Lead Time Reduction at Rudolph Foods

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Senior Design Project

Title: Lead Time Reduction at Rudolph Foods

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Company: Rudolph Foods

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Executive Summary

The overall goal of this project is to increase productivity and improve the processes of production as well as look at warehouse operations to see if there can be improvements implemented to the Rudolph Foods facility located in Lawrenceville, Georgia. While Rudolph Foods has a simple production process, there are improvements that can be made so that it may be more efficient. Rudolph Foods has an excellent production and shipping standard, but there are instances where management wishes production could be better. In some cases, while working on large orders, there are smaller orders that get put on the backburner that must wait until the larger orders are completed. Management would like our team to investigate production efficiency as well as any ways to reduce cleaning time and downtime for machines that reduce productivity.

We began our project as any team would by scheduling a meeting with a person in the management team for Rudolph Foods. We toured the facility, gathered information, asked valuable questions about production process operations, and generally inspected the facility and equipment that need improvement. After spending time at both of their facilities in Lawrenceville, Georgia, we concluded we had enough data to go off from what has been said to us through communication with the employees at their facilities and through email. We will consider using aspects of the Define, Measure, Analyze, Improve, and Control (DMAIC) method to help gather pertinent information as to the source of problems at Rudolph Foods. With data collected by the team visit and Arturo Rodriguez during his internship with Rudolph Foods, we considered our options as to what some solutions could be.
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I. CHAPTER ONE: PROJECT BACKGROUND

A. Introduction
The overall goal of this project is to increase productivity and improve the processes of production and the warehouse operations. While Rudolph Foods has a simple production process, there are improvements that can be made so that it may be more efficient. The warehouse operations are not meeting standards set by management and they would like to see improvement in that as well.

B. Overview
Rudolph Foods has the priority of delivering high quality products in a timely manner. Rudolph Foods’ warehouse operations are not meeting standards. Problems Rudolph is experiencing include having a quick turnover rate, completing orders on time, and getting products to the warehouse for shipping. As it stands, Rudolph’s production process has areas such as cleaning that could be improved upon and that will be where we focus our efforts.

The current process begins with adding pork pellets to a fryer, if they need to be seasoned, they move down the process line, if they do not need seasoning, they are ready to be packaged. From there, the pork rinds enter the seasoning tumblers, sent up a conveyor belt where they are weighed and packaged by weight, and sent to be boxed and palletized. If the quantity of the order has been met, the process begins anew and if not then more needs to be produced to meet the quota. A truck will then bring the pallets to their warehouse where they are unloaded and organized. The orders are pulled depending on customer demands if there is enough product, then it is shipped out, if not the product is set aside, and it will not be sent out until the order is fulfilled.

C. Objective
Our main goal for this design project is to create a solution that is viable for Rudolph that grants them the ability to keep the building they are in and still decrease the lead time in the production process. In order to have weight to our solutions, we will conduct a detailed analysis of our solutions so that Rudolph Foods can observe our methods. We will be working under the constraint that Rudolph Foods cannot, without repercussions, cease production. With that constraint in mind, we will come up with the solution that fits this scenario best.

D. Justification
At first glance, there were a couple areas that we could see in the immediate vicinity that could use improvement. There are two massive seasoning tumblers they currently use. They are very heavy and take upwards of 45 minutes to change each time in order to clean, and the cleaning happens twice daily on average. We believe the tumblers to be their biggest bottleneck in the production process and improvement to these tumblers could positively affect lead time reduction. The storage of the pork rinds after they are made is also a problem. The warehouse space is very limited and needs a reorganization.

E. Project Information
The process starts when they receive all the pork skins from suppliers and finishes when all the completed orders are being shipped from the warehouse to the different stores. They currently provide different customers like convenience stores and other snack companies; the quality
standards of product even though do not have a significance variation it does changes the way they label and package their bags of pork rinds.

They currently run the operations by flavors, so for example if they have 10 orders (all from different stores or customers) to be completed they add all the quantity need it for the specific flavor and run it, so every time they need to start making a new flavor they need to stop the process and take apart the seasoning tumbler, wash it an then adding the new flavor to the machine. (between 40 min to an hour they must wait to get started again)

Orders are planned a week in advance so for example the week from February 10th through the 16th they are planning for the operations and outbound for February the 17th to the 23rd. what happens sometimes customer will call and ask for additional product that can put all the operation behind, sometimes the order are bigger that can feet in a full truck load so it is basically a bet when it come for weekly planning also considering they are producing almost at capacity.

The manufacture operates 4.5 to 5 days a week, 24 hours operations divided into different shifts. Employees have a 30-minute brake and two brakes of 15 min each.

The company offers around 40 different pork rinds and other products flavors, in this specific plant they use only 9 of those. Being the most popular ones “BBQ and Hot”. They also produce plain pork rinds which they do not add any type of salt or condiment to it.

F. Problem Statement
Optimize Prime has chosen the pork rind manufacturer Rudolph Foods. Rudolph Foods is the largest pork rind manufacturer in the world. They supply many different companies with their product all over the world. They have seven facilities in the United States and three international Ventures.

The purpose of the project is to be able to find solutions for an optimal production line and warehouse operations for the Atlanta site located in Lawrenceville, GA. This site operates 6 days a week for 24 hours a day. Rudolph Foods has many customers and they must meet certain timelines in order to keep them happy. This causes them to have inventory with a very quick turnover rate. The stress of needing to complete orders on time, along with being able to get product to the warehouse for it to ship out in a timely manner can really add up. Therefore, their processes must flow as smoothly as possible. Our goal as a team is to identify bottlenecks in the process in order to find solutions to improve the overall efficiency and speed up production. We will mainly look for flaws in three different areas. The first will be the production line itself. The second will be the transportation of products from their production site to their warehouse. Finally, we will analyze the warehouse layout.
II. CHAPTER TWO: LITERATURE REVIEW

Based on the TNA case studies reviewed by the team we have learned how the food snacks manufacturing business is usually very busy and encounters many types of problems such as production shortage, high variation in their products, spacing issues, supply chain problems and many other. The case study of Maravilla snack manufacturer 2020 describes the necessity of efficiency like “In every production line, plant managers want to optimize the speed and performance of their manufacturing to ensure targets are met. This means that products need to be processed as quickly and efficiently as possible.” As any other type of food industry business, the regulations trend to be stricter and more intense than others. Giving to companies a small room for mistakes that can be easily translated into losing customers and other type of businesses. Looking at how many companies have solved their issues in the past helped us to understand and to have a better approach trying to solve the existing problem.

