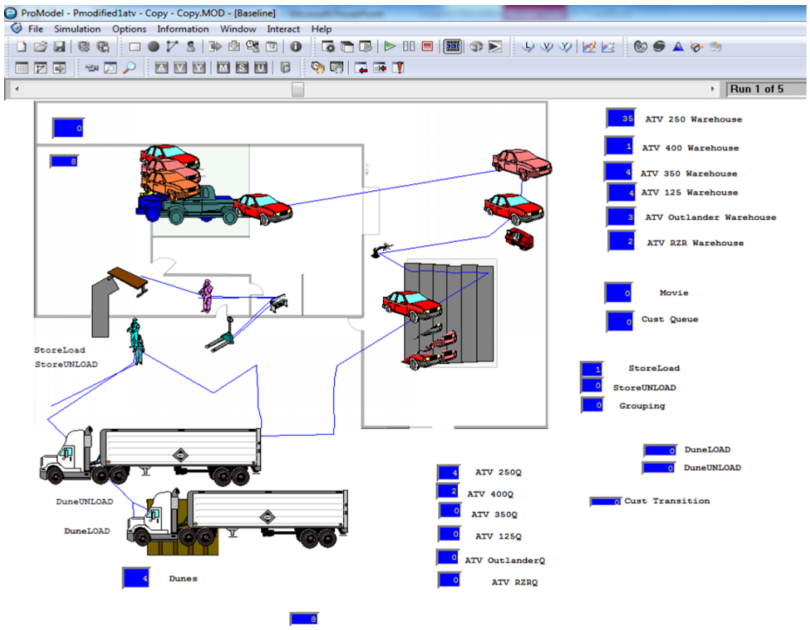
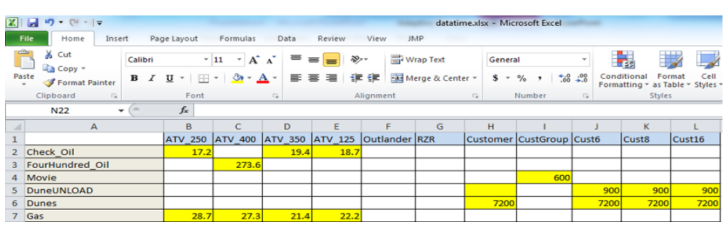


Figure 3: Simulation Snapshot

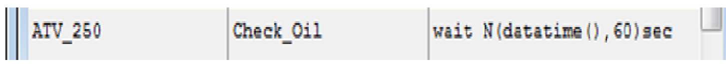
The figure above illustrates the current process at ABC's ATV Rentals. In this scenario, there are two bike runners, two operable trailers, and one desk worker. This model was run using gathered data as inputs. These inputs were mostly stored in an Excel file and called though a function into ProModel. This process was designed with Adaptability in mind, as changing values in Excel is a lot more efficient than changing values in ProModel.



	A	B	C	D	E	F	G	H	I	J	K	L
1		ATV_250	ATV_400	ATV_350	ATV_125	Outlander	RZR	Customer	CustGroup	Cust6	Cust8	Cust16
2	Check_Oil	17.2		19.4	18.7							
3	FourHundred_Oil		273.6									
4	Movie								600			
5	DuneUNLOAD									900	900	900
6	Dunes							7200		7200	7200	7200
7	Gas	28.7	27.3	21.4	22.2							

Figure 4: Excel Snapshot

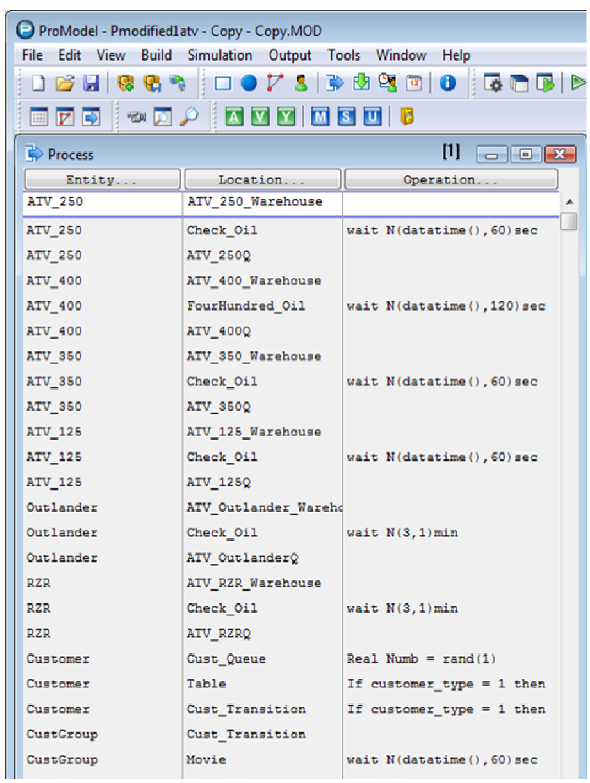
The Excel file, named "datatime", contains the data gathered from time studies. These values were then called from the Excel file through "N(datatime(),60)sec". In the example below, this correlates to the ATV_250 at the Check_Oil station. Basically, this function dictates that the amount of time the ATV_250 needs to wait at the Check_Oil station is normally distributed with a mean of the corresponding Excel value, with a set standard deviation, both in seconds.



