A Case Analysis on Productivity Improvement: Reducing Operating Costs by Increasing Efficiency at a Flora Company

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This paper discusses issues and their resolutions with regard to operational planning and procedures in one of the most labor intensive businesses in California, namely that of cut flower manufacturing. Issues of productivity improvements, packaging and layouts are addressed. A spreadsheet template is developed for improving planning and scheduling.

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I. INTRODUCTION

A California company, which we will call Coastal Flora (CF), was established in 1973 and has become a leading grower, supplier, and distributor of fresh cut flowers in the Western United States. CF's major processing facility is located in northern San Diego County and ships to customers in Southern California, Arizona, Utah and Nevada. CF's customers are mainly large chain stores such as Albertsons, Costco, Kroger, and Trader Joe's who only remain competitive in their markets by keeping their prices low. This demand for low prices has forced CF to reduce operating costs, and because the production process at CF is labor intensive, management constantly seeks ways to streamline processes and improve efficiencies in its production facility. The cut flower industry has an annual impact of $10 billion and $780 million on the economy of the State and San Diego County, respectively. California accounts for 77 percent of the US total of cut flowers with more than $320 million (wholesale value) annually, to florists, supermarkets as well as to numerous kiosks and outlets. Moreover, the floral bouquet manufacturing process is very labor intensive – in San Diego County wholesalers and retail florists contribute directly to the creation of over 7,000 jobs (Chambers, 2009; Carman, 2010, Commodity Fact Sheet, 2012).

II. PROJECT OBJECTIVES AND METHODOLOGY

CF's facility in San Diego County currently employs over 300 employees to receive and store raw materials, manufacture bouquets and floral arrangements, as well as provide other support and administration functions. Typically, tables are setup before the start of the actual production. During the set up time, the production requirements and the bouquet bill of materials are placed on each table. Based on the requirements, runners place the raw materials (e.g., flowers, fillers, flower food, wraps) on the tables and then replenish them throughout the day as needed. Bouquets are manufactured using different techniques based on the number of the stems in each bouquet. Some are individually assembled, others are put together by an assembly line, and yet a few others use some combination of the two techniques. The assemblers pick the stems based on a bill of materials, prepare the bouquet, cut the stems to the desired length, use rubber bands to tie the stems, wrap the bouquet, place the flower food on the stems of the bouquet, and then place it in a bucket. When a bucket is full, it is sent to the packaging department where the bouquets are prepared for final shipment to the customer.

To improve CF's operations and determine where production processes can operate more efficiently and reduce labor expenditures as a percentage of sales the project was divided into the following four areas:

1. Identifying improvements and balance work between production and packaging areas
2. Creating a standardized flower assembly process for each order type
3. Eliminating process waste in the production area
4. Improving the inventory in the production area

2.1 Line Balancing – Methodology, Results and Analysis

The data collected by CF was analyzed to identify reasons for the bottleneck in the packaging area. The analysis began by calculating the average number of boxes produced per hour per table. The packaging workers were then observed to determine the average number of boxes packaged per hour by each worker. When the number of boxes produced is greater than the packaging capacity a backup occurs; if the number of boxes produced is less than the packaging capacity there will be underutilization of packaging labor. Both situations result in an increase in labor costs per box packaged. Based on analyses of the production data and the observations of the number of boxes packed per hour in the packaging department, it was discovered that the production area was producing buckets faster than the packaging department could pack. Table 1 is an example of boxes produced and packaged during eight full production days in October. The average boxes packed per hour were approximately 125 boxes per person.

Table 1 - Boxes Produced vs. Boxes Packed

Full Production Date	**10/8/**	**10/9/**	**10/12/**	**10/13/**	**10/14/**	**10/15/**	**10/16/**	**10/19/**
Total Number of Boxes Produced	2188	2973	1725	2577	2998	2710	2865	1971
Total Number of Boxes Packed	2000	2000	2000	2000	2000	2000	2000	2000
Delta	188	973	-275	577	998	710	865	-29

To balance the line, the existing production data was used to develop a customized forecasting tool; Appendix A shows a screen shot of the tool. This tool helps CF plan daily production by table and forecast potential backups in the packaging department by hour based on the orders being produced. The inputs for the tool are the table name, product name, number of bouquets in the order, number of bouquets packed per box and number of workers packing boxes. The tool uses CF's data to schedule production throughout the day and then compute the number of boxes that will be produced per hour based on the planned production schedule. If needed, CF can add workers to the packaging department to eliminate bottlenecks or remove workers to eliminate the under-utilization of the packaging workers.

At the time of study, CF was experiencing substantial overtime costs in the packaging department. Because the tables were producing more boxes than the packaging department could handle, the packaging workers were staying late to finish packing the orders. By using the forecasting tool, CF was able to balance the work between packaging and production departments. This balance was estimated to save approximately $66,000 in annual overtime costs in the packaging department (this assumes nine production workers, at $14.00 per hour, 1.75 hours of overtime, 300 days per year). This approach was also more practical than the model developed by Caixeat-Filho et al. (2002), who developed a linear programming model for revenue enhancement in production of lily flowers. Other and more complex models with applications in agriculture can be found in the extensive work by Valenzuela (2008). Zhang and Wilhelm (2011) provide a comprehensive review of decision support models for nursery and floriculture crops along with other agricultural products.

2.2 Standardization - Methodology, Results and Analysis

CF's data for the months of September and October were evaluated to find the most efficient production table. To keep the data consistent, CF assigned the employees to a production table where they worked every day during this time period. Based on the data, the average number of stems assembled per hour by the different tables for each of the three stem count categories were calculated: stem count under 10, stem count between 10 and 19, and stem count more than 20. Table 2 shows the average stems per hour by each production table. Appendix B shows the raw productivity data used to calculate this information.

Table 2 Average Stems per Hour by Table

Table Name	Stem Count more than 20	Stem Count between 10 and 19	Stem Count less than 10
Daisy	448.94	424.62	328.66
Dhalia	498.22	619.34	328.73
Gerbera	467.10	405.45	276.62
Gladiolus	407.91	453.13	308.36
Iris	420.12	448.28	289.98
Lisianthus	535.20	523.28	303.48
Margaritas	437.84	455.73	296.22
Orquidias	460.07	371.05	291.95
Pompons	476.99	467.60	317.99
Safari Sunset	532.66	560.75	356.79
Stargazer	425.79	447.63	290.77

A one-way ANOVA analysis was conducted to determine if there was a difference in the means of the average stem count for each table, as well as among the three stem count categories. The results suggest that the means of the average stems assembled per hour by the different tables are statistically different. Furthermore, the means of the average stems assembled per hour are different among the three stem count categories (see Appendix C for details).

To reduce the difference in the mean of the average stem count within the same stem count category, it is necessary to standardize the bouquet manufacturing processes. As the Table 2 shows, when the bouquet has less than 10 stems, the three fastest tables are Safari Sunset, Dhalia and Daisy. For stem counts between 10 and 19, the three fastest tables are

Dhalia, Safari Sunset and Lisianthus, and for stem counts of more than 20, the three fastest tables are Lisianthus, Safari Sunset and Dhalia (see Appendix D for the details).

It could be assumed that tables are assembling the bouquets faster by compromising the quality. To ascertain if production speed and the bouquet quality were related, a correlation analysis between the table's rate of bouquet assembly and its corresponding quality issues was conducted. The most common quality issues were: raw materials being stacked too high on the production table; stems not cut to the desired length; incorrect location of the flower food on the bouquet; incorrect location of the plastic sleeve; and the number of stems in the bouquet being different from the recipe. From the quality data collected by CF, the cumulative percentage of quality defects by table was tabulated. Then the table ranking based on the average stems assembled per hour and their corresponding quality defect percentages were computed for the following four different scenarios:

Scenario #1: Correlation analysis between the average stem produced per hour ranking for the stem count category under 10 and non-compliance percentage

Scenario #2: Correlation analysis between the average stem produced per hour ranking for the stem count category between 10-19 and non-compliance percentages

Scenario #3: Correlation analysis between the average stem produced per hour ranking for the stem count category more than 20 and non-compliance percentages

Scenario #4: Correlation analysis between the overall average stem produced per hour ranking and non-compliance percentages

The results for the various scenarios are summarized in the Table 3 (see Appendix E for details).

Table 3 Correlation Analysis

	Multiple R	**R Square**
Scenario #1	0.089	0.008
Scenario #2	0.224	0.050
Scenario #3	0.179	0.032
Scenario #4	0.064	0.004

The results of the correlation analysis showed a very low multiple R and R Square, which means that there is no statistical correlation between the rate of production and the quality of the bouquet produced for these tables.

The assembly techniques for the three most efficient tables were used on random production tables to determine the best assembly technique for the different stem count category, table set up and the number of people at each table. Time samples were recorded for each technique. The explanations of the techniques are given below:

<u>Technique #1</u>: To assemble the bouquet the workers used an assembly line method. All items needed for bouquet assembly were placed in sequential order on the production table. The first worker gathered their portion of the bouquet and passed it to the next worker until the bouquet reached the second to the last worker. The second to last worker in the assembly line completed the arrangement of the bouquet, cut the stems to the desired length, used rubber bands to tie the stems of the bouquet, and stacked the bouquets next to the cutter. The worker at the end of the assembly line wrapped the bouquet in the protective plastic sleeve, taped the flower food, and placed the finished bouquet in the bucket.