TNA case studies from “Donkey Brand, Future foods, pata and Brandneu” had different problems to solve, but at some point, they all referred to say that one of their biggest concerns was flavoring consistency. Based on the compiled information the efficiency of this process is key for the whole production. The correct amount of seasoning on the product is going to determine part of the quality requirements of the snack, especially when the brand offers a variety of different flavors. They must be able to run a specific seasoning as consistent as the rest of them and the very first bag must be almost identical to the last one of that same batch.

Rudolph’s food actual problem is part of a production issue and the way they run the operation and it is not going to help solve the problem by its own. Many of the case studies analyzed have similar productivity issues, lack of production, being unable to complete orders in a certain time and some packaging issues as well. All the companies approached the issue in the same way which was investing in new equipment plus redesigning their work structure. Just like Donkey Brand’s associate Tisljar adds described ‘Now that the new system is up and running, we are experiencing double the production volumes, consistent seasoning application, reduced product breakage and virtually no downtime.’ The whole project ran extremely smoothly, and we were especially impressed with FOODesign’s exceptional level of service and flexibility in system design. We immediately saw the benefits of their cutting-edge manufacturing solutions which delivered the speed, performance and accuracy we were looking for, while still producing the quality tortilla chips Donkey Brands customers have come to expect.’

Investing in the business can be beneficial and have great outcomes for the company. Preziosi foods wrote their own experience working together with TNA solutions (a TNA brand) “The tna robag FX 3ci meets all of our expectations in terms of performance and simplicity, as well as providing additional benefits like keeping waste to a minimum. I’m convinced the new system will enable us to meet the local market’s increasing demand for batch-fried chips head on.’ Increasing production is directly creating a new market of opportunities for that company”. There is enough evidence that challenges can be approached by letting a third party to get involve in the situation, that is why as a team we have also learned how a machine supplier can offer different solutions as well. This kind of companies are the ones making the machines, so they know better and have a great background experience on the field as well.
III. CHAPTER THREE: PROJECT MANAGEMENT

A. Problem Solving Approach
With the problem defined, Optimize Prime has combined different tools available to display the different data collected throughout the project time. Such as overall production of the plant in pounds and the schedule of the workers according to an average shift. We also introduced a Six Sigma matrix template called quality function deployment (QFD) to analyze the different criteria to match for our design according to customer’s specifications and needs. Other charts and matrixes were also used to achieve a more accurate comparison between possible solutions. Optimize Prime considered pertinent to include a 5S Lean methodology for one of the solutions offered to achieve a higher and more competitive solution.

B. Requirements
Optimize Prime requirements for the project were based on quality, safety, and efficiency to ensure our customer’s satisfaction level is above expectations. That is the reason why we have come together with some minimum requirements to meet.

- Solution reduces average lead time by at least 10%.
- Optimize production rate by at least 5%.
- Solution does not compromise safety at any circumstances.
- Maximize profit by reducing waste.
- Identify additional problems on the way to acknowledge the customer for future problem-solving opportunities that can be done by Optimize Prime.

C. Gantt Chart

![Gantt Chart for Optimize Prime](image-url)
D. Flow Charts

Next diagram shows the current process for Rudolph’s food at Lawrenceville GA. As it is now, the current process which we will be improving upon with the proposed solution, see VII.1 for the solution details, is given by the flow chart in Figure 2.

**Figure 2: Current Process Flow Chart**

**Figure 3: Plant layout pictures**
The flow chart “current process” is a visual representation of the company’s daily operations form start to end. Running this same operations through all the 9 packaging lines. The process is described as it follows:

1. Manually adding pork skin “pellets”: according to Rudolph’s food management the initial process of the pork rinses starts by manually introducing the pork skins that come directly from the corporate supplier, the employer knows the amount that will be needed for the certain batch and adds this to the conveyor line.
2. Frying process: the pork skins are fried approximately at 350 degrees where they increase in size and they get the desire texture. One of the most important characteristics of this snacks is the crunchiness obtained by this step.
3. Pork Rinds Travel #1: after the Rinds are cooked, they travel on the conveyor belt to be seasoned or not in the seasoned tumbler. The plain (no flavor or salt added) pork rinds still go though the tumblers, the difference is that they do not add any seasoning to them. So, this process will be repeated for any flavor as well as for plain pork Rinds.
4. Seasoning process: the production is divided into five lines that are seasoned by one machine and at the other side of the plant they have four lines running with another seasoning machine (See figure two for image reference). The process consists of adding the specific flavor for that batch through the machines. At the beginning of the machine there is a laser that scans the pork rinds measure the quantity of product coming inside the
machine, the purpose of this reading is the machine can balance the amount of seasoning that is going to be spread into the items.

5. Pork Rinds Travel #2: after the pork rinds are seasoned, they travel to the second level (see figure 2 for reference). At this point they get distributed into the five packaging machines located at the second level.

6. Packaging process: Each machine weights the amount of product they need according to the packaging size they need for the order (small, medium, and large bags). This process also includes selecting the plastic bag material with the right labels for the batch flavor. Different flavors have different color packages, which are also part of their image having a see-through bag (see picture three for reference).