ATV_250	Check_Oil	wait N(datatime(),60)sec

Figure 5: Excel in Process Line

However, this is just one small part of the simulation. Different stations require different time values. The figure below is a snapshot of part of the process table. As shown in the table, there is more than one instance of this Excel call function.



Entity...	Location...	Operation...
ATV_250	ATV_250_Warehouse	
ATV_250	Check_Oil	wait N(datatime(),60)sec
ATV_250	ATV_250Q	
ATV_400	ATV_400_Warehouse	
ATV_400	FourHundred_Oil	wait N(datatime(),120)sec
ATV_400	ATV_400Q	
ATV_350	ATV_350_Warehouse	
ATV_350	Check_Oil	wait N(datatime(),60)sec
ATV_350	ATV_350Q	
ATV_125	ATV_125_Warehouse	
ATV_125	Check_Oil	wait N(datatime(),60)sec
ATV_125	ATV_125Q	
Outlander	ATV_Outlander_Warehc	
Outlander	Check_Oil	wait N(3,1)min
Outlander	ATV_OutlanderQ	
RZR	ATV_RZR_Warehouse	
RZR	Check_Oil	wait N(3,1)min
RZR	ATV_RZRQ	
Customer	Cust_Queue	Real Numb = rand(1)
Customer	Table	If customer_type = 1 then
Customer	Cust_Transition	If customer_type = 1 then
CustGroup	Cust_Transition	
CustGroup	Movie	wait N(datatime(),60)sec

Figure 6: Excel in Various Process Lines

This first model was made to accurately mimic ABC's ATV Rental's current run times and customer arrival rate. After all data was input into the simulation, the model was run to simulate a 13-hour work day with 5 reiterations. This step of the method was to determine if the model was valid and verified. The results of this simulation were presented to an ABC's ATV Rental representative, who verified and validated the model. Here is a walkthrough of how the process goes:

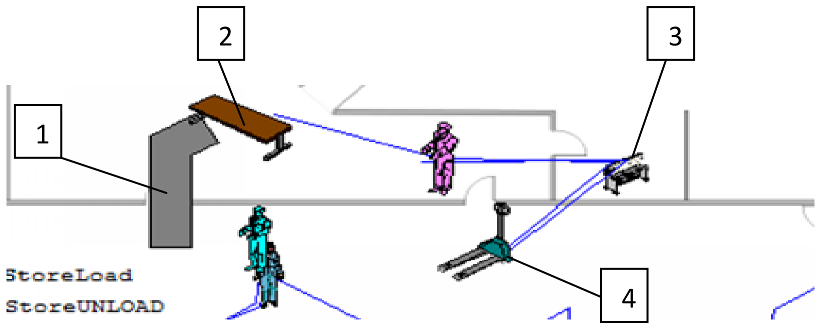


Figure 7: Customer Arrival Procedures

Customers arrive at the Customer Queue, denoted (1), and then proceed to the front desk to fill out a liability waiver as well as rent the ATV (2). After filling out all appropriate forms, the customer is required to watch an instructional video detailing the risks of riding ATVs and giving beginner tips (3). After the video is concluded, the customers are then lead outside to a waiting area to wait while their ATVs are being loaded onto the trailers (4).

While the customer is being serviced by the desk worker, the bike runners are preparing ATVs for the customer to ride.