Technique #2: All items needed for bouquet assembly were placed in sequential order on the production table. Each worker, except one finisher, was individually responsible for gathering all the flowers to make one bouquet at a time. The workers individually arranged the bouquet, cut the stems to the desired length, used rubber bands to tie the stems, and stacked the bouquets next to the cutter. The finisher wrapped the bouquet in the protective plastic sleeve, taped the flower food, and placed the finished bouquet in the bucket.

Technique #3: This technique was only measured at a table on the side where there are four workers. The workers were split into teams of two. Each worker was individually responsible for completely assembling one bouquet at a time. All of the workers arranged their bouquet, cut the stems to the desired length, used rubber bands to tie the stems of the bouquet, wrapped the bouquet in the protective plastic sleeve, taped the flower food, and placed the finished bouquet in the bucket.

Technique #4: This technique was only used at a table on the side where there were four workers. The workers were split into teams of two; one assembler and one finisher. The assembler arranged the bouquet, cut the stems to the desired length, and used rubber bands to tie the stems of the bouquet. The finisher wrapped the bouquet, taped the flower food, and placed the finished bouquet in the bucket.

Once the data sampling was complete, the average time it took the table to complete different bouquet sizes using different techniques was calculated. The average assembly times were compared for each bouquet size to determine the most efficient assembly method for each bouquet. When the stem count was more than 20, technique #1 and #2 were compared as technique #3 and #4 were not tested because of the limited table space. The average time for assembling bouquets with stem counts greater than 20 using technique #1 was 151 seconds. The average time for assembling similar bouquets using technique #2 was only 114 seconds. A two-sample t test was conducted and it was found that the averages of the two techniques are statistically different. This means assembling one bouquet with 20 or more stems using technique #2 is statistically significantly faster than using technique #1 (see Appendix F for details).

When bouquets with stem counts between 10 and 19 were produced, CF utilized two different layouts. If a “combo box” was being produced, the production table was split and techniques #3 and #4 were used (a combo box is a box containing up to four different bouquet variations). If a regular box was being produced, the table was set up by arranging all the raw materials throughout the entire length of the table and techniques #1 and #2 were used. All four techniques were tested on randomly selected tables. Average times were calculated for assembling a bouquet; it took 56 and 46 seconds, respectively, for using techniques #1 and #2. A two-sample t test was conducted and it was found that the averages of the two techniques are statistically different. This means assembling one bouquet with a stem count between 10 and 19 using technique #2 is faster than using technique #1 (see Appendix F for details).

Average times for assembling a combo box bouquet using techniques #3 and #4 for stem counts between 10 and 19 were 49 and 48 seconds, respectively. A two-sample t test was conducted and it was found that the averages for the two techniques are not statistically different. This means that assembling one bouquet with a stem count between 10 and 19 using technique #3 is not faster than using technique #4 and vice versa (see Appendix F for details).

Techniques #3 and #4 were tested on randomly selected tables that were assembling bouquets with stem counts less than 10. Techniques #1 and #2 were not tested because these techniques require the raw materials to be arranged along the entire length of the table. When the stem count is low this requires the workers to walk the entire length of the table to make one bouquet and this walk is a non-value-added activity. The average times for assembling bouquets using technique #3 were 39 seconds and 36 seconds using technique #4. A two-sample t test was conducted and it was found that the averages for the two techniques are not statistically different. This means that assembling one bouquet with a stem count of less than 10 using technique #3 is not faster than using technique #4 and vice versa (see Appendix F for details).

When a regular box was produced all the raw materials were arranged along the length of the table, irrespective to the number of stems in the bouquet. This type of table setup is the major reason for the low average stems per hour when the stem count is less than 10. All of the production tables are the same size. As the stem count of the bouquets increased the raw materials were stacked very close together because of the lack of space on the table. When this occurs the assemblers do not need to move laterally to pick up the flowers. However, when the numbers of stems in the bouquet were less, more space was left between the stacks of raw materials on the production tables and the assemblers had to spend time moving laterally in order to assemble one bouquet. Figure 1 shows a table set up for eight stems; and Figure 2 shows a table set up for production of a bouquet of 22 stems. The recommended techniques for the different stem categories are summarized in Table 4.

Figure 1 - Table Set up for an 8 stem Bouquet

Figure 2 - Table Set up for a 22 stem Bouquet

Table 4 - Recommended Techniques for the Stem Count Categories

Stem Category	Recommended Technique
More than 20	2
Between10-19: Regular	2
Between10-19: Combo Box	4
Less than 10	4

For stem counts of more than 20, it is recommended that CF utilize technique #2. The reasons for the time differences between techniques #1 and #2 are wait time, flower location, and hand size of the assemblers. The production workers experienced wait times while using technique #1. Some assemblers produced the bouquets faster than others. The faster assemblers had to wait for the slower assemblers to complete his or her share of work. The wait time was generally between two and five seconds for each bouquet. When the wait time is aggregated for the entire production day and for all the tables, it results in substantial nonproductive time.

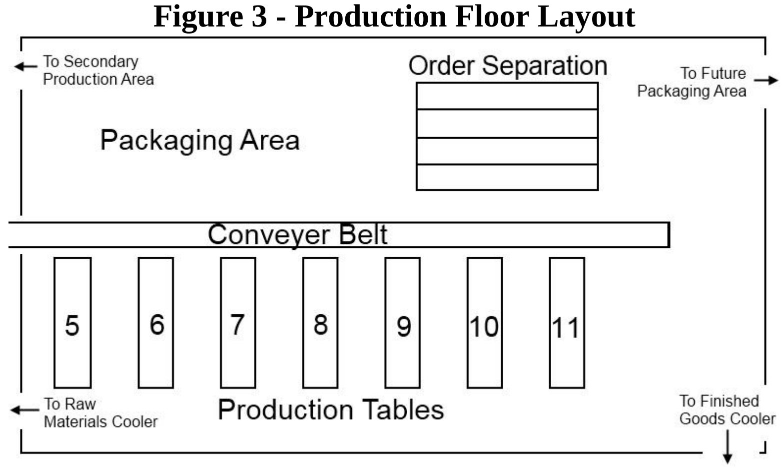
2.3 Process Waste - Methodology, Results and Analysis

There are three major stages in the production process: set-up, bouquet manufacturing, and end of day. All three stages were first observed to determine the "normal" processes that occurred each production day. These observations identified the process requirements for each stage in the production day. Next, each stage was monitored to document inefficient or out of sequence or non-value-added activities in bouquet assembly or quality tracking processes.

After the process waste for each stage of the production day was determined, the duration for each of the processes was recorded. The time data was used to create a cost estimate for each process waste that occurred at each stage of production. To create a cost estimate a high, medium, and low frequency of occurrence for each individual process waste was estimated. The average labor rate for production workers and frequency of occurrence was applied to each time estimate to create a low, medium and high cost estimate for each process. The cost estimate shows the best, worst and most-likely potential cost savings from removing or improving process waste in each stage of the production process.

Set up begins before the assemblers and the majority of the runners arrive. The racks of flowers were brought out by the pullers and stored just outside of the raw materials cooler. During set up a runner placed flowers on the tables based on the first orders of the day. Figure 3 shows a diagram of the production floor. The flowers are placed on tables in no systematic order. For example, the runner may start at Table #5, then set flowers on Table #9, and continue on to Table #6. Time is wasted as the runner made unnecessary movements across the production floor.

Figure 3 - Production Floor Layout



Occasionally, the runner left the production area to pull more racks of flowers from the area just outside of the raw materials cooler. Some of the runners did not know all of the flower types or could not match the color of the flowers that needed to be put on the tables with those specified in the bill of materials. The runner often left their assigned production table to ask another employee for assistance identifying flowers.

The table leads read through the recipe for the first order of the day. Production workers organized flowers on the tables and cut the ties off the bundled flowers. Most of these flowers were unpackaged, but some remained in cardboard boxes and in protective plastic sleeves (see Figure 4 for an example of boxed flowers on the production tables).

Figure 4 - Boxes of Flowers on Production Table

Production workers cut open the boxes and removed any protective plastic sleeves. As the production tables were replenished with flowers for orders throughout the day, they occasionally received product that is still in boxes and protective sleeves. This was another occurrence of waste for the production workers because they had to stop assembling bouquets to remove the flowers from their packaging. Also, when flowers were removed from boxes in the production area, there was an increased amount of trash in the production area. This caused the runner to spend time breaking down the boxes. Anytime the runner was too busy to assist the production tables, the table lead left the production table, which caused the table to operate with one less bouquet assembler.

The production tables need to be restocked with flowers frequently. The restocking is required because stacking flowers too high on the tables can cause damage to the products. The bouquet assemblers asked their runner to replenish the flowers. Occasionally, the flowers required for an order were not on the rack located directly next to the production table in need. The runner traveled distances of up to 72 feet in the production area to retrieve the flowers necessary to complete the order. Frequent trips to the raw materials cooler were being made throughout the day. The runners or pullers only retrieved small amounts of flowers in each trip to the raw materials cooler.