7. Boxing process: two employees for each line manually introduce the final product in the boxes according to their size. This is the final verification for the product as well, if the bag has any damages or defects the employees proceed to discard the item into a trash can. Also, the quality department or any manager can take a random sample at this point to evaluate the product in different aspects such as; flavor consistency, low variance in pork rinses sizes, crunchiness, excess of air in the bag, inaccurate weight of the package and for general inspections as well.

8. Building the pallets: after filling the box with the final products the workers start wrapping them into the pallets with a plastic wrap. After the plastic covers the boxes, they label the orders according to customer’s specifications. Some customers have a standard way of their labels to be in a specific place in every order, so the workers make sure this gets done for the “special customers”. The customer that do not require any labeling preference are labeled randomly by the worker of that shift. At this point they check for the first time to see if they have matched a specific flavor requirement, if the answer is yes, they proceed with a new order. If the answer is negative, the process must start over for the amount that is required.

9. Revision of pallets and delivery of pallets: after the pallets are completed, they are loaded in a truck and delivered to the warehouse (mainly) located five minutes away from the factory.

10. Organizing the inventory: once the product arrives to the warehouse it gets organize in the warehouse according to customers orders, the organization in the warehouse is based on workers decision to locate the products according to available space.

11. Sending products to the customers: orders are pulled according to necessity; a third-party logistics company delivers the products to the stores. If the warehouse is running low in a specific flavor, they contact the factory so they can send a specific request to the line and try to get it done in a rushed period.

- After adding the ideal solution to the process, the flow chart for the improved process is given by Figure 4.
Optimize prime ideal solution involves eliminating some of the steps in the current process to avoid delays and respond to the order quicker than the actual status. Reducing the amount of time, the warehouse must wait for a specific flavor to be processed will be beneficial for Rudolph’s foods associates and for their customers as well. It can create new market opportunities eventually by being able to increase their order quantity. One of the biggest problems is they only rely on two seasoning machines only, so when they start to produce an order is only based on a certain flavor because they do not have a way of doing multiple flavors a time. In addition, after a batch is completed before they change the flavor at the machine the workers need to clean and sanitize the seasoning tumblers which takes time and money to do it. Optimize prime believes that most of their lack of production is based on the fact the do not have additional machines to help the current one and even if they had another seasoning machine if would not be beneficial based on the current plant layout they have. New equipment and redesigning the plant set up is part of what is an ideal solution for Rudolph’s foods.
IV. CHAPTER FOUR: WORK BREAKDOWN STRUCTURE

Figure 6: Project Work Breakdown Structure
WBS

The work breakdown structure is a graphic representation of how our team split the different tasks we had to cover in order to get the project going efficiently. Our four members started from having specific tasks to narrow them down so at the last quarter of the project it was more about getting the job done instead of having a defined functional work structure, in that sense we all made sure the team was meeting the short terms goals for every week period.

A. Overall Schedule
Our team plans to visit the site at least once a week and spend hours with employees to really understand their overall process from beginning to end. We will create a work breakdown structure and an overall schedule to have organization throughout the project. We will analyze data collected from each visit and create simulations using Arena modeling to show visualizations to easily understand their process. With data collected we will show a data summary on Minitab that projects important statistical data. The process of picking up finished goods and shipping them out will be represented through flowcharts. In the end, we hope to organize our possible solutions in a weighted criteria matrix to find the best solution/s for Rudolph Foods.

<table>
<thead>
<tr>
<th>Number</th>
<th>Date</th>
<th>Milestones Reached</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>01/22/2019</td>
<td>Initial Design Review</td>
</tr>
<tr>
<td>2</td>
<td>02/19/2019</td>
<td>Preliminary Design Review</td>
</tr>
<tr>
<td>3</td>
<td>03/18/2019</td>
<td>In Progress Review</td>
</tr>
<tr>
<td>4</td>
<td>04/8/2019</td>
<td>Critical Design Review</td>
</tr>
<tr>
<td>5</td>
<td>04/22/2019</td>
<td>Final Design Review</td>
</tr>
</tbody>
</table>

*Figure 7: Project Schedule as of January 22, 2020*

<table>
<thead>
<tr>
<th>Number</th>
<th>Date</th>
<th>Tasks</th>
</tr>
</thead>
</table>
| 1      | 01/22/2019-02/19/2019 | -Prior meet to decide project scope and designate roles  
                                  -Agree on schedule and project                          |
| 2      | 02/19/2019-03/18/2019 | -Visit facility and establish relationship       
                                  -Collect data and potential areas of improvement |
| 3      | 03/18/2019-04/8/2019 | -Being analysis of existing data  
                                  -Create models of all ideas use of software             |
| 4      | 04/8/2019-04/22/2019 | -Finalize findings and being to prepare for final design review |
| 5      | 04/22/2019   | Final Design Review                                                             |

*Figure 8: Project Schedule with Work Achieved*
B. Budget
Optimize prime considered an initial budget of $5,000. This amount of money is a baseline for the rest of the project, as a team we will provide the most feasible and affordable solution possible. The company has knowledge that there must be an investment done at some point that will have a return in revenue further on. Process improvement can be expensive but optimize prime focuses on achieving results with a high level of reliability and a realistic cost analysis.

C. Material, Methods and Tools

- Excel and Power point were used to design diagrams from the data we collected. Having the data distributed in graphs is beneficial to do analysis that are going to help elaborating the possible solutions.
- Solid Works was used to design the seasoning tumbler for solution three. Due to the spacing constraint at the factory there must be a specific seasoning machine size that will fit between the conveyor and the packaging scale machine. This model helped to have a visual perception of the solution approach.
- We had access to take pictures and video at the plant while our visit in the Lawrenceville location. This helped to have a better visual of how the process flows without been present at the facility. Also, it helped the team to compare the equipment Rudolph’s food has compare to the new products available from suppliers in 2020 market.
- Optimize Prime time and commitment came together to create a practical efficient solutions scenario.