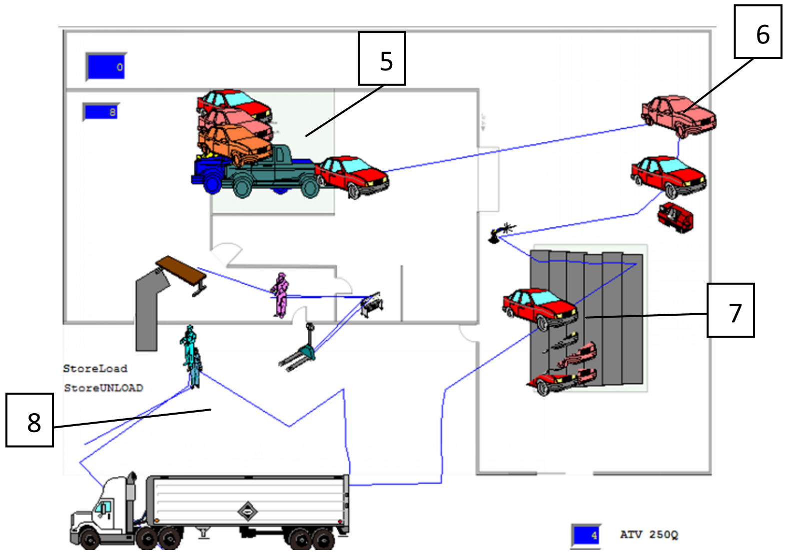


Figure 8: ATV Readying Procedures

The ATVs are first pulled from the garage, denoted (5), then taken to a designated area to have their oil checked (6). After the ATVs are pulled and checked, they are sent to a waiting area to await customer demand (7). The ATVs then remain there until they are grouped with a customer and loaded onto a trailer (8).

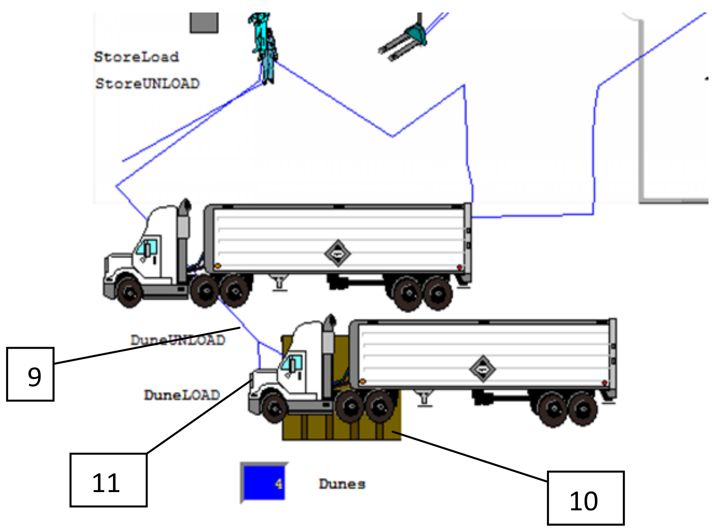


Figure 9: Trailer Procedures

After the customers are loaded onto a trailer, they are then transported to the dune unload point (9). Here, the customers are unloaded off the trailers and are taught how to operate their ATVs. After the customers are briefed, they proceed to ride out on the dunes (10), and when

finished, return to the dune load point (11). At that point, the trailer comes back to pick them up and bring them back to the store. Back at the store, the customer goes to the front desk to pick up their deposit and then leaves the system.

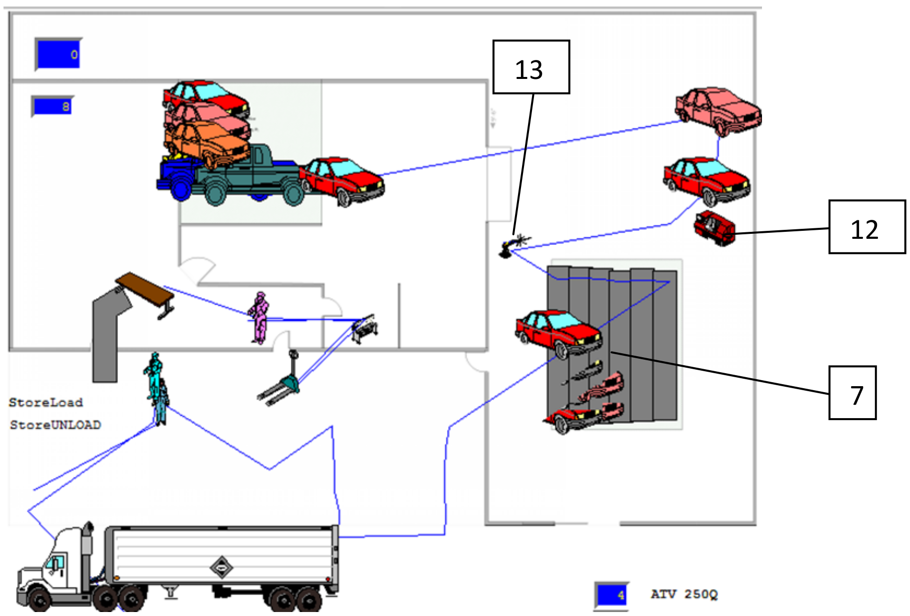


Figure 10: ATV Return Procedure

The ATVs are then checked to see if they have been returned in a satisfactory condition. The ATVs are then taken to be refueled (12) and possibly have tire air replenished (13). After these items are done, the ATV is then placed back into the waiting area previously defined as (7).