CF uses the two-way radio to allow employees to contact one another. However, this tool was not used by table leads to contact runners. A lack of immediate communication between these groups caused increased nonproductive time by the production workers.

There is an automatic cutter on one end of the table and a manual hand cutter on the other end. When regular box orders are produced, only the automatic cutter is utilized. For smaller bouquet sizes the tables were split in two, which required the hand cutters to be used at one end of the production table. The hand cutters caused a large amount of debris to pile up at the table and the debris needed to be cleared periodically. Timing of the two cutters showed using the hand cutter requires 400% more time than the automatic cutter and required the use of a ruler on the table to determine the correct length. Using the ruler on the table was difficult for workers because it was often covered by the flowers on the tables. This caused an increase in likelihood of cutting the bouquets at an incorrect length.

There were different quality issues that occurred at production tables and in the packaging area. Quality control workers monitored quality at two different checkpoints. One checkpoint was at the production tables. The quality control worker in the production area audited one to three tables at a time for a series of quality issues. If the quality of the bouquets at these tables was below par, the bouquets were reworked to improve quality. When the quality supervisor audited a production table they wrote their findings on a small piece of paper and then later traveled to their workstation to fill out a quality control form. This data was later fed into the quality control system. Daily reports were created from the quality control system. When reports were shared with a production table, the production workers often did not pay attention to the table lead as they explained the previous quality errors. A quality board was updated monthly and displayed outside the production area. The quality board displayed an outline of the percentage of quality defect occurrences at each table.

In packaging, a quality control worker checked the quality of all orders and returned any unacceptable bouquets to the production area for rework. Defects observed in packaging were not tracked and were not part of the quality report given to each table or the quality board displayed outside the production area. At the end of the day, the production workers removed all remaining raw materials from the production tables and placed them back onto the racks. The runners temporarily stored the racks in the finished goods cooler before they were returned to the raw material cooler. Damaged raw materials were discarded. Any pieces of flower or stem remaining on the tables were swept onto the floor. The production workers swept debris from under the rubber floor mats into piles. Not all debris was removed at this time. The piles of debris were discarded in the trash. All of the production workers left and a separate crew of cleaners arrived. The cleaners removed the rubber floor mats and leaf blowers were used to remove the remaining debris.

Table 5 is a summary of observed or estimated time for each process waste that occurred during the three stages of production.

Most non-value added activities occur several times a day. From the list above a cost estimate was created, which is shown in Table 6.

To standardize the set up process, CF has to train its employees properly. Since CF did not have a documented set up process, a checklist was created to assist the employees and it can be found in Appendix G.

All employees should be trained on flower types as well as different color varieties to reduce time wasted asking other employees for assistance. To reduce time wasted on finding flower food packets and rubber bands during the production day, a smaller bin should be used on the tables. The current bins are too large and are not being utilized by most production tables because they are difficult to reach. This bin should be small enough and light enough for production workers to pick up and remove its contents.

The production set up time can be reduced by preparing the tables the afternoon before with all items except the flowers. CF knows the production schedule for the following day, which means the required flower food packets and rubber bands could be stocked on the tables the afternoon before. Restocking the previous afternoon and using the new bins would cut down the amount of time wasted trying to find flower food packets and rubber bands during production.

A form was developed to track quality both at the production tables and in the packaging department. The form tracks the occurrence of quality issues and the reason for the occurrence of rework (see Appendix H). It is recommended that the quality control employees fill out the quality control sheet while they are observing the quality issues in the production or packaging area. Doing this helps CF track all of the quality issues efficiently and reduces the possibility of quality issue tracking errors.

2.4 Inventory- Methodology, Results and Analysis

To manage inventory in the production area CF uses a colored bucket system to store the excess, damaged, and questionable flowers. Damaged flowers that needed to be thrown away are placed into red colored buckets; if a worker is unsure if a flower should be discarded she places it in a yellow colored bucket. If there is excess inventory when an order is completed, the production workers place the reusable flowers in a green bucket. A quality control worker examines the flowers in the yellow buckets to determine if they should be discarded or reused. The quality control worker reviews the type and quantity of flowers in the red buckets and discards the flowers and records the type and quantity of discarded flowers from the inventory management system.

The cardboard boxes placed under the tables were the biggest issue in tracking inventory in the production area. While the boxes were meant for greens only, in many instances the production workers place flower stems in them (this is shown in Figure 5). Neither the greens nor the flower stems placed in the cardboard boxes are counted and removed from the inventory tracking system. The contents of the boxes are discarded without being evaluated by the quality control personnel.

Table 5 - Process Waste

Process Waste	**Set Up**	**Production**	**End of Day**	**Times per Occurrence**
Bringing of broom and rake to tables in the morning	X			11 sec
Setting up of colored buckets	X			4.5 mins
Setting up of garbage cans	X			Necessary waste
Repeated small trips instead of combining for setting up (i.e., Inventory to production, onto the tables, and sleeves)	X			25.6 sec each
Not all pullers appear familiar with flower names	X			13 sec
Recounting of sleeves	X	X		144 sec
Piles of flower preservative not where needed	X	X		34 sec
Unopened boxes of flowers	X	X		442 sec
Flowers still in plastic wrap	X	X		399 sec
Flowers not located next to tables that needs them	X	X		43 sec
Assemblers stop because they have run out of flowers		X		44 sec
Use of hand cutter instead of automatic cutter		X		1.2 sec
Hand cutting extra-long stems prior to bouquet assembly		X		1.6 sec
Box of mixed flower preservatives, forcing bouquet assemblers to sort through for the correct one		X		177 sec
Bouquet rework		X		96.6 sec
Break down boxes that had flowers in them		X		16 sec
Rearranging racks on the production floor		X		Necessary Waste
Runners grabbing more product from cooler in small batches		X		660 sec
Only few flowers in a bucket, grabbing one at a time		X		18 sec
Production workers bundling up leftover flowers and taking them to the rack instead of the runners		X	X	325 sec

Table 6 - Process Waste Cost Estimate

		Low			Medium			High		
Process	**Time Duration per Occurrence (sec)**	**Est. # of Occurrences**	**Total Amount of Time (Min)**	**Cost (Per Day)**	**Est. # of Occurrences**	**Total Amount of Time (Min)**	**Cost (Per Day)**	**Est. # of Occurrences**	**Total Amount of Time (Min)**	**Cost (Per Day)**
Bringing of broom and rake to tables in the morning	11.0	20	3.7	$ 0.54	20	3.7	$ 0.54	20	3.7	$ 0.54
Setting up of colored buckets	270.0	1	4.5	$ 0.66	1	4.5	$ 0.66	1	4.5	$ 0.66
Repeated small trips instead of combining for setting up (i.e., Inventory to production, onto the tables, and sleeves)	25.0	10	4.2	$ 0.61	15	6.3	$ 0.92	25	10.4	$ 1.53
Not all runners appear familiar with flower names	13.0	2	0.4	$ 0.06	5	1.1	$ 0.16	10	2.2	$ 0.32
Recounting of sleeves	144.0	10	24.0	$ 3.52	30	72.0	$ 10.55	50	120.0	$ 17.58
Piles of flower preservative not where needed	34.0	160	90.7	$ 13.28	240	136	$ 19.92	320	181.3	$ 26.57
Unopened boxes of flowers	450.0	20	150.0	$ 21.98	60	450	$ 65.93	120	900.0	$ 131.85
Flowers still in plastic sleeves	399.0	35	232.8	$ 34.10	100	665	$ 97.42	160	1064.0	$ 155.88
Flowers not located next to tables that need them	43.0	10	7.2	$ 1.05	50	35.8	$ 5.25	100	71.7	$ 10.50
Assemblers stopped due to running out of flowers	44.0	3	2.2	$ 0.32	9	6.6	$ 0.97	22	16.1	$ 2.36
Use of hand cutter instead of automatic cutter *	1.2	4200	84.0	$ 12.31	6000	120	$ 17.58	8000	160.0	$ 23.44
hand cutting extra-long stems prior to bouquet assembly	1.6	700	18.7	$ 2.73	1300	34.7	$ 5.08	2600	69.3	$ 10.16
Box of mixed flower preservative, forcing production assemblers to sort for the correct one	177.0	3	8.9	$ 1.30	6	17.7	$ 2.59	9	26.6	$ 3.89
Bouquet rework	97.0	280	452.7	$ 66.32	360	582	$ 85.26	400	646.7	$ 94.74

		Low			**Medium**			**High**		
Process	**Time Duration per Occurrence (sec)**	**Est. # of Occurrences**	**Total Amount of Time (Min)**	**Cost (Per Day)**	**Est. # of Occurrences**	**Total Amount of Time (Min)**	**Cost (Per Day)**	**Est. # of Occurrences**	**Total Amount of Time (Min)**	**Cost (Per Day)**
Break down boxes that had flowers in them	16.0	20	5.3	$ 0.78	60	16.0	$ 2.34	120	32.0	$ 4.69
Runner grabbing more product from cooler in small batches	660.0	4	44.0	$ 6.45	10	110	$ 16.12	16	176.0	$ 25.78
Only few flowers in a bucket, grabbing one at a time	18.0	10	3.0	$ 0.44	30	9.0	$ 1.32	60	18.0	$ 2.64
Bringing flowers back to coolers at end of day	900	5	75.0	$ 10.99	10	150	$ 21.98	15	225.0	$ 32.96
Production workers bundling up leftover flowers and taking them to the rack instead of the runners	325	15	81.3	$ 11.90	30	162.5	$ 23.81	50	270.8	$ 39.68
Totals per Day				$ 188.79			$ 377.84			$ 585.21
Totals per Year (300 day production year)				$ 56,636			$ 113,353			$ 175,563

Figure 5 Flowers in Cardboard Box

Occasionally, flowers were accidently broken off of the stem when the racks were pushed too close together by the runners. During production, the "empty stems" were discarded without being counted. This means that these stems were also not being removed from the inventory tracking system and were assumed to be lost product.