D. Resources Available
In order to achieve minimum success, we hope to find the bottlenecks in each of the three areas we will be analyzing and find at least one possible solution for each. We hope to have found solutions to overall production cycle, and improvements to the layout of the warehouse.

Schools lab limited due to COVID-19 circumstances. An additional resource of visiting the facility was also restricted. No extra expenses were taken in consideration by optimize prime.
V. CHAPTER FIVE: ISSUES RUDOLPH IS FACING

Rudolph’s foods currently have two locations in Lawrenceville GA, the warehouse where they keep inventory and the production facility for all the pork rinds (about five minutes apart from each other). The problem they currently have is that sometimes they have to wait to ship an order from the warehouse to their client because they need additional final product to be completed at the main site. Having to stage orders to the side increases the cycle time of the product which causes a longer duration of wait time that the client faces. There is also a negative impact in the warehouse itself due to needing a separate space for staging orders that are not able to be completed. This problem is over crowding their already limited space and costing them money by not being able to bring on new clients considering they are already over capacity. Production cannot be sped up considering they are already running at high speeds that cause a lot of down times for the machines. The machines could not handle faster speeds. All the pork rinds travel through one big fryer and then through one big seasoning tumbler. The management team checks all the orders that need to be fulfilled the following weeks and records the number of pounds needed for each specific seasoning. Considering they only have one seasoning tumbler working at once, they must produce all pork rinds of one specific seasoning until all the pork rinds for that week are complete before producing the next seasoning. Miscalculating or random “emergency” orders that need to be fit in the current week cause there to be a shortage in product. This is where the problem of having to stage unfinished orders in the warehouse arises. There needs to be a solution that can increase their production rates and save them time and money.
VI. CHAPTER SIX: RESULTS AND DISCUSSION

The team main goal was to determine which possible scenarios could help the company to reduce their lead time and improve production in general. The following analysis, tables and graph are tools used for the team to have a better understanding of comparing the three possible solutions optimized prime came together with.

A. Data Collected

![Graph of the Current Average Production Per Hour](image)

- Hours 2, 7, 10, 15, 18, and 23 = 15 Minute Breaks
- Hours 4, 12, 20 = 30 Minute Lunch Break
- Hours 9 and 17 = 45 Minute Change Over

*Figure 9: Graph of the Current Average Production*

Previous image represents the hourly distribution of the plant’s operations. Compares the number of hours invested with the quantity of pork rinds made in pounds. We can identify a big gap of approximately 30 min to an hour during change over. This represents what the workers must get done to change between one flavor to another. Which includes taking out the seasoning tumbler to wash it and sanitize it before the new batch starts to produce a different flavor or to produce plain pork rinds if that is the case of the order. Reducing this gap time is crucial for optimize prime to achieve the lead time reduction objective of the problem. The following problem-solving proposals are going to target to reduce this number.
B. Challenges
All projects have challenges to face but specifically this one has been unique; with the current situation the world is facing regarding the Corona Virus it has affected everything that was “normal” for us three weeks ago. The fact those activities are being restricted has affected not only the senior design project but also the rest of the courses for this semester. Considering that our project is based on a food manufacturer it means that they do not welcome any kinds of visits during this period. So, the information we can obtained is limited to the managers’ ability to respond our questions. On the other hand, the companies that manufacture the equipment have not been cooperating in the fact of giving us more details about their products. Another challenge has been of the fact we cannot meet in person to discuss about different topics and how to go forward with the project, the team has been trying its best to have better communication within the members. An important constraint has been time, considering the four members are in their final semester and work schedules added to that makes it more challenging for the team to work together. Going forward, we face the issue of not having access to crucial software that allows us to be able to perform tasks which we would not easily be able to do without. All these challenges have been considered and we are doing our best to overcome them.
VII. CHAPTER SEVEN: COST ANALYSIS OF SOLUTIONS

During the analysis, we came across the Project Cost Analysis performed by a Chic-Fil-A restaurant on labor savings, which was the first cost that we estimated. Below, is the cost analysis performed by the Chic-Fil-A and the results listed in Figure 1. An economical cost analysis was performed in this project, to help verify some of the supply chain team objectives. The first cost was estimated as labor savings. This cost savings was one of the supply chain team’s goal for this test. With the implementation of the suggested optimal replenishment process, the operator and manager at sugarloaf & 316 estimated an hour of labor savings per day. Using the average Chick-fil-A wages posted from Glassdoor, it was estimated that one labor hour is worth $9 per hour. When collaborating this information, the labor-saving table below was produced. The team considered this analysis could be replicated into our project because if the change over time is reduce at the plant it will save hourly waged employees to the company. It is a fact that producing more product in lower times can reduce operations cost dramatically.

<table>
<thead>
<tr>
<th>Labor Savings At $9/HR</th>
<th>Hours</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly</td>
<td>6</td>
<td>$54.00</td>
</tr>
<tr>
<td>Monthly</td>
<td>24</td>
<td>$216.00</td>
</tr>
<tr>
<td>Yearly</td>
<td>288</td>
<td>$2,259.20</td>
</tr>
</tbody>
</table>

*Figure 10: Cost Analysis of Labor Savings Using Chick-Fil-A Wages*

A. Solution One

Possible Solution: By increasing the amount of pork rinds produced in each batch it will produce an extra inventory that they can easily keep at the warehouse because they do not have a spacing constraint like in the production area. Considering the fact pork rinds have a 90-day policy it is a flexible time frame to ship out those extra products, keeping some extra inventory on hand will reduce the time the warehouse has to wait for a certain pork rinds flavor to be completed. Without having to put new orders on the side because a previous load is not completed.

The company already keeps good amounts of the pork skins as well of seasoning packages so no extra investment will have to be adjusted. The production lane receives some of the material they use to package directly from their customer so no extra labels or plastic will need to be purchased as well.