After laying out the simulation process, the data collected through time studies were compiled. Customer arrival times were input into Minitab to find an appropriate statistical expression. None of the statistical expressions have a P-Value of over 0.05, meaning all are not appropriate to use. Therefore, the customer arrival time for a normal day is assumed to be normally distributed with a mean of 35minutes and a standard deviation of 2 minutes. Other data numbers collected are as follows:

- Average ATV Pull Time – 35 seconds
- Average ATV Gas Time – 28.7 seconds
- Average ATV 250 Oil Time – 17.2 seconds
- Average ATV 400 Oil Time – 273.6 seconds
- Average ATV Load Time – 25.3 seconds
- Average ATV Unload Time – 16 seconds
- Average Travel to Dune Time – 5 minutes
- Average Time at Front Desk – 6 minutes
- Average Time at Movie – 10 minutes
- Average Time Being Instructed – 15 minutes
- Average Time Spent Riding In Dunes – 120 minutes

The simulation includes 4 different types of resources. First is the desk worker resource, who is used when customers enter the system, fill out paper work, and are ushered to the movie. The second resource is the "movie resource", whose function is to only allow one group to watch the movie at a time; one group cannot enter halfway through a previous group's movie. The next resource is the bike runner, which has a quantity of two. These resources are responsible for the movement of ATVs through the system, as well as grouping and ungrouping customer with the ATVs. The last resource type is the trailer, which also has a quantity of two. The trailers take the customer to and from the dunes.

In the baseline scenario, all resources are used, and a customer arrival time of N(35,2)min is assumed. Four other scenarios were run to explore the effects of various changes in variable input.

The first scenario aims to simulate a slow day, where all resources are used, but customer arrival time is reduced to N(60,2)min. This scenario is meant to explore utilization of resources as well as to explore possible options for reducing resource levels for an expected work day.

The second scenario aims to simulate a high capacity day, where all resources are used, and customer arrival is increased to N(20,2)min. This scenario is meant to find where bottlenecks occur on days with very high customer arrivals. Basically, this simulation is meant to find where the system breaks down (if at all) if there is an overwhelming number of customers.

The third scenario explores the impact the system feels if a trailer breaks down and is unusable for that particular day. The customer arrival time is set at the baseline rate of N(35,2)min with all resource quantities remaining the same except the trailer resource quantity is reduced by one, meaning only one trailer will be in operation. This scenario serves to test the theory that the trailer is the main bottleneck of the system.

The fourth and last scenario is the case where a bike runner calls in sick, so ABC's ATV Rentals is short-handed. In this scenario, customer arrival rate is also set at the baseline rate of N(35,2)min, with resource levels remaining the same except for the reduction of one of the bike runner resources. This simulation is to determine whether or not a single bike runner is able to match customer ATV demand; specifically, whether or not a single bike runner can pull, service, and load ATVs onto a trailer and still keep up with customer demand.

Results

The table below shows the results of the baseline.

Table 4: Baseline Entity Summary

Entity Summary (Avg. Reps)								
Replication	Name	Total Exits	Current Quantity In System	Average Time In System (Min)	Average Time In Move Logic (Min)	Average Time Waiting (Min)	Average Time In Operation (Min)	Average Time Blocked (Min)
Avg	Customer	173.20	44.00	174.63	20.75	8.09	145.79	0.00
Avg	CustGroup	29.80	0.40	11.40	1.53	0.00	9.88	0.00
Avg	Cust6	9.40	2.20	154.16	18.53	0.00	135.62	0.00
Avg	Cust8	7.20	1.20	154.00	18.87	0.00	135.13	0.00
Avg	Cust16	7.40	2.20	155.23	20.09	0.00	135.14	0.00

The average time the customer spends in the system is 174.63 minutes, or 2 hours and 54 minutes. Most of this time is spent in the dunes, however, approximately 30 minutes is spent in transport or waiting. The pareto chart below serves to illustrate where the customer is experiencing wait time.