III. CONCLUSIONS AND RECOMMENDATIONS

While observing the line balance between production and packaging, it was found that the production tables were able to assemble bouquet orders faster than the packaging department could package them for final delivery. It was also found that production and packaging schedules could easily be adjusted to reduce or eliminate the bottleneck which was occurring in the packaging department. A forecasting tool was developed to assist CF with scheduling in its production and packaging areas. This tool allows CF to schedule each hour of the entire production day by table. The output then allows CF to forecast how many packaging employees will be needed to complete the packaging for each respective hour of production. CF production workers were observed assembling bouquet orders using a variety of techniques. This resulted in some production workers being less efficient than others. To create standardized processes for bouquet assembly, data was collected on the most efficient techniques for assembling bouquets. Because efficiency differed based on bouquet stem counts, different techniques should be used based on the bouquet's stem count. For bouquets with more than 20 stems, and regular boxes (a regular box is a customer order that does not contain multiple flower arrangements, colors, or flower types) containing between 10 and 19 stems; it is recommended that all items needed for bouquet assembly be placed in sequential order on the production table. Each worker, except the finisher, should individually be responsible for gathering all the flowers to make one bouquet at a time. The workers should individually arrange the bouquet, cut the stems to the desired length, use rubber bands to tie the stems, and stack the bouquet next to the cutter. The finisher then will wrap the bouquet in the protective plastic sleeve, tape the flower food and place the finished bouquet in the bucket. For combo boxes (a combo box is a customer order that contains multiple flower arrangements, colors, or flower types) containing between 10 and 19 stems and all bouquets with less than 10 stems, it is recommended that workers be split into teams of two; one assembler and one finisher. The assembler will arrange the bouquet, cut the stems to the desired length, and use rubber bands to tie the stems of the bouquet. The finisher will wrap the bouquet, tape the flower food, and place the finished bouquet in the bucket.

While observing the production floor, it was found that production workers and runners performed several non-value added activities throughout the day. In order to reduce and eliminate this process waste, recommendations have been made for set up, production, and end of day processes. A set up checklist was developed which requires employees to perform activities in sequential order, eliminating wasted time and energy between actions. A similar checklist was developed for end-of-day procedures to reduce time spent performing those activities. Additionally it is recommended that several activities which occurred at the beginning of the production day instead take place the evening before. This will allow production workers to concentrate on bouquet assembly rather than setting up the production table in the morning.

Small bins are recommended to reduce the time used to replenish the flower food packets and rubber bands necessary to assemble bouquets. Furthermore, racks of raw materials should be staged near the tables that require them to complete an order. Storing these racks in the correct location will reduce the time runners spend retrieving the raw materials needed by the production tables.

It was found that CF's lost inventory in the production area was due to poor tracking processes. A standardized inventory tracking form was created to assist the quality control employees in tracking disposed or reusable flowers. To improve the process of tracking inventory, it is recommended that the red buckets to be used to dispose of poor quality flowers be placed under the tables. Greens should also be included in the inventory tracking system and placed in the same red buckets when quality is poor.

Finally, aggregate data should be used when pulling flowers from the raw materials cooler. This will result in accurate amounts of raw materials being removed from the cooler. Flowers are perishable raw materials and can be damaged very quickly when they are left in the warmer production area and handled by the pullers, runners, and production workers. It is important to track inventory accurately and pull only the required amount of raw materials from the cooler to reduce the amount of inventory loss.

IV. ACKNOWLEDGEMENT

We would like to recognize the dedicated work by Vinoth Arunachalam, Tim Baron, Megan Fitzgerald and Jennifer Jensen, who participated in the data gathering, analysis and earlier drafts of this case study under the supervision of the authors.

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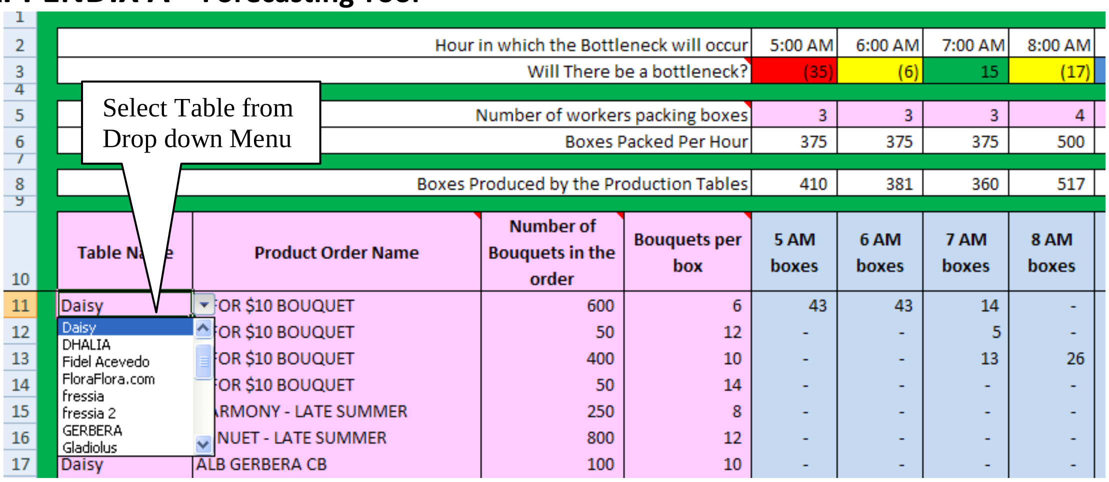
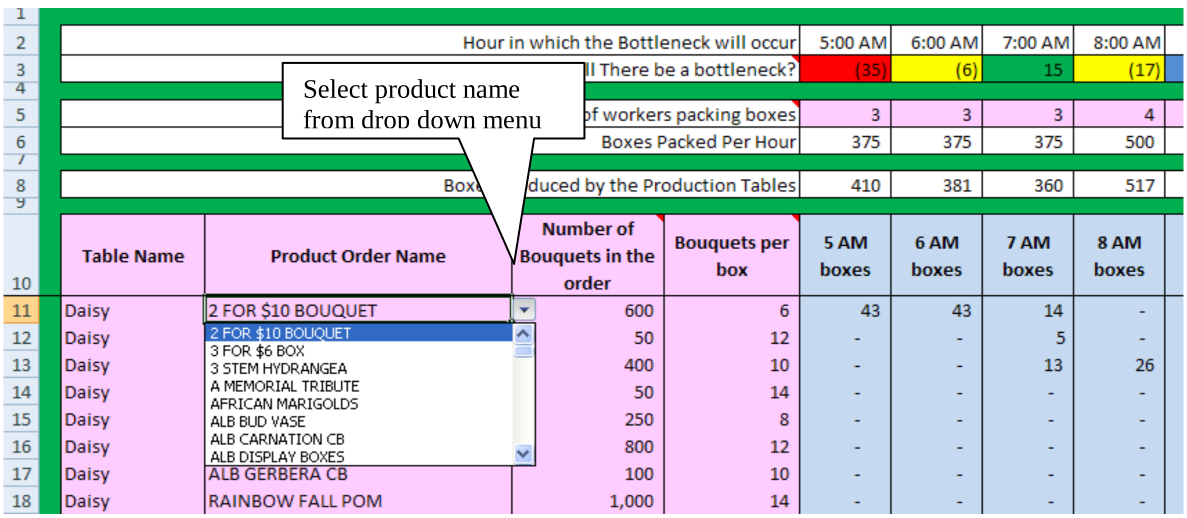
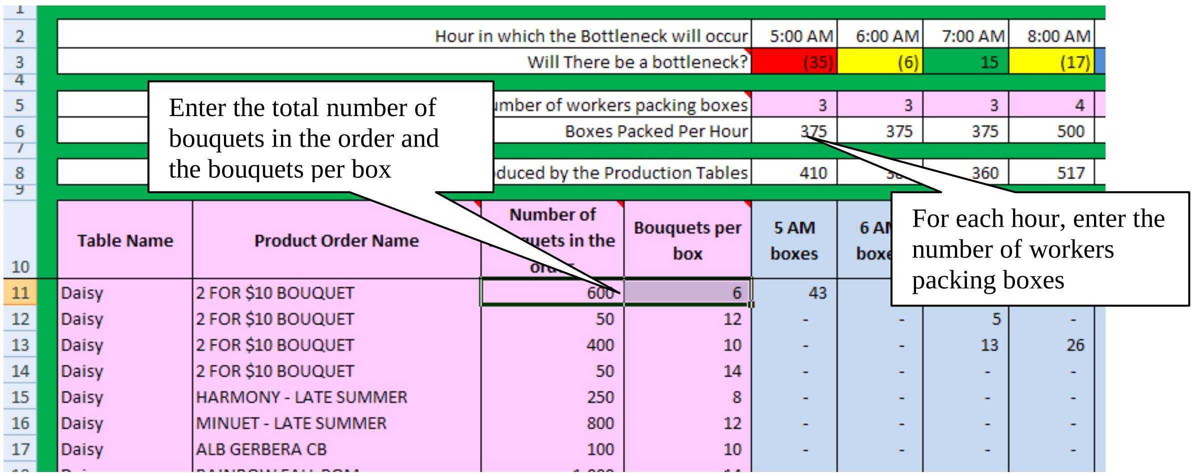
APPENDIX A – Forecasting Tool