Consequences of Approach: By producing extra amount of pork rinds for each flavor they would not be able to respond to any on the spot orders they receive often that are usually a rush for the workers but it is also a good sales opportunity for the facility and they are always trying to keep their customers as happy as possible. Also, by overproducing you always have the issue with damaged inventory, broken bags and quality is easily going to be affected.
B. Solution Two

Solution Two involves expanding the plant into a new and bigger location, because their main constraint is mostly spacing. One of the reasons they have not moved to a different facility is because right now they own the property that they operate all the production of pork rinds. They do not own the land their property is built on, so they still must pay some fees to operate in that space.

The building they are operating now is 38,000 sqft. Finding a new warehouse to operate in the same Lawrenceville area could be a 55,360 sqft building located in 2160 Breckinridge Blvd, the cost is around $5.25/year resulting on an estimated cost of $291,000. That does not include any extra equipment they have to buy, the shipping of all the existing material and the time without any production going on. Included with the new warehouse is 13,628 sqft of dedicated office space, 12 Loading Docks, 55,360 sqft, natural gas, using the city water system, and using the city sewer system.

The solution is ideal in theory but unrealistic to happened, expanding, or moving is not being considered by the chiefs of the company because the fact they own the current property and do not feel the necessity of investment now.

Another factor is being able to outsource the orders that will be coming those days. Having the factory being relocated is going to be a big impact for the current customer and for the others Rudolph’s food locations. Changes on schedules and shipping cost are going to have a huge variation that can have more cons that positive points.

Figure 11: Property for lease layout retrieved from Loopner/listing:
C. Solution Three

The way the process is currently running it consists of only one seasoning barrel operating for 5 lines and another one that serves the other 4. Our plan is to eliminate those two seasoning tumblers and add one tumbler machine for each independent line. So, in that sense each machine can have their independent seasoning going on without depending in the other flavors to be finished. The company will be more prepared to respond to different orders during the week. Also, the production would not have to stop because one of the tumblers is being sanitized or while a flavor change is being made. This solution would solve the problem of not having enough product ready for a specific order to be shipped out. If an order were waiting for a specific flavor of pork rind, one of the five tumblers can easily be changed out and the product needed could easily be produced without having to affect the other four lines. The other four lines can continue to produce the flavors as scheduled.

The new seasoning tumblers that would be used will be made from high-density polyethylene (HDPE) which is food safe and has a high melting point of 266 degrees Fahrenheit. It can withstand the heat that the oil gives off as well as protect the pork rinds from absorbing any chemicals. This plastic is lightweight and would easily be able to be handled by your average operator when it came to change over to a new tumbler for a new seasoning. We have created a tumbler using HDPE material in a 3D model using Solid works. We kept in mind the average wingspan of a person as well as the dimensions of the conveyor belt so that it would be easy to handle and fit in the current production process. Below is part drawing (figure 12) and its dimensions as well as specifications (figure 11).

For Solution three the budget is as follows: The estimated cost of the machine is 8,000 USD with an additional shipping freight of 1,200 USD for each one of those machines. The project will require nine machines one for each line at the factory. Added to that the installation cost is going to be around 50 USD an hour for a certified technician and labor time is going to be 12 hours for each machine. (all cost are estimations made on the market price for some similar seasoning machines sold outside of the US).
• Total cost of installing one machine = machine cost + FC + labor = $8,000 + $1,200 + $50(x)12 = $9,800

<table>
<thead>
<tr>
<th>machine cost</th>
<th>FC</th>
<th>labor</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>$8,000</td>
<td>$1,200</td>
<td>$50(x)12</td>
<td>$9,800</td>
</tr>
</tbody>
</table>

*Table 1: Total Cost of Implementing the Solution*

• Total cost of implementing solution = Total cost of installing one machine (x) # machines = $9,800 (x) 9 = $88,200 = that we will round up to $90K for any extra expenses required.

<table>
<thead>
<tr>
<th>Total cost of installing one machine (x) # machines</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>$9,800 (x) 9</td>
<td>$88,200</td>
</tr>
</tbody>
</table>

*Table 2: Total Cost of Implementing the Solution*

Image 14: of proposed solution, blue barrels (source: TNA Solutions)

This image 13 shows how TNA had designed a seasoning system were the tumblers are located right before they get packaged. This kind of set up is more common in snack manufactures that specialize in fried items like potato chips for example. Independently of the items being fried the seasoning tumblers can be set up each one of them in a different configuration for multiple flavors. The computers located in the machine are connected with the company’s recipes so it will add the precise amount of seasoning according to batch dimension that is being read by the scanner right before the go inside of the tumbler.
Image 14 is the actual space available to implement the new potential solution. The designed prototype has the size specs required to fit in the current location. One tumbler machine is recommended for each line, having nine machines in total. The picture also displays the packaging machines right under the end of the conveyor belt. The idea of creating a design is to have a custom shop tumbler machine made for the space available due to the fact the company does not have any extra spacing available in the floor plan.
TNA offers a tumbler machine system that can be easily interchangeable to be wash and sanitize. The optimize prime solution in addition of having new machines also includes having two tumbles for each line so they will be no need of waiting for one to be washed to keep running the line. Having spare tumblers will create a habit of been more productive within the employees because all the time wasted in changeover can be used to realize a different task.

Image 17: 5S diagram example source: “smart draw”
According to ASQ “5S is defined as a methodology that results in a workplace that is clean, uncluttered, safe, and well organized to help reduce waste and optimize productivity. It is designed to help build a quality work environment, both physically and mentally. The 5S philosophy applies in any work area suited for visual control and lean production. The 5S condition of a work area is critical to employees and is the basis of customers’ first impressions” optimize prime believes that together with solution three there has to be a lean 5S mentality attached to have a sustainable solution for short and long term. 5S implementation will ensure the employees and management work together to keep the operations running in a great overall performance on top of that it will raise safety and ambience appearance at the plant in general.