Table 5: Baseline Time per Location

Name	Average Time Per Entry (Min)
Cust Queue	0.10
Table	*
Movie	*
Cust Transition	1.66
Cust Wait	0.00
StoreLoad	1.71
Trailer Park	0.00
DuneUNLOAD	*
DuneLOAD	6.11
Dunes	*
C250Q	0.00
C400Q	0.00
Load250	4.31
Load400	1.39
Grouping	3.91
Point	0.00

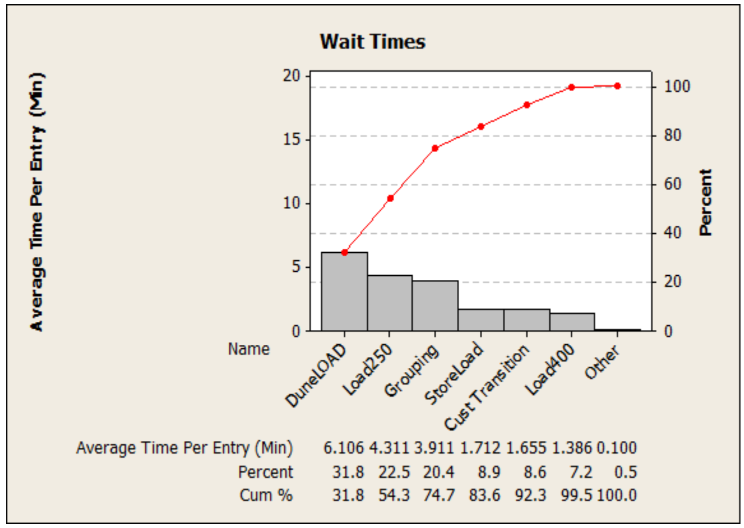


Figure 11: Pareto Chart of Baseline Time per Location

From the table and Pareto chart above, we see that the customer spends the most time waiting to get picked up at the Dune Load area. The next area for most time waiting is at the Load250 area, where customers are waiting to be grouped with their ATVs and loaded onto the trailer. We see similar results for the low customer arrival. Most of the wait time experienced by the customer is at the Dune Load and Load250 areas.

Low Customer Arrival

Table 6: Low Arrival Time per Location

Name	Average Time Per Entry (Min)
Cust Queue	0.10
Table	*
Movie	*
Cust Transition	1.92
Cust Wait	0.00
StoreLoad	1.07
Trailer Park	0.00
DuneUNLOAD	*
DuneLOAD	6.07
Dunes	*
C250Q	0.00
C400Q	0.00
Load250	4.19
Load400	1.08
Grouping	3.83
Point	0.00

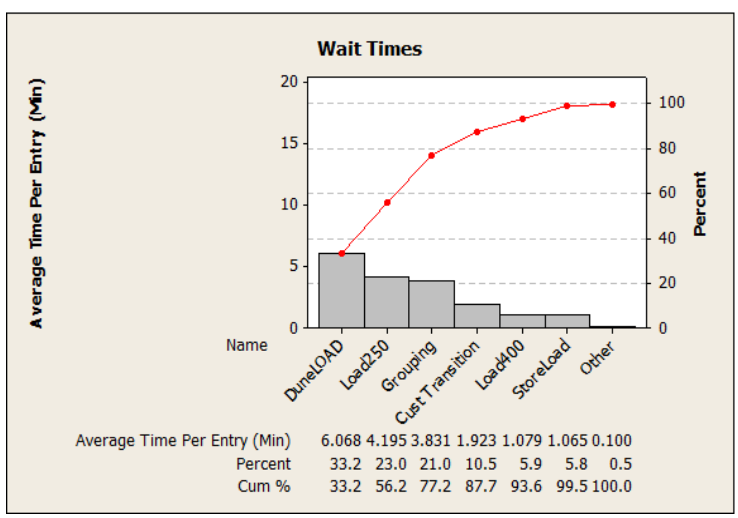


Figure 12: Pareto Chart of Low Arrival Time per Location

We also see a similar total average time in the system. The table shows the results of the low customer arrival scenario.