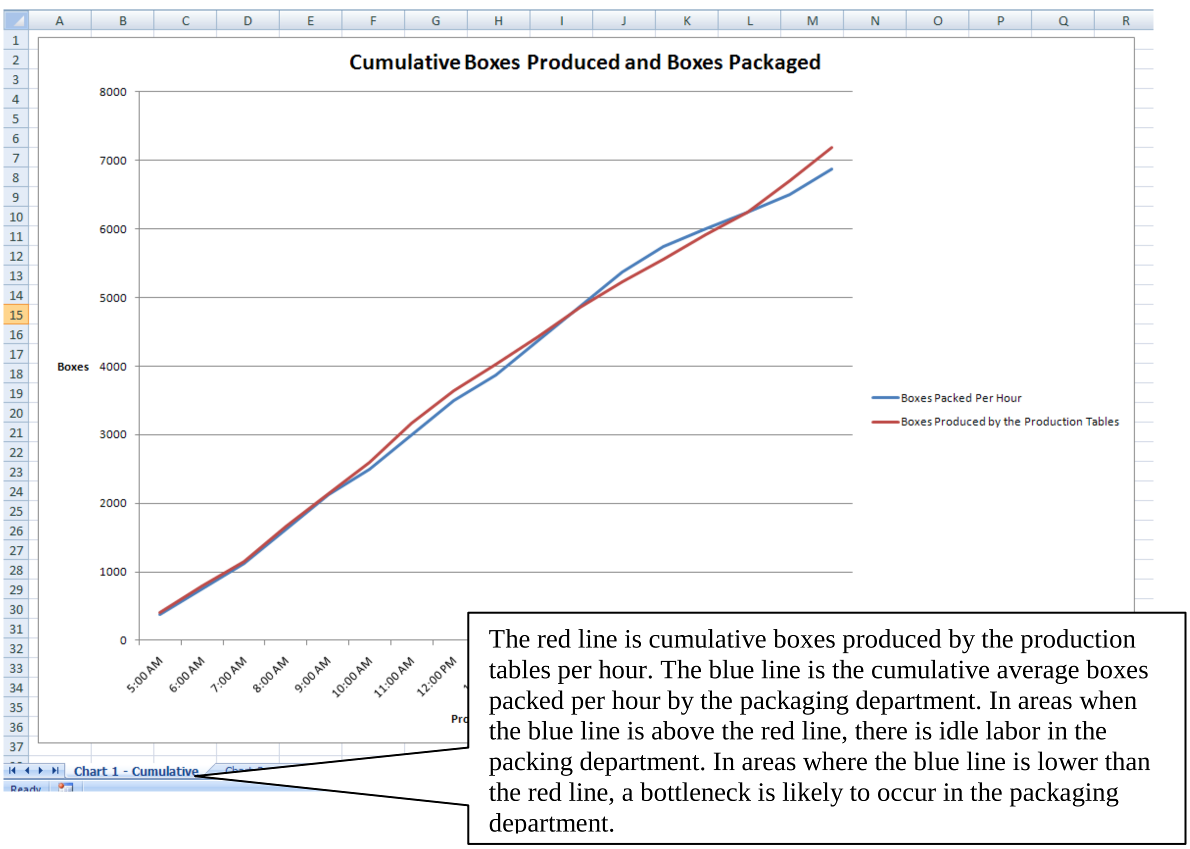


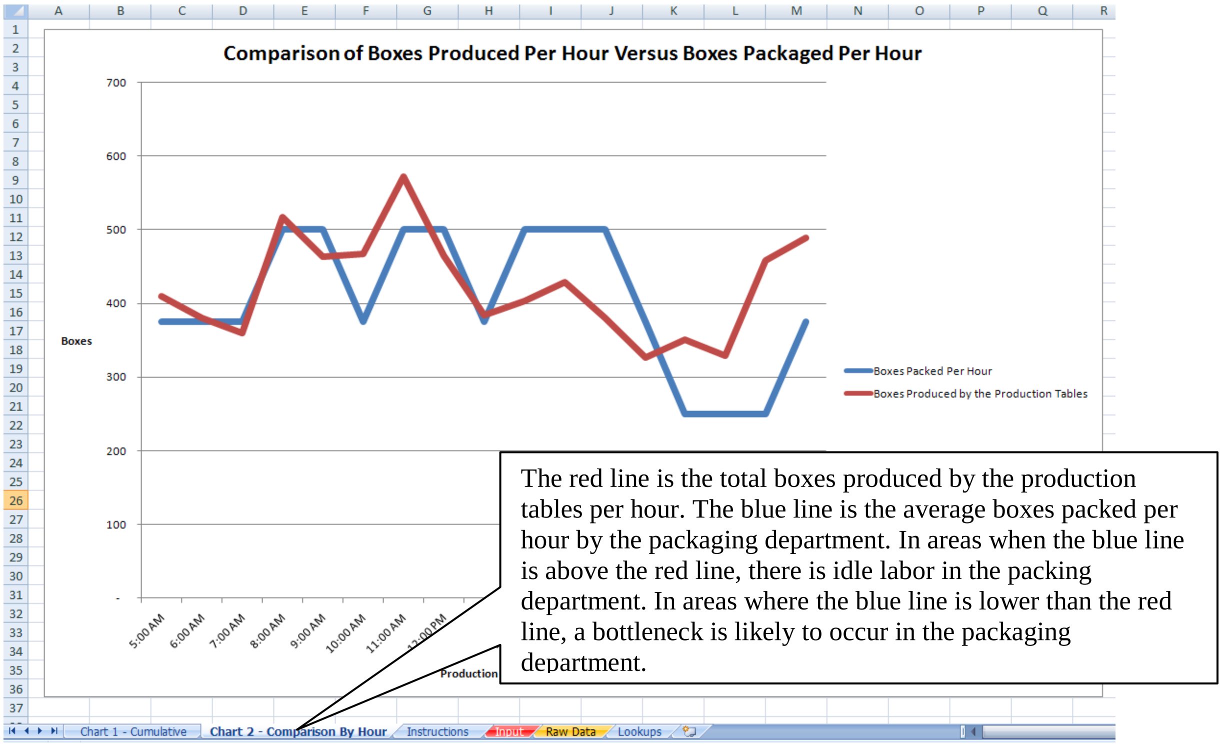
Row	Table Name	Product Order Name	Number of Bouquets in the order	Bouquets per box	5 AM boxes	6 AM boxes	7 AM boxes	8 AM boxes
2				Hour in which the Bottleneck will occur	5:00 AM	6:00 AM	7:00 AM	8:00 AM
3				Will There be a bottleneck?	(35)	(6)	15	(17)
5				Number of workers packing boxes	3	3	3	4
6				Boxes Packed Per Hour	375	375	375	500
8				Boxes Produced by the Production Tables	410	381	360	517
11	Daisy	OR $10 BOUQUET	600	6	43	43	14	-
12		OR $10 BOUQUET	50	12	-	-	5	-
13		OR $10 BOUQUET	400	10	-	-	13	26
14		OR $10 BOUQUET	50	14	-	-	-	-
15		RMONY - LATE SUMMER	250	8	-	-	-	-
16		NUET - LATE SUMMER	800	12	-	-	-	-
17	Daisy	ALB GERBERA CB	100	10	-	-	-	-



Row	Table Name	Product Order Name	Number of Bouquets in the order	Bouquets per box	5 AM boxes	6 AM boxes	7 AM boxes	8 AM boxes
2				Hour in which the Bottleneck will occur	5:00 AM	6:00 AM	7:00 AM	8:00 AM
3				ll There be a bottleneck?	(35)	(6)	15	(17)
5				of workers packing boxes	3	3	3	4
6				Boxes Packed Per Hour	375	375	375	500
8				Box… duced by the Production Tables	410	381	360	517
11	Daisy	2 FOR $10 BOUQUET	600	6	43	43	14	-
12	Daisy		50	12	-	-	5	-
13	Daisy		400	10	-	-	13	26
14	Daisy		50	14	-	-	-	-
15	Daisy		250	8	-	-	-	-
16	Daisy		800	12	-	-	-	-
17	Daisy	ALB GERBERA CB	100	10	-	-	-	-
18	Daisy	RAINBOW FALL POM	1,000	14	-	-	-	-