1. The first step is Sort or “seiri” (organize): eliminate all the previous tools used for the older machines, finding a retail value to get some money back as well. Also, discard all the cleaning chemicals and tools that they would not need anymore. By sorting Rudolph’s food will make sure to have enough space for the new cleaning products recommended by the suppliers.

2. Second step set in order “seiton” (orderliness): new machines involves having new tools and manuals as well as having new seasoning tumblers that will need to be stored in an area easy to access for workers. This will make the employees to know where to look when they need to interchange tumblers or to grab a specific tool for maintenance.

3. Third step shine “seiso” (cleanliness): having more machines involves more production but also more to clean. The fact the pork rinds are rotating inside of a cylindrical tumblers makes it less likely to be wasted on the floor, but like how we observed in our visit to the factory most of the crumbs on the floor were coming out of the fryers and conveyors belt in general. There must be a consideration that cleaning might be more extensive than before because they will have more seasoning tumblers to deep clean. This part of the steps is particularly important because Rudolph’s food is a food manufacturer, so cleanliness is crucial for their quality and to avoid any kind of penalties from the health department.

4. Fourth step is standardize “seiketsu” (standardize): The company will need to change their cleaning schedule after a couple of weeks with the new machines according to the new cleaning necessities. We recommended that they could use the 30 minutes to an hour gap they had before to clean the tumblers they need for that moment. This step might take some time to plan and implement but is key to make the prior steps to be successful. The cooperation of management and associates is important to standardize the cleaning process.

5. Fifth step is sustain “shitsuke” (discipline): probably the most important step and the hardest one, the last step distinguishes a successful company from an average manufacturer. Sustain means to keep everything running all the time and adopting this idea as a way of life. Lean has proven to be considered a philosophy by its own. Companies with the lean mentality are on top of the game when it comes about quality and being successful.

Having a lean mentality inside of a business can have a lot of benefits not only for the general appearance but it is proven that reducing wastes can also reduce operations costs in the industry and at the end of the day if the company spends less money they will receive a higher income.
Also, safety wise is important having such a grease product in the floor can cause an unwanted scenario for the company and their associates.

**Quality function deployment (QFD)**

According to ASQ “a quality function deployment or also called matrix product planning, decision matrices, customer-driven engineering. Every organization has customers. Some have only internal customers, some have only external customers, and some have both. When you are working to determine what you need to accomplish to satisfy or even delight your customers, quality function deployment is an essential tool.” According to suggestions Optimize Prime encouraged to use the following matrix to display how our design meet customer’s expectations based on a priority and importance system. Also, we have compared the team with other competitors in the industry to support our analysis.

![QFD Chart](https://via.placeholder.com/150)
At first, we determined quality characteristics that are important for the team to maximize (speed, quality and added value) and then demanded quality items from the customer to decrease as a goal (cycle time, defects, and costs). All of them had a 1-5 importance weight assigned by the team. After we defined the designs requirements for the project: Efficiency, low waste, implementation, maintainability, easy to wash and seasoning consistency. We compared such characteristics with the quality items on the left adding a relationship symbol to represent their interaction.

![Figure 19: QFD Chart ZOOM in](image)

After we compared our approach to each of the elements with other companies, the colored lines on the right represent graphically the grading scale from 1 to 5 on how each company scores in those quality characteristics and demanded.
Finally, the bottom section describes how difficult from 1 to 10 is going to be to meet each of the design’s characteristic. Having seasoning consistency and implementation as the most important items for the customer.

We compared the three solutions to find the most feasible solution.

<table>
<thead>
<tr>
<th>Cost of Solutions</th>
<th>Budget</th>
<th>Actual</th>
<th>Variance</th>
<th>Var %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementing New Machines</td>
<td>$5,000</td>
<td>$90,000</td>
<td>$85,000</td>
<td>1,700%</td>
</tr>
<tr>
<td>Increase Batch Sizes</td>
<td>$5,000</td>
<td>$0</td>
<td>$(5,000)</td>
<td>-</td>
</tr>
<tr>
<td>Moving and Expanding</td>
<td>$5,000</td>
<td>$291,000</td>
<td>$286,000</td>
<td>5,720%</td>
</tr>
</tbody>
</table>
This table represents a comparison between the initial budget and the estimated price to complete the project, also shows a variance percentage to display if the solution is feasible according to the money available. Based on the chart the solution that refers to moving and expanding goes way higher than over budget, so it is going to be harder to implement without further analysis. Solution #1 is the one that fits the budget the most due to the fact the company already has enough of raw material needed in stock if they needed to increase the production por a conservative percentage at a starting point. On the other hand solution 3 seems to be in the middle considering budget but is the one that offers more benefits in the short term, the next graph and tools used will be the optimize prime decision trigger to solve the problem.

<table>
<thead>
<tr>
<th>Decision Tree Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>What Decision is more beneficial?</td>
</tr>
</tbody>
</table>
| Implementing New Machines (#3) | • Increase Productivity Rate  
• Reduce Lead Time  
• Produce Multiple flavors at once  
• Cost Involved  
• Redesign process structure |
| Increase Batch Sizes (#1) | • Quicker Response for orders (sometimes)  
• Reduce Time at warehouse  
• Machines can be compromised  
• Safety related issue  
• Increases packaging time |
| Moving and Expanding (#2) | • Solve spacing constraint  
• The company will be able to restructure the orders  
• Shut down of operations  
• Very expensive  
• Not been able to outsource while moving (loose sales) |

*Figures 23: Decision Tree Model/Chart*
The decision tree chart is a tool that helps to make a better approach in terms of selecting the most beneficial solution to the company’s major problem. Based on the description of previous solutions the team determined which were the pros and cons for each of the solutions. Being the most beneficial ones implementing new machines and increasing the batch size. Moving and expanding was discarded at this point due to inefficiency to been able to solve the problem in short term also considering figure 16 this approach goes way over the budget. Optimize prime will make all the decisions based on solutions one and three. Both of this problem approaches offer a more realistic problem-solving scenario that is typically used in the snack manufacturing industry.
## Weighted Criteria Matrix