Table 7: Low Arrival Entity Summary

Entity Summary (Avg. Reps)								
Replication	Name	Total Exits	Current Quantity In System	Average Time In System (Min)	Average Time In Move Logic (Min)	Average Time Waiting (Min)	Average Time In Operation (Min)	Average Time Blocked (Min)
Avg	Customer	102.00	20.80	174.36	20.55	7.79	146.02	0.00
Avg	CustGroup	17.00	0.20	11.58	1.75	0.00	9.84	0.00
Avg	Cust6	6.60	1.00	154.06	18.93	0.00	135.13	0.00
Avg	Cust8	2.80	0.60	154.77	18.09	0.00	136.67	0.00
Avg	Cust16	5.00	1.00	154.24	18.95	0.00	135.29	0.00

Both the baseline and the low customer arrival scenario have an average time in system of 174 minutes. This leads us to conclude that the normal accepted time a customer should spend in the system is around 174 minutes. If a customer is required to wait any longer, a part of the system is running more slowly than the others, causing a bottleneck.

Going on to the high customer scenario, the main area of wait time is now Load250, which has been switched with Dune Load. The average time a customer spends in the system is

also increased to approximately 196 minutes, which is around a 20 minute increase from the base and low customer arrival rates.

High Customer Arrival

Table 8: High Arrival Time per Location

Name	Average Time Per Entry (Min)
Cust Queue	0.10
Table	*
Movie	*
Cust Transition	1.93
Cust Wait	0.00
StoreLoad	12.64
Trailer Park	0.00
DuneUNLOAD	*
DuneLOAD	16.34
Dunes	*
C250Q	0.00
C400Q	0.00
Load250	24.30
Load400	1.17
Grouping	5.70
Point	0.00

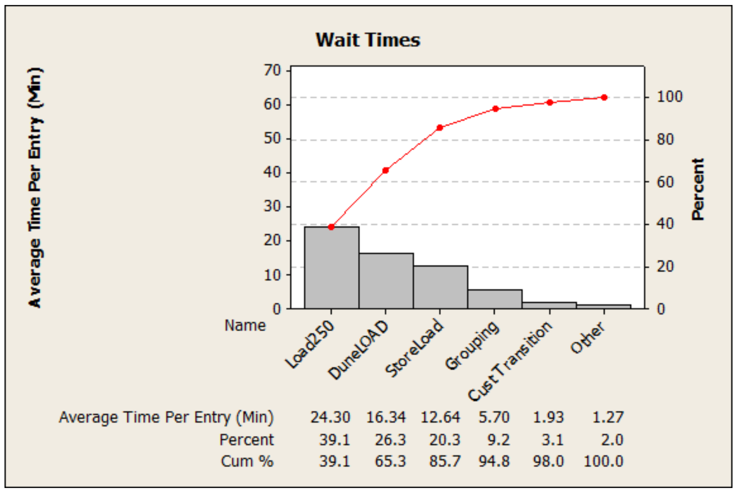


Figure 13: Pareto Chart of High Arrival Timer per Location

Table 9: High Arrival Entity Summary

Entity Summary (Avg. Reps)								
Replication	Name	Total Exits	Current Quantity In System	Average Time In System (Min)	Average Time In Move Logic (Min)	Average Time Waiting (Min)	Average Time In Operation (Min)	Average Time Blocked (Min)
Avg	Customer	276.80	95.60	196.62	42.77	8.03	145.81	0.00
Avg	CustGroup	51.40	0.80	11.79	1.76	0.00	10.03	0.00
Avg	Cust6	16.80	1.40	173.97	39.22	0.00	134.75	0.00
Avg	Cust8	9.60	1.20	175.33	39.60	0.00	135.73	0.00
Avg	Cust16	12.40	1.00	176.53	41.47	0.00	135.06	0.00

The increase in customer wait time at Load250 and Store Load indicate that the customers are not able to efficiently flow through the system at those points. The governing factor of flow in those areas is the trailers. This supports the theory that the main bottleneck in the system is the trailer fleet size. To further explore this option, two more scenarios were added; the trailer fleet size was reduced to 1 and simulated on a baseline arrival time, and the trailer fleet size was increased to 3 and simulated on a high customer arrival time. The results of these two simulations are as follows.

Trailer Fleet Size 1, Customer Arrival N(35,2)min

Table 10: Trailer Fleet Size 1, Arrival N(35,2)min

Entity Summary (Avg. Reps)								
Replication	Name	Total Exits	Current Quantity In System	Average Time In System (Min)	Average Time In Move Logic (Min)	Average Time Waiting (Min)	Average Time In Operation (Min)	Average Time Blocked (Min)
Avg	Customer	151.60	68.40	244.59	90.84	8.20	145.56	0.00
Avg	CustGroup	30.00	0.40	11.75	1.76	0.00	9.99	0.00
Avg	Cust6	7.40	4.20	220.16	85.11	0.00	135.05	0.00
Avg	Cust8	5.60	2.20	231.99	96.74	0.00	135.26	0.00
Avg	Cust16	7.80	2.60	224.52	89.50	0.00	135.02	0.00

The most outstanding statistic in this scenario is the average time the customer spends in the system. With only one trailer operating, the time the customer spends in the system goes from 174 minutes to 244 minutes; a 70 minute increase. Furthermore, this additional 70 minutes are purely customer wait time, meaning that if one trailer were to break down, a customer will have to wait 70 minutes longer than they should.

Table 11: Trailer Fleet Size 1, Time per Location

Name	Average Time Per Entry (Min)
Cust Queue	0.10
Table	*
Movie	*
Cust Transition	1.95
Cust Wait	0.00
StoreLoad	36.03
Trailer Park	0.00
DuneUNLOAD	*
DuneLOAD	47.14
Dunes	*
C250Q	0.00
C400Q	0.00
Load250	4.34
Load400	1.23
Grouping	3.86
Point	0.00

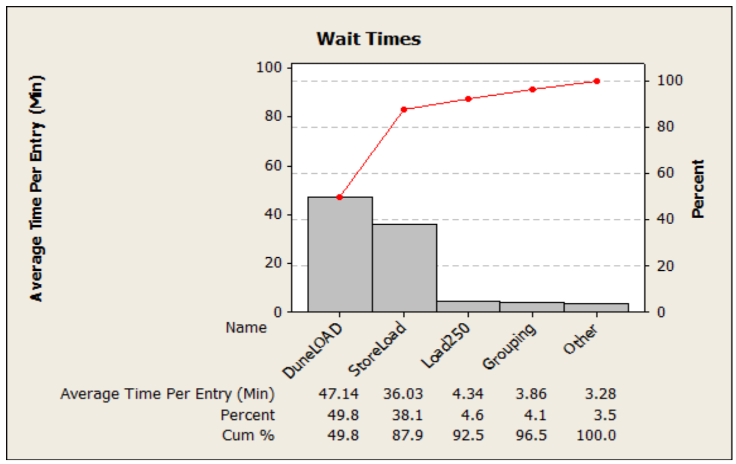


Figure 14: Pareto Chart of Trailer Fleet Size 1 Time per Location

Looking at the figures above, we see that Dune Load and Store Load time values skyrocket. ABC's ATV Rentals, with only 1 trailer, is unable to successfully meet customer demand, leading to large wait times in areas requiring the use of the trailers. With the results of this simulation, it is safe to say the company is heavily reliant on two working trailers, and therefore don't possess two trailers just in case one breaks down.

Trailer Fleet Size 3, Customer Arrival N(20,2)min

Table 12: Trailer Fleet Size 3, Arrival N(20,2)min

Entity Summary (Avg. Reps)								
Replication	Name	Total Exits	Current Quantity In System	Average Time In System (Min)	Average Time In Move Logic (Min)	Average Time Waiting (Min)	Average Time In Operation (Min)	Average Time Blocked (Min)
Avg	Customer	289.20	80.20	174.78	21.25	7.80	145.74	0.00
Avg	CustGroup	51.60	0.80	11.88	1.86	0.00	10.02	0.00
Avg	Cust6	19.40	2.20	154.02	19.15	0.00	134.86	0.00
Avg	Cust8	10.00	0.80	154.90	19.61	0.00	135.29	0.00
Avg	Cust16	11.60	0.20	153.82	19.06	0.00	134.76	0.00

Looking at the average time spent in the system by the customer, we see that with 3 trailers, ABC's ATV Rentals is able to bring that time back down to baseline value. We can thus conclude that increasing the trailer fleet will increase ABC's ATV Rentals customer capacity. This can be concluded because all other resource quantities remained the same with the only variable changed being trailer fleet size. These two different scenarios illustrate that the main bottleneck in the system is in fact the trailer fleet size.

However, if at all possible, we want to avoid large purchases. Another solution to try and mitigate the effects of high customer arrival times is the idea of moving all ATVs to the dunes before customers arrive. This would eliminate any customer wait time at the facility relating to the loading and unloading of ATVs. To explore this possibility, two more simulations were created. These scenarios used current baseline variables for resource quantities and operation times with the only changing variable to be customer arrival rate. The first scenario was tested at a baseline arrival rate while the second scenario was tested at a high customer arrival rate. The results are shown below.