Hour in which the Bottleneck will occur
5:00 AM
6:00 AM
7:00 AM
8:00 AM
Will There be a bottleneck?
(35)
(6)
15
(17)
umber of workers packing boxes
3
3
3
4
Boxes Packed Per Hour
375
375
375
500
duced by the Production Tables
410
360
517
Enter the total number of bouquets in the order and the bouquets per box
For each hour, enter the number of workers packing boxes
Table Name
Product Order Name
Number of
Bouquets per box
5 AM boxes
Daisy
2 FOR $10 BOUQUET
600
6
43
50
12
5
400
10
13
26
50
14
HARMONY - LATE SUMMER
250
8
MINUET - LATE SUMMER
800
12
ALB GERBERA CB
100
10


Cumulative Boxes Produced and Boxes Packaged
Boxes
8000
7000
6000
5000
4000
3000
2000
1000
0
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
12:00 PM
Boxes Packed Per Hour
Boxes Produced by the Production Tables
Chart 1 - Cumulative
The red line is cumulative boxes produced by the production tables per hour. The blue line is the cumulative average boxes packed per hour by the packaging department. In areas when the blue line is above the red line, there is idle labor in the packing department. In areas where the blue line is lower than the red line, a bottleneck is likely to occur in the packaging department.


Comparison of Boxes Produced Per Hour Versus Boxes Packaged Per Hour
700
600
500
400
300
200
100
-
Boxes
5:00 AM
6:00 AM
7:00 AM
8:00 AM
9:00 AM
10:00 AM
11:00 AM
Production
Boxes Packed Per Hour
Boxes Produced by the Production Tables
The red line is the total boxes produced by the production tables per hour. The blue line is the average boxes packed per hour by the packaging department. In areas when the blue line is above the red line, there is idle labor in the packing department. In areas where the blue line is lower than the red line, a bottleneck is likely to occur in the packaging department.
Chart 1 - Cumulative
Chart 2 - Comparison By Hour
Instructions
Input
Raw Data
Lookups