<table>
<thead>
<tr>
<th>Prioritization Rate Criteria</th>
<th>Value</th>
<th>New Machines</th>
<th>Score</th>
<th>Increase Batch Size</th>
<th>Score</th>
<th>Moving Plus Expanding</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost to Implement</td>
<td>8</td>
<td>Around 90K USD</td>
<td>8</td>
<td>Close to Zero investment</td>
<td>9</td>
<td>Close to 290K USD</td>
<td>6</td>
</tr>
<tr>
<td>Time to Implement</td>
<td>7</td>
<td>1 Week</td>
<td>10</td>
<td>1-2 Weeks</td>
<td>9</td>
<td>2-3 Months</td>
<td>6</td>
</tr>
<tr>
<td>Impact On problem</td>
<td>10</td>
<td>Improving Lead Time Average</td>
<td>10</td>
<td>Being Able to respond Sometimes</td>
<td>6</td>
<td>Improve Spacing Constraint but operation wise remains the same</td>
<td>6</td>
</tr>
<tr>
<td>Overall Impact on Workers</td>
<td>7</td>
<td>Training Must Be done on new machines usage</td>
<td>7</td>
<td>Small Amount of Worker’s Training</td>
<td>9</td>
<td>Detailed and proper training must be done</td>
<td>6</td>
</tr>
<tr>
<td>Value Times Score</td>
<td>(64) + (70) + (100) + (49)</td>
<td>(72) + (63) +(60) +(81)</td>
<td>(48) + (42) +(60) +(42)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Score</td>
<td>283</td>
<td>276</td>
<td>192</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 24: Weighted Criteria Matrix
The Weighted criteria matrix is another tool Optimize prime used to compare the solutions. The three solutions are displayed on the table with the prioritization criteria as well. The criteria is scaled from six to ten (six is the least important and ten is the more important) this was based on the team perception of problem approach. Then the score means how that solution has an impact on the root problem (six is a poor score while 10 is an excellent score). After multiplying and adding the results we could identify adding the new machines as our main solution.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Solution 1</th>
<th>Solution 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator Reaction</td>
<td>Negative</td>
<td>Positive</td>
</tr>
<tr>
<td>Supervisor Reaction</td>
<td>Moderate</td>
<td>Positive</td>
</tr>
<tr>
<td>Turnover Rate</td>
<td>Increase</td>
<td>Decrease</td>
</tr>
<tr>
<td>Product Quality</td>
<td>Decrease</td>
<td>Increase</td>
</tr>
<tr>
<td>Machine Downtime</td>
<td>Not Affected</td>
<td>Decreased</td>
</tr>
<tr>
<td>Cycle Time of Product</td>
<td>Decreases</td>
<td>Decreases</td>
</tr>
<tr>
<td>Budget</td>
<td>Over</td>
<td>Over</td>
</tr>
</tbody>
</table>

*Figure 25: Potential Outcomes*

The figure 20 is a closer look to solutions one and three from a different point of view. The team chose between negative, moderate, and positive for different associate’s reactions for the potential outcome. Also, optimize prime selected decrease, increase, over and not affected for more quantitative outcomes. The results of this graph show that in overall employee’s reactions are more favorable for solution 3 to happen. On the quantitative side we can assume that solution three offers a better coverage for quality and safety purposes. Also, the turnover rate will be higher for the new machines been installed versus increasing the production.

**VIII. CHAPTER EIGHT: RESULTS**

According to TNA seasoning machines average working rate is around 3,539 lbs./hr. working on the maximum safe capacity. After running the operations for 21 hours a day 5 day a week, the new amount the machines will be able to produce per day will be approximately 70,000 / 74,1430 Lbs. in a regular week. Versus the 56,000 pounds they produce on average right now. This will represent having an increment in production of an average of 25% with the extra benefit of being able to produce multiple flavors at the same time. Solution number three is feasible and the numbers motivate the need to implement the solution. Optimize Prime considers the solution can be implement in the first four lines to see how workers interact with the learning curve and how management gets use to handle the extra capacity. Doing changes in small terms can be more beneficial for the whole process, dramatical changes in operations can cause more problems than improvements. We strongly suggest the invest on this new seasoning system that will raise quality and production to the company.
XX CHAPTER TWENTY: CONCLUSIONS AND RECOMMENDATIONS

The main idea of this project was to improve cycle time of the product as well as improve inefficiency in production. We wanted to come up with a solution that can save them time and money while being able to increase quality and customer satisfaction. Rudolph Foods struggled with overcapacity and production rates. They simply were not able to speed up production or the amount of time an order could be shipped out. The warehouse was overstocked, and orders were left waiting on more product to come in. This frustrated all employees including managers and operators.

To begin, we toured the facility and learned how their process worked beginning to end. Fully understanding the process and the steps needed to get raw material made into the final product and out the door to the customer was essential in being able to start this project. We made our visits count and stayed if we could gather as much data as possible. We shadowed different employees and watched them do their job as well as had conversations with them about the process. We specifically shadowed a fryer, packager, palletizer, transporter, order picker, and shipping employees to fully understand their job roles and overall process. Conversation with the employees were most beneficial especially since they provided feedback only experienced operators and workers can provide. They know the process better than most and their insight was helpful. They explained how the speed of production was just not up to par with the demands they were receiving. The employees also explained how there was frustration due to the equipment and machinery that being used. Another complaint was about how the warehouse was overcrowded and order were not able to be sent out in adequate time considering there is never enough product.

After careful evaluation of all the problems occurring within their production site and warehouse, we came up with three possible solutions that could potentially solve some if not all their problems.