Customer Arrival N(35,2)min

Table 13: Customer Arrival N(35,2)min Entity Summary

Entity Summary (Avg. Reps)								
Replication	Name	Total Exits	Current Quantity In System	Average Time In System (Min)	Average Time In Move Logic (Min)	Average Time Waiting (Min)	Average Time In Operation (Min)	Average Time Blocked (Min)
Avg	Customer	176.40	49.80	159.98	17.63	7.99	145.97	0.00
Avg	CustGroup	31.00	0.00	12.10	1.97	0.00	10.12	0.00
Avg	Cust6	9.40	1.40	138.89	15.57	0.00	134.93	0.00
Avg	Cust8	6.60	1.40	139.01	15.46	0.00	135.17	0.00
Avg	Cust16	8.40	3.40	139.46	16.17	0.00	134.91	0.00

The results show that by eliminating ATV load times, the average time the customer spends in the system is reduced by approximately 14 minutes. This elimination of ATV load/unload time also serves to free trailers that would otherwise be waiting as the ATVs are being loaded onto them.

Customer Arrival N(20,2)min

Table 14: Customer Arrival N(20,2)min Entity Summary

Entity Summary (Avg. Reps)								
Replication	Name	Total Exits	Current Quantity In System	Average Time In System (Min)	Average Time In Move Logic (Min)	Average Time Waiting (Min)	Average Time In Operation (Min)	Average Time Blocked (Min)
Avg	Customer	271.60	102.40	176.73	22.95	8.39	145.39	0.00
Avg	CustGroup	52.00	0.60	11.92	1.93	0.00	9.98	0.00
Avg	Cust6	17.80	0.80	156.67	22.04	0.00	134.63	0.00
Avg	Cust8	8.60	1.00	154.79	19.96	0.00	134.83	0.00
Avg	Cust16	12.00	0.60	155.03	20.52	0.00	134.51	0.00

The high customer arrival rates also give similar results in reducing average time the customer spends in the system. For a busy day, ABC's ATV Rental company would be able to

reduce the average customer time in system by approximately 20 minutes. Both scenarios prove that customer capacity will be greatly increased by moving ATVs to the dunes instead of loading them on a customer by customer basis.

Conclusion

The objective of this project was to discover bottlenecks in ABC's ATV Rental Company's process and create alternatives to address them. These objectives were achieved through data gathered through time studies as well as researched, which were then input into a simulation to create various possible scenarios. The results of these scenarios, as shown in the results section, indicate the main bottleneck in ABC's ATV Rental company's system of operation is their trailer fleet size. It was also shown in the results section that if a trailer were to break down, customer wait time would skyrocket. These results have lead to two main alternatives for the current system:

- Increase Trailer Fleet Size
- Eliminate ATV load/unload time

The first alternative is to keep the current process and just acquire a 3rd trailer to add to the existing fleet size. This serves two main purposes. The first purpose is to directly address high customer arrival times. Since ABC's ATV Rentals does not take reservations, they do not know how many customers will be arriving on a single given day. We saw that with 2 trailers, ABC's still encounters sluggish customer wait times on high arrival days. Furthermore, due to not knowing what day will be a high arrival day, it would be impractical to blindly take large quantities of ATVs to the dunes to eliminate load/unload time in the case no customers arrive. Therefore, having a 3rd trailer on hand serves to mitigate the effects of an overwhelming number of customer arrivals. The second purpose of increasing the trailer fleet size by 1 is to mitigate the effects of a trailer breaking down. We saw that if a trailer were to break down, customer wait

time goes up by approximately 70 minutes. However, with a 3rd trailer in the fleet, customer wait time will only go up to the expected high customer arrival scenario value.

The second alternative is to move ATVs onto the dunes. This alternative requires no additional costs to the company past the extra work it takes to move ATVs to and from the dunes. This alternative should be implemented in tandem with a reservation policy. This is attributed to the randomness of customer arrival times. ABC's ATV Rentals don't want to move more bikes to the dunes than they have customers, therefore getting a rough idea of how many customers will arrive that day serves to help approximate an appropriate number of ATVs to move.

In conclusion, I would recommend ABC's ATV Rentals invest in another trailer, as well as introduce a reservation policy. The increased fleet size allows customers to flow through the system more quickly, therefore improving customer experience, possibility increasing good ratings and generating recommendations for the company. The reservation policy goes hand in hand with moving ATVs to the dunes. By taking reservations, ABC's can not only get an accurate number of ATVs to move before hand, but they also obtain data to customer riding trends, allowing them to more accurately forecast busy or slow days.

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