APPENDIX B – Sample of Productivity Data

Date Finished	Hrs. Worked	Empl/Group	Workers	Product	Boxes	Units	Stems	Stems/ Hour	Task
9/15/2010 10:28	0.02	Orquidias	7	CONCERTO: EARLY FALL	17	51	1,377	9,836	House Made
9/28/2010 6:06	0.02	Safary sunset		LAGUNA BOUQUET	15	120	1,320	9,429	House Made
9/8/2010 5:10	0.03	pompons	8	SYMPHONY: EARLY FALL	33	99	2,178	9,075	House Made
9/9/2010 12:46	0.02	Lisianthus	7	COSTCO RAINBOW ROSE	15	45	1,215	8,679	House Made
9/24/2010 8:10	0.03	fressia	6	ALB BUD VASE	20	120	1,340	7,444	House Made
9/18/2010 10:21	0.05	IRIS	6	SIMPLE SUN	21	315	2,205	7,350	House Made
9/14/2010 10:32	0.02	Stargazer	7	RLPHS - WHITE BOX	12	120	1,008	7,200	House Made
9/4/2010 10:12	0.02	fressia	5	RLPHS - GERBERA BOX	7	70	700	7,000	House Made
9/4/2010 10:12	0.03	fressia	5	RLPHS - GREEN TROPICAL BOX	10	100	960	6,400	House Made
9/18/2010 11:37	0.07	IRIS	6	RAINBOW FALL POM	22	220	2,640	6,286	House Made
9/8/2010 5:10	0.02	pompons	8	SYMPHONY: EARLY FALL	15	45	990	6,188	House Made
9/28/2010 6:38	0.01	DHALIA	5	ALB MIXED GREEN BOX F	2	20	304	6,080	House Made
9/3/2010 10:08	0.07	Safary sunset	8	COMBO BOX 1	47	705	3,384	6,043	Chop And Drop
9/16/2010 9:08	0.01	Stargazer	7	COSTCO MINI COLOR CALLAS	7	42	420	6,000	House Made
9/3/2010 13:19	0.03	IRIS	6	3 STEM HYDRANGEA	43	344	1,032	5,733	Chop And Drop
9/23/2010 10:47	0.06	grupo de empaque	3	COSTCO TINT POM	10	60	1,020	5,667	Chop And Drop
9/7/2010 8:52	0.11	grupo de empaque	2	COSTCO MINI CARNS	9	54	1,188	5,400	Chop And Drop
9/7/2010 8:52	0.11	grupo de empaque	2	COSTCO MINI RAINBOW CARN	9	54	1,188	5,400	Chop And Drop
9/7/2010 8:52	0.37	grupo de empaque	2	COSTCO MINI RAINBOW CARN	30	180	3,960	5,351	Chop And Drop
9/2/2010 13:40	0.5	grupo de empaque	2	COSTCO MINI RAINBOW CARN	39	234	5,148	5,148	Chop And Drop
9/3/2010 13:19	0.04	IRIS	6	3 STEM HYDRANGEA	51	408	1,224	5,100	Chop And Drop
9/2/2010 13:40	0.13	grupo de empaque	2	COSTCO MINI CARNS	10	60	1,320	5,077	Chop And Drop
9/17/2010 14:37	0.13	grupo de empaque	2	COSTCO MINI RAINBOW CARN	10	60	1,320	5,077	Chop And Drop
9/7/2010 8:52	0.13	grupo de empaque	2	COSTCO ALSTROMERIA	11	66	1,320	5,077	Chop And Drop
10/14/2010 6:00	0.13	Gladiolus	8	COSTCO MINI RAINBOW CARN	40	240	5,280.00	5,077	Chop And Drop
9/23/2010 13:41	0.04	grupo de empaque	3	RAINBOW FALL POM	5	50	600	5,000	Chop And Drop
9/30/2010 10:50	0.04	grupo de empaque	3	RAINBOW FALL POM	5	50	600	5,000	Chop And Drop
10/9/2010 5:40	0.1	Safary sunset	7	COSTCO RAINBOW ROSE	43	129	3,483.00	4,976	Chop And Drop
9/7/2010 8:52	0.04	grupo de empaque	2	COSTCO MINI CARNS	3	18	396	4,950	Chop And Drop
9/2/2010 13:40	0.12	grupo de empaque	2	COSTCO MINI CARNS	9	54	1,188	4,950	Chop And Drop
9/8/2010 8:42	0.1	Orquidias	8	KROGER - CA NOVELTY BOX	50	900	3,950	4,938	House Made
10/14/2010 6:00	0.2	Gladiolus	8	COSTCO MINI RAINBOW CARN	59	354	7,788.00	4,868	Chop And Drop
9/2/2010 13:40	0.15	grupo de empaque	2	COSTCO ALSTROMERIA	12	72	1,440	4,800	Chop And Drop
9/2/2010 13:40	0.14	grupo de empaque	2	COSTCO ALSTROMERIA	11	66	1,320	4,714	Chop And Drop
9/23/2010 13:41	0.52	grupo de empaque	3	RAINBOW FALL POM	59	590	7,080	4,538	Chop And Drop
9/7/2010 8:52	0.04	grupo de empaque	2	COSTCO ALSTROMERIA	3	18	360	4,500	Chop And Drop
9/7/2010 8:52	0.06	grupo de empaque	2	COSTCO POMS	5	30	540	4,500	Chop And Drop
9/30/2010 10:50	0.26	grupo de empaque	3	RAINBOW FALL POM	29	290	3,480	4,462	Chop And Drop
9/7/2010 8:52	0.21	grupo de empaque	2	COSTCO POMS	17	102	1,836	4,371	Chop And Drop
9/20/2010 7:45	0.35	grupo de empaque	3	RAINBOW FALL POM	38	380	4,560	4,343	Chop And Drop
9/7/2010 8:52	0.06	grupo de empaque	2	COSTCO TINT POM	5	30	510	4,250	Chop And Drop
9/2/2010 5:19	0.07	pompons	7	COSTCO PINK ORIENTAL	18	108	2,052	4,188	House Made
9/2/2010 13:40	0.31	grupo de empaque	2	COSTCO POMS	24	144	2,592	4,181	Chop And Drop
9/7/2010 8:52	0.21	grupo de empaque	2	COSTCO TINT POM	17	102	1,734	4,129	Chop And Drop
9/2/2010 13:40	0.28	grupo de empaque	2	COSTCO TINT POM	22	132	2,244	4,007	Chop And Drop
9/16/2010 13:57	0.01	grupo de empaque	3	3 STEM HYDRANGEA	5	40	120	4,000	Chop And Drop
9/24/2010 15:34	0.06	grupo de empaque	3	RAINBOW FALL POM	6	60	720	4,000	Chop And Drop
9/24/2010 15:34	0.07	grupo de empaque	3	RAINBOW FALL POM	7	70	840	4,000	Chop And Drop
9/24/2010 15:34	0.39	grupo de empaque	3	RAINBOW FALL POM	38	380	4,560	3,897	Chop And Drop
9/24/2010 15:34	0.31	grupo de empaque	3	RAINBOW FALL POM	30	300	3,600	3,871	Chop And Drop
9/2/2010 5:19	0.08	pompons	7	COSTCO PINK ORIENTAL	19	114	2,166	3,868	House Made
9/2/2010 5:45	0.02	GERBERA	7	RLPHS - ORANGE BOX	8	80	520	3,714	House Made
9/10/2010 6:48	0.33	Lisianthus	7	MINUET: EARLY FALL	43	774	8,514	3,686	Chop And Drop
9/29/2010 12:36	0.05	Margaritas	6	DOZEN ROSE BOUQUET	7	84	1,092	3,640	Chop And Drop
9/13/2010 5:15	0.03	Daisy	7	RLPHS - GERBERA BOX	7	70	700	3,333	House Made
9/28/2010 8:03	0.35	DHALIA	5	MINUET - LATE SUMMER	35	525	5,775	3,300	Chop And Drop
9/30/2010 5:35	0.35	Margaritas	5	MINUET - LATE SUMMER	35	525	5,775	3,300	Chop And Drop
9/29/2010 5:26	0.23	Daisy	8	MINUET - LATE SUMMER	35	525	5,775	3,139	Chop And Drop
10/11/2010 5:23	0.23	Lisianthus	8	MINUET - LATE SUMMER	35	525	5,775.00	3,139	Chop And Drop
10/15/2010 12:39	0.13	Gladiolus	6	RAINBOW FALL POM	20	200	2,400.00	3,077	Chop And Drop
10/15/2010 12:39	0.7	Gladiolus	6	RAINBOW FALL POM	107	1,070	12,840.00	3,057	Chop And Drop
10/16/2010 10:23	0.09	Gladiolus	7	RAINBOW FALL POM	16	160	1,920.00	3,048	Chop And Drop
10/15/2010 12:39	0.85	Gladiolus	6	RAINBOW FALL POM	129	1,290	15,480.00	3,035	Chop And Drop
9/21/2010 10:25	0.02	DHALIA	6	COSTCO ALSTROMERIA	3	18	360	3,000	Chop And Drop
9/30/2010 12:25	0.01	Lisianthus	6	ALB PROMO FILLER BOX	5	50	180	3,000	House Made
10/16/2010 10:23	0.44	Gladiolus	7	RAINBOW FALL POM	77	770	9,240.00	3,000	Chop And Drop
9/9/2010 12:44	0.02	Lisianthus	7	COSTCO PUMPKIN/CHILI PEPPER	12	72	408	2,914	House Made
9/16/2010 13:57	0.16	grupo de empaque	3	3 STEM HYDRANGEA	58	464	1,392	2,900	Chop And Drop
10/15/2010 12:39	0.09	Gladiolus	6	RAINBOW FALL POM	13	130	1,560.00	2,889	Chop And Drop
9/16/2010 8:13	0.4	IRIS	6	MINUET - LATE SUMMER	42	630	6,930	2,888	Chop And Drop
9/13/2010 6:58	0.05	Daisy	7	RLPHS - WHITE BOX	12	120	1,008	2,880	House Made
9/1/2010 5:28	0.22	pompons	8	ROSE BUNCH PROMO	34	408	4,896	2,782	Repack
10/16/2010 7:13	0.05	Stargazer	7	COSTCO POMS	9	54	972	2,777	Chop And Drop
9/17/2010 8:33	0.13	Daisy	8	LONG STEM ROSES	20	240	2,880	2,769	Repack
9/2/2010 8:36	0.35	DHALIA	6	MINUET - LATE SUMMER	35	525	5,775	2,750	Chop And Drop
10/13/2010 14:23	0.2	Lisianthus	8	COSTCO MINI RAINBOW CARN	33	198	4,356.00	2,723	Chop And Drop
9/8/2010 8:43	1.25	Margaritas	7	MINUET: EARLY FALL	120	2,160	23,760	2,715	Chop And Drop
10/16/2010 7:13	0.14	Stargazer	7	COSTCO MINI RAINBOW CARN	20	120	2,640.00	2,694	Chop And Drop
9/25/2010 4:30	0.05	pompons	5	FIELD FRESH	6	60	660	2,640	House Made
9/17/2010 10:27	0.29	Gladiolus	7	MINUET: EARLY FALL	27	486	5,346	2,633	Chop And Drop
9/17/2010 10:27	0.13	Gladiolus	7	MINUET: EARLY FALL	12	216	2,376	2,611	Chop And Drop
9/9/2010 8:15	0.28	DHALIA	8	MINUET - LATE SUMMER	35	525	5,775	2,578	Chop And Drop
10/16/2010 7:13	0.04	Stargazer	7	COSTCO TINT POM	7	42	714	2,550	Chop And Drop
9/3/2010 8:39	0.75	GERBERA	4	MINUET - LATE SUMMER	45	675	7,425	2,475	Chop And Drop
9/15/2010 8:21	0.62	IRIS	7	MINUET: EARLY FALL	54	972	10,692	2,464	Chop And Drop
9/15/2010 8:21	1.29	IRIS	7	MINUET: EARLY FALL	112	2,016	22,176	2,456	Chop And Drop
9/23/2010 5:29	0.38	Lisianthus	8	MINUET - LATE SUMMER	45	675	7,425	2,442	Chop And Drop
10/9/2010 4:49	0.68	Safary sunset	7	MINUET - LATE SUMMER	70	1,050	11,550.00	2,426	Chop And Drop
9/10/2010 14:19	0.01	grupo de empaque	3	3 STEM HYDRANGEA	3	24	72	2,400	Chop And Drop
9/15/2010 7:39	0.08	Orquidias	8	COSTCO SUNS	14	84	1,512	2,363	House Made
9/10/2010 5:34	0.4	pompons	7	MINUET - LATE SUMMER	40	600	6,600	2,357	Chop And Drop
9/8/2010 7:26	0.3	Margaritas	6	MINUET - LATE SUMMER	25	375	4,125	2,292	Chop And Drop
9/13/2010 5:15	0.04	Daisy	7	RLPHS - PINK BOX	8	80	640	2,286	House Made
9/11/2010 11:14	0.23	Safary sunset	8	DOZEN ROSES	35	350	4,200	2,283	House Made
9/25/2010 5:59	0.93	Safary sunset	7	MINUET - LATE SUMMER	90	1,350	14,850	2,281	Chop And Drop
9/18/2010 9:48	0.47	Gladiolus	7	MINUET - LATE SUMMER	70	1,050	7,350	2,234	Chop And Drop
10/18/2010 11:07	0.46	Safary sunset	11	RAINBOW FALL POM	94	940	11,280.00	2,229	Chop And Drop
10/18/2010 11:07	0.08	Safary sunset	11	RAINBOW FALL POM	16	160	1,920.00	2,182	Chop And Drop
9/20/2010 7:19	0.38	Lisianthus	7	MINUET - LATE SUMMER	35	525	5,775	2,171	Chop And Drop
10/14/2010 11:56	0.68	IRIS	7	RAINBOW FALL POM	86	860	10,320.00	2,168	Chop And Drop
9/30/2010 12:25	0.04	Lisianthus	6	MIXED FILLER BUNCH	10	100	520	2,167	House Made
10/14/2010 11:40	0.24	Safary sunset	7	RAINBOW FALL POM	30	300	3,600.00	2,143	Chop And Drop

APPENDIX C – One way ANOVA

Comparison of Mean for the Different Stem Category

Null Hypothesis: $\mu_1 = \mu_2 = \mu_3$

Analysis of variance to compare means
ANOVA Table

Source of Variation	df	SS	MS	Computed F	Critical F	Probability Associated with Computed F	Decision Regarding H_o
Among	2	200763.91	100381.95	24.95	3.29	0.00	Reject H_o
Within	33	132763.20	4023.13				
Total	35	333527.10	9529.35				

Scheffe Test for multiple comparisons of means

	Fewer than 10	Between 10 - 20	More than 20
Fewer than 10	0	35.0938	39.6225
Between 10 - 20	6.5698	0	0.1374
More than 20	6.5698	6.5698	0

APPENDIX D – Table Ranking

Ranking for the different stem count category and the current Non Compliance percentage

Table Name	Ranking for Stem count more than 20	Ranking for Stem count between 10 and 19	Ranking for Stem count less than 10	Current Non Compliance Percentage
Daisy	7	9	3	5
Dhalia	3	1	2	5
Gerbera	5	10	11	6
Gladiolus	11	6	5	5
Iris	10	7	10	4
Lisianthus	1	3	6	5
Margaritas	8	5	7	6
Orquidias	6	11	8	6
Pompons	4	4	4	5
Safari Sunset	2	2	1	6
Stargazer	9	8	9	6

APPENDIX E – Correlation Analysis

Scenario #1: Correlation analysis between the average stem produced per hour ranking for the stem count category under 10 and non-compliance percentage.

Regression Statistics Output	Rate of Production as a function of Non Compliance percentage
Multiple R	0.0894
R Square	0.0080
Adjusted R Square	-0.1022
Standard Error of Est.	3.4820
Observations	11

Scenario #2: Correlation analysis between the average stem produced per hour ranking for the stem count category between 10-19and non-compliance percentages.