- Solution 1: Produce 10% more of the amount of lbs. pork rinds needed
- Solution 2: Expansion of Plant to new bigger location
- Solution 3: Add seasoning tumbler machines to each individual line

Our first solution suggests that in order to have orders go out in a timely manner and avoid having to hold it we could increase the number of lbs. needed for the week by 10%. We believe that by doing so, there would be a surplus of product available to be able to fill up orders. This way whenever there is an unexpected order that needed to be squeezed in the current week or quality control decided to hold back on a couple cases there is still product available to finish out existing and new orders for the week. The problem here would be loss of inventory considering the 90-day expiration dates on the products. Waste and space are the biggest issue there. The second solution would provide a bigger space to be able to store more product in an organized manner. The possibility of adding in more machines would help in keeping up with production demands as well. While this seems to be able to solve most of the problems, it would be a very big project to tackle and a big investment that Rudolph Foods would have to make. The company would have to stop
production completely to be able to move everything. The company would also have to invest in a bigger facility.

Based off the weighted Criteria Matrix and the Cost Analysis of the three solutions, the third solution was chosen as the best option. Adding individual machines to each line helps decrease downtimes. When the company was ready to change over in their current process, it took them over an hour to complete the change to a new seasoning flavor considering they had an entire cleaning process due to the one big seasoning tumbler at the beginning of the process. Adding individual tumblers to each line towards the end of the process reduces downtime to only 10 minutes while changing over. The tumblers are light weight and easy to change out. Different seasonings can be running at once considering individual tumblers and if there was ever a shortage in product, one line could stop production and changeover and not affect the other 8 lines. While this option puts us over budget, it is the option that makes more sense and saves them the most time and money in the long run. Many factors supported this conclusion as shown earlier in the report.

**Recommendations**

- Optimize Prime believes that for this project to succeed the company must be willing to invest money. There would not be any significant improvement at the production process if they do not compensate the costs involved, potential loss of customers might get compromised if the company do nothing about this.

- The 5’s lean methodology must be implemented together with solution number three in order to succeed. A lean mentality process will be tied together with obtaining the desire results. It will help management to identify where there has been waste and we know they do have.

- We recommend of doing a five S workplace diagnostic checklist (see image 24 for reference) it is a good way to keep track of all the different items they must focus every day. It has room for a rating level that will keep scores of their overall performance.

- The team understands how working on a daily operation makes it harder for management to find solutions in a bigger scale, that is why we have done the pertinent analysis to help the company achieve their goals. Teamwork is a strength that can have great results in the manufacturing environment.

**Additional problems identified**

During our visit at the factory and talking with different associates we identified they also had some other problem in a second scale degree. Such as labeling, training and forklifts routes. The first of this problems as mentioned before, is an issue that is related with a missing lean mentality in the whole system within the organization. After the pallets are wrapped they worker only have a standart way of pasting the labels for a specific client they have, while the rest of the order the labels are pasted in a more random selection. The problem is that when the product gets to the warehouse is hard for the forklift drivers to quickly identify what produc is inside and what costumer’s order is. Not only the location of the label could be anywhere but also the ID number of the item varies a lot between customers making it even more confusing. Oprimize Prime
recommendation for this issue is again implementing a 5s strictly for packaging and labeling. Where they create a standard label and a standard location for them as well.

The second additional problem identified was the factory does not have a proper training program at all for the floor employees. Based on management experience, they are training the worker “on the spot”. Having untrained workers can cause several consequences on the production side of a company as well of the safety side that involves that. A proper training program must be developed in order to fix this issue, one of the managers said they were implementing a strategy between physical and online classes for their workers but the idea was not being consolidated at the time.

The last additional problem identified was a missing forklifts drivers route. At the factory’s small storage the drivers go between the finished pallets and the loading ducks without any designated route labeled on the floor. This causes that sometimes a walking employee could be on the way of the driver and even thought they have not have any accident it is a clear potential risk for safety. In addition workers used their ear protectors that makes it harder for them to know if a driver is coming into their way. Optimize Prime believes this particular issue can be fix in a short term by labeling a “sidewalk” for drivers and to avoid potential contact with the walking personnel.

Optimize Prime will be more than happy to work together with Rudolph’s Food to implement all the proposals necessary to help them achieve their production, quality and safety goals.

![Figure 26: Five S workplace Scan Diagnostic Checklist Example Retrieved from ASQ](image-url)
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APPENDIX A: ACKNOWLEDGEMENTS
Optimize Prime would like to say special thanks to all the Rudolph’s Foods associates and management that helped us during our senior design project. All the information provided we used the best we could and, they gave us a nice tour into their facilities as well. The team would like to thank Dr. Khaled for all his help and for his patience during this period we are all facing with the global pandemic. Without their help this project would not have been successful to finish.

APPENDIX B

<table>
<thead>
<tr>
<th>Name</th>
<th>Email</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nelson Farfan</td>
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<td>(678) 301-0332</td>
</tr>
<tr>
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<td>(419) 302-7018</td>
</tr>
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<td></td>
</tr>
</tbody>
</table>

APPENDIX C

Reflections

Nelson Farfan: This project opened my eyes a lot and it helped to visualize what an Industrial Engineer can do. Been able to visit the factory was one of my favorite parts of the project and been able to see all the operations running. I also learned how to analyze data in a way that makes more sense in the competitive world we live. Working in teams can be very hard sometimes but teamwork is important for most organizations and we must work with that in order to have a successful career.

Arturo Rodriguez: it was a pleasure to work with the team I have learn so much more about production in general and thanks to Tony from Rudolph’s that helped us get the information we need it. I hope to use this learned tool in future projects and for my engineering jobs.

Fahd Sharfuddin: Getting together to do a project for Rudolph’s was very fun and interactive, also I would like to thank Kennesaw State university, the department of Systems and Industrial engineering and Dr. Khalid for all their support. Overall, it was a nice experience!

Jackson Botti: Overall great experience to work in the senior design project. I have worked in different project in the past, but each project gets more serious and complicated when you go through the engineering life. I wish the best of luck for all the team members and hope to see them on the floor!
APPENDIX X