Regression Statistics Output	Rate of Production as a function of Non Compliance percentage
Multiple R	0.2236
R Square	0.0500
Adjusted R Square	-0.0556
Standard Error of Est.	3.4075
Observations	11

Scenario #3: Correlation analysis between the average stem produced per hour ranking for the stem count category more than 20 and non-compliance percentages.

Regression Statistics Output	Rate of Production as a function of Non Compliance percentage
Multiple R	0.1789
R Square	0.0320
Adjusted R Square	-0.0756
Standard Error of Est.	3.4396
Observations	11

Scenario #4: Correlation analysis between the overall average stem produced per hour ranking and non-compliance percentages.

Regression Statistics Output	Rate of Production as a function of Non Compliance percentage
Multiple R	0.0636
R Square	0.0040
Adjusted R Square	-0.1066
Standard Error of Est.	2.8239
Observations	11

APPENDIX F – Standardization Test Results

Raw Data and Statistical Analysis

Raw Data for Stem Count Category more than 20

Technique #1	**Technique #2**
152	120.6
171	104
151	112
174	120.1
120.2	120.8
135	102
140	112
135	130
140	131
158	95
162	99
159	116
165	120.3

Two sample independent t test
Stem Count Category more than 20

Null Hypothesis: µ1=µ2
Two-tailed (non-directional) test for comparing means
Desired alpha level 0.05
Expected differences under the null hypothesis 0

Summary Statistics	Technique #1	Technique #2
Sample sizes	13	13
Degrees of freedom	12	12
Sample means	150.9385	114.0615
Sample standard deviations	15.9755	11.3785
Sample variances	255.2159	129.4709
Standard errors of the means	4.4308	3.1558

Observed differences between means	36.8769
Expected differences between means	0.0000
Standard error of the differences	5.4398
df	24
Critical t-value	±2.0638
2-tailed computed probability	0.0000
Decision regarding test for means	Reject H_o

<u>Raw Data for Stem Count Category between 10 and 19</u>
For Technique #1 versus Technique #2

Technique #1	Technique #2
54	48
55	46
56	45
52	44
47	45
52	43
56	45
52	46
56	45
54	48
53	49
53	48
58	44
58	43
52	46
48	48
56	47
53	50
55	45
56	46
58	
57	

Two sample independent t test
Stem Count Category between 10 and 19
For Technique #1 versus Technique #2

Null Hypothesis: $\mu 1=\mu 2$
Two-tailed (non-directional) test for comparing means

Desired alpha level	0.05
Expected differences under the null hypothesis	0

Summary Statistics	Technique #1	Technique #2
Sample sizes	22	20
Degrees of freedom	21	19
Sample means	54.1364	46.0500
Sample standard deviations	2.9487	1.9595
Sample variances	8.6948	3.8395
Standard errors of the means	0.6287	0.4381

Observed differences between means	8.0864
Expected differences between means	0.0000
Standard error of the differences	0.7809
df	40
Critical t-value	±2.0210
2-tailed computed probability	0.0000
Decision regarding test for means	Reject H_o

Raw Data for Stem Count Category between 10 and 19
For Technique #3 versus Technique #4

Technique #3	Technique #4	Technique #3	Technique #4
43	60	59	42
45	43	43	54
52	46	41	49
48	40	49	54
47	48	63	47
53	45	48	46
52	38	44	47
37	36	56	43
43	47	47	49
46	57	53	48
51	61	50	49
58	67	47	50
23	42	65	46
45	40	54	46
45	51	56	43
48	56	51	45
58	44	56	
48	55	49	
44	55	48	
48	45	49	
48	58	45	
52	45	51	
64	45	50	
38	39	51	
53	42	52	
54	52	48	
55	44	48	
48	44	45	
62	45		
40	55		
45	46		

Two-sample independent t-test
Stem Count Category between 10 and 19
For Technique #3 versus Technique #4

Null Hypothesis: µ1=µ2
Two-tailed (non-directional) test for comparing means
Desired alpha level 0.05
Expected differences under the null hypothesis 0

Summary Statistics	Technique #3	Technique #4
Sample sizes	59	47
Degrees of freedom	58	46
Sample means	49.3390	47.8511
Sample standard deviations	6.9570	6.4773
Sample variances	48.4004	41.9556
Standard errors of the means	0.9057	0.9448

Observed differences between means	1.4879
Expected differences between means	0.0000
Standard error of the differences	1.3195
df	104
Critical t-value	±1.9830
2-tailed computed probability	0.2621
Decision regarding test for means	Unable to reject H_o

Raw Data for Stem Count Category less than 10
For Technique #3 versus Technique #4

Technique #3	Technique# 4
38.4	37.7
41.6	25.1
34	38.2
38.4	33.1
45.6	32.4
35.4	33.1
35.6	29.6
37	34.6
32.6	32.7
38	42.7
33.8	36.3
30	29.4
30.7	36.5
44	43.1
38.2	40.7
33.5	29.8
40.2	33.7
35.9	38.1
40.2	48.5
45.1	36.6
46.7	
31.2	
32.3	
47.7	

Two-sample independent t-test
Stem Count Category less than 10
For Technique #3 versus Technique #4

Null Hypothesis: μ1=μ2	
Two-tailed (non-directional) test for comparing means	
Desired alpha level	0.05
Expected differences under the null hypothesis	0

Summary Statistics	**Technique #3**	**Technique #4**
Sample sizes	24	20
Degrees of freedom	23	19
Sample means	37.7542	35.5950
Sample standard deviations	5.2440	5.4911
Sample variances	27.5000	30.1521
Standard errors of the means	1.0704	1.2278

Observed differences between means	2.1592
Expected differences between means	0.0000
Standard error of the differences	1.6220
df	42
Critical t-value	±2.0180
2-tailed computed probability	0.1903
Decision regarding test for means	Unable to reject H_o

APPENDIX G – Setup and End of Day Checklist - English

CF South
Operating Checklist
Date: __________________ ______________________________________ Operating Manager

Set up Activities (Beginning of Day)

- ☐ Pull all flowers needed for first orders of the day
- ☐ Place racks in front of correct tables
- ☐ Remove flowers from boxes (if not already)
- ☐ Remove flowers from plastic wrap
- ☐ Place flowers on tables
- ☐ Break down cardboard boxes
- ☐ Place any excess plastic wraps in garbage
- ☐ Make sure all tables have flower food (replace as needed)
- ☐ Make sure all tables have rubber bands (replace as needed)
- ☐ Make sure all tables have rakes and brooms
- ☐ Make sure all colored buckets are at each table

CF South
Operating Checklist
Date: __________________ ______________________________________ Operating Manager

End of Day Activities

- ☐ Place all excess stems in buckets
- ☐ Place all buckets back on racks
- ☐ Take racks back to coolers
- ☐ Remove colored buckets
- ☐ Dump used water from colored buckets
- ☐ Refill colored buckets with new water
- ☐ Remove rubber flooring
- ☐ Brush all garbage (flower remains) onto floor
- ☐ Leaf blow all garbage into piles
- ☐ Sweep piles into garbage
- ☐ Replace rubber flooring
- ☐ Take out all garbage
- ☐ Replace colored buckets at tables
- ☐ Refill flower food packets in table bins
- ☐ Refill rubber bands in table bins
- ☐ Replace garbage cans at tables
- ☐ Be sure all aisle ways are clear for the following morning

APPENDIX H – Quality Control Sheet - English

Supply - Quality Control Sheet

Supervisor Name ____________ Is the problem recurring for this shift: Yes No

Signature ____________ Date: ____________

TABLE	**QUALITY ISSUE**	**Count**
☐ Daisy		
☐ Dhalia	☐ Flowers stacked too high	______
☐ Gerbera	☐ Length of stem	______
☐ Gladiolus	☐ Location of the flower	______
☐ Iris	☐ Location of the plastic	______
☐ Lisianthus	☐ Number of stems	______
☐ Margaritas	☐ Length of bouquet	______
☐ Orquidias	☐ Accumulation of flowers	______
☐ Pompons		
☐ Safary Sunset		
☐ Stargazer		

QUALITY REPORT

Table Name: ____________ Time: ____________

Rejected Due to: ____

____

Is it reoccurring during this shift? ____________

Comment: ____

____

____

APPENDIX I - Inventory Tracking Form - English

Inventory Tracking Sheet

Supervisor Name: ________________ Date: ________________

Signature: Table Name:

No.	Time	Red Bucket	Yellow Bucket	Green Bucket	No.	Time	Red Bucket	Yellow Bucket	Green Bucket
1					41				
2					42				
3					43				
4					44				
5					45				
6					46				
7					47				
8					48				
9					49				
10					50				
11					51				
12					52				
13					53				
14					54				
15					55				
16					56				
17					57				
18					58				
19					59				
20					60				
21					61				
22					62				
23					63				
24					64				
25					65				
26					66				
27					67				
28					68				
29					69				
30					70				
31					71				
32					72				
33					73				
34					74				
35					75				
36					76				
37					77				
38					78				
39					79				
40					80				

Notes: