Comparison and Implementation of Data Evaluation Systems within the Cal Poly Creamery

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Connor Wagner

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ABSTRACT

The objective of this project is to implement a new data evaluation system at the Cal Poly Creamery. This project examines the implications of using hard copies versus an Excel spreadsheet to store and evaluate data obtained from the quality control department at the Cal Poly Creamery. By reviewing the current system of data evaluation that utilizes hard copies, the need for a new system of data record keeping was necessary. The history of the creamery's quality performance needs to be reviewable in a quick and easy manner. By utilizing Microsoft Excel Pivot Tables, this means of historical data evaluation can be used by the creamery. A Pivot table can be very powerful when used within an Excel spreadsheet for multiple data point evaluations. The information in a pivot table can also be made into a graph for a visually appealing way of evaluating data in the spreadsheet. Within the spreadsheet, data will be recorded by the date the product was made, product type and the test ran on the product. By using this spreadsheet data can be recorded quickly and easily. Also, the data evaluated can be emailed to the necessary people for their approval. Third party audits can be performed on the creamery, and without this information recorded in a computer the audit will be more difficult and take longer to look through a binder of unorganized hard copies. Hard copies are good to have as a back up in case the computer crashes, but utilizing the power of the computer makes data evaluation fast and easy. The implementation of the new data evaluation system needs to become a standard operating procedure. Training exercises will need to be held in order for proper utilization of the spreadsheet. A flow chart diagram has been generated for easy training on the data evaluation system as well, which can be seen in Appendix 1.

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INTRODUCTION

The systems of record keeping and data analysis are very important to any well-managed processing facility. All record keeping systems are different with respect to what product is made and what requirements need to be met. The Cal Poly Creamery needs a way to evaluate data collected by the quality control department. To improve the record evaluation system at the Cal Poly Creamery, an Excel spreadsheet will be introduced. The proposed spreadsheet will organize and evaluate quality control data in a graphical form. This graphical form will help managers monitor their product and strive toward a continuously improving goal of microbiological and standards testing. By studying various quality control systems, the spreadsheet was made to be user friendly, visually appealing, and a cost effective system for the Cal Poly Creamery to utilize within their processing operation. The Cal Poly Creamery will have the ability to test and record Final Product (FP) specifications in order to determine if a contamination outbreak occurred during processing or after the product was shipped. By testing FP specifications a Root Cause Analysis (RCA) can be determined to find the source of contamination. An RCA drills down to the root cause of a contamination by asking where, how, and why the contamination occurred. An RCA is a good tool to use when identifying problems within the plant. This project along with the new Standard Operating Procedures (SOP's) proposed will help the creamery improve their record evaluation system, and in time improve their standardized and microbiological specifications.

REVIEW OF LITERATURE

Quality Control History

The history of quality control in the United States can be dated as far back as 100 years (DeVor et. al., 1992). A man named Fredrick Winslow Taylor pioneered quality control in the field of industrial management (DeVor et. al., 1992). Labor was changing into the need for a division of tasks as apposed to the traditional method of having individual craftsmen who would see the process from beginning to end. Taylor noticed the need for quality control with this new style of labor. Workers were no longer able to make a product from beginning to end and therefore could not personally check the quality of their work on the end product. The workers were responsible for just a small part of the production process, and were not able to control any part of production before or after their own work area. Two major problems came from this new division of labor. The first problem had to do with the quality of the final product. The workers did not see the final product, and their new tasks were repetitive and boring. This made it hard for the workers to have a sense of ownership toward the product, and the quality of the product suffered as a result. The second problem was a productivity issue. From the reasons stated above, workers did not feel the need to complete their tasks in a timely manner, which resulted in lower productivity and a loss of profit. Taylor knew that in order for the new division of labor to work, the management of workers needed to be analyzed on a scientific basis. Taylor worked on ways to monitor and improve upon measuring time of performance; through this the work standard was born (DeVor et. al., 1992). This established a standard time it would take to perform a given task. Several problems came with the establishment of the work standard. One problem was it only looked to improve

upon the productivity issue. The next problem is, a worker was no longer responsible for the quality of what they were doing, but rather the speed at which they performed their task.

Where Taylor worked on the productivity issue, a man named Walter Shewhart worked to improve upon the issue of quality. Shewhart worked for Bell Labs in the 1920's (DeVor et. al., 1992). His goal was to detect and eliminate sources of variation in the production process by means of statistical quality control (SQC). In 1931, Shewhart published, *Economic Control of Quality of Manufactured Product* (DeVor et. al., 1992). In this book he explains how to improve quality by means of statistical methods to analyze variation patterns of a product over time (DeVor et. al., 1992).

Deming's 14 Points of Management

It was W. Edwards Deming that said, "Sources of variation are sources of waste and inefficiency and that for every source of variation identified and removed we will experience increases in both quality and productivity." (DeVor et. al., 1992). In his book, *Out of the Crisis,* published in 1982, Deming established his 14 points for management (Cohen, 2012). With these 14 points, Deming revolutionized Japan's manufacturing industry after World War II. The 14 points are paraphrased as follows (Cohen, 2012):

1. "Create constancy of purpose towards improvement". Replace short-term reaction with long-term planning. You need to view where your processing facility will be in the next 2 to 5 to 10 years and strive to be there by continuously improving.
2. "Adopt the new philosophy". Management should adopt this philosophy, and not expect the workforce to do so. Everyone from the plant floor to the office needs to embrace this way of thinking and not just expect it to happen.

3. "Cease dependence on inspection". If variation is reduced, there will be no need to inspect manufactured items for defects, because there won't be any. Inspections are still important on standards and microbiological levels but operators should not simply expect the quality assurance department to catch any defects.
4. "Move towards a single supplier for any one item." Multiple suppliers mean more variation between raw materials. It is smart to know your milk suppliers and audit their operations at the dairy.
5. "Improve constantly and forever". Always strive to reduce variation and always strive for improvement. If you do not strive for continuously improving goals, then production quality and quantity will actually move backwards.
6. "Institute training on the job". If people are not trained properly, they will not all work the same way, which will cause variation. It is also important to utilize cross-training so everyone will know how to do every job and this will improve the quality on the line of production.
7. "Institute leadership". There is a difference between leadership and supervision. The Leaders of the plant need to be on the floor with the operators and become their co-workers before they become their managers and bosses. This will help communication between the various departments.
8. "Drive out fear". Management by fear does not work in the company's best interest. Everyone needs to be on the same page, because management can always learn from supervisors and operators. Again, Management needs to instill in the operators minds that they are co-workers.

9. "Break down barriers between departments". Each department serves the other departments that use its outputs. Every part of the plant is striving toward the same goal, to better the company in any way.

10. "Eliminate slogans". It is not people who make most mistakes, it is the process they are working within. At the end of the day, the slogan does not make the mistake, the person does. Concentrate on training and don't spend as much energy on creating slogans.

11. "Eliminate management by objectives". Deming saw production targets as encouraging the delivery of poor-quality goods. The plant needs to focus on quality and not quantity, because producing quality products will benefit the company the most at the end of the day.

12. "Remove barriers to pride of workmanship". Many of the other problems outlined reduce worker satisfaction. When worker satisfaction suffers the entire plant suffers.

13. "Institute education and self-improvement". Offer education and class incentives. An educated worker is a good worker. Also, by cross-training an employee will learn more about the company and will strive to improve it.

14. "The transformation is everyone's job". Everyone needs to buy into these points so that everyone will benefit.

Deming's 14 points are widely used in the manufacturing industry in the United States and throughout the world. The 14 points helped shape the role of quality assurance and quality control departments within a wide range of manufacturing companies.

HACCP Implications

Perhaps the most important innovation in the field of quality control came with the implementation of Hazard Analysis by Critical Control Point (HACCP). The HACCP procedure is a management tool created by the Pillsbury Company in the 1960s, as a means of ensuring the safety of food for space flights (Ropkins, 2000). Food companies use the HACCP procedure for developing safety assurance procedures. The HACCP plan is a protocol for implementation of a quality assurance program. The seven basic steps of HACCP implementation are (Ropkins, 2000):

1. "Conduct hazard analysis, considering all ingredients, processing steps, handling procedures and other activities involved in a foodstuff's production." Hazard analysis needs to be monitored in every aspect of the plant. It does no good to use HACCP in only some of the areas in the plant.
2. "Identify Critical Control Points (CCP's)." Locate and monitor potential areas that can be of hazard to the product as well as employees.
3. "Define critical limits for ensuring the control of each CCP." Implement SOP's on the various CCP's found. Employment needs to know how to monitor these CCP's.
4. "Establish monitoring procedures to determine if critical limits have been exceeded and define procedure(s) for maintaining control." Be able to monitor any CCP that comes out of spec, and keep a history of the out of spec CCP so it will be less likely for it to happen again.

5. "Define corrective actions to be taken if control is lost (i.e., monitoring indicates that critical limits have been exceeded)." Identify and implement SOP's for corrective actions when a CCP becomes out of spec.
6. "Establish effective documentation and record-keeping procedures for developed HACCP procedure." An effective and accurate documentation system is important to monitoring continuous out of spec CCP's, in order to focus on areas of improvement.
7. "Establish verification procedures for routinely assessing the effectiveness of the HACCP procedure, once implemented." Auditing systems need to be put in place to ensure that once a corrective action has been made, the corrective action continues to correct the out of spec CCP.

These implementation steps stressed the importance of record keeping within the food processing industry. Through this system of HACCP record keeping procedures stemmed the necessity of keeping a history of records on standards of identity and microbiological testing. The U.S. Food and Drug Administration (FDA) has a Code of Federal Regulations (CFR), which includes the definition of cheese, and cheese related products, and standard of identities for such products.

Food Standards

Standards of identity for cheese are defined under the Federal Food, Drug, and Cosmetic Act. Cheeses include: "pasteurized process cheese; pasteurized process cheese with fruits, vegetables, or meats; pasteurized blended cheese; pasteurized process cheese food; pasteurized process cheese spread, and related foods" (FDA, 2012a). Standards of identity classify a name for these various cheeses given their product specifications and

require that this name appear on the package label. Standards for cheese as identified by the FDA within the CFR include:

Cheddar. "Cheddar cheese is the food prepared by the procedure set forth in paragraph (a)(3) of this section, or by any other procedure, which produces a finished cheese having the same physical and chemical properties. The minimum milkfat content is 50 percent by weight of the solids, and the maximum moisture content is 39 percent by weight, as determined by the methods described in 133.5. If the dairy ingredients used are not pasteurized, the cheese is cured at a temperature of not less than 35 deg. F for at least 60 days." (FDA, 2012a).

Gouda. "Gouda cheese conforms to the definition and standard of identity and complies with the requirements for label declaration of ingredients prescribed for edam cheese by 133.138, except that the minimum milkfat content is 46 percent by weight of the solids, as determined by the methods described in 133.5 and the maximum moisture content is 45 percent by weight." (FDA, 2012a).

MJ. "Monterey cheese, monterey jack cheese is the food prepared by the procedure set forth in paragraph (a)(3) of this section, or by any other procedure which produces a finished cheese having the same physical and chemical properties. The minimum milk fat content is 50 percent by weight of the solids, and the maximum moisture content is 44 percent by weight, as determined by the methods described in 133.5. The dairy ingredients used are pasteurized." (FDA, 2012a).

The standards listed above are very specific to the type of cheese made. There are many other standards of identities for cheese; these are only a few examples, which include three of the cheeses made at the Cal Poly Creamery. If test results show anything

that is outside the standard minimum or maximum percentages for that cheese, then the name cannot be placed on the package label.

Standards Testing Methods

Methods by which standards of identity tests are to be performed are defined within the CFR as follows: “Moisture, milk fat, and phosphatase levels in cheeses will be determined by the following methods of analysis from "Official Methods of Analysis of the Association of Official Analytical Chemists," 13th ed., 1980, which is incorporated by reference (copies are available from the AOAC INTERNATIONAL, 481 North Frederick Ave., suite 500, Gaithersburg, MD 20877, or available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030, or go to: http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.htm) : (a) Moisture content--section 16.233 "Method I (52)--Official Final Action", under the heading "Moisture". (b) Milkfat content--section 16.255 "Fat (60)--Official Final Action". (c) Phenol equivalent value--section 16.275 "Reagents", section 16.276 "Sampling", and section 16.277 "Determination", under the heading "Residual Phosphatase (27) Official Final Action". (d) Milkfat in solids (fat on a dry basis)--Subtract the percent of moisture found from 100; divide the remainder into the percent milkfat found. The quotient, multiplied by 100, shall be considered to be the percent of milkfat contained in the solids. [48 FR 2742, Jan. 21, 1983; 48 FR 11426, Mar, 18, 1983, as amended at 54 FR 24893, June 12 1989; 63 FR 14035, Mar. 24, 1998]” (FDA, 2012b).

The standards testing methods listed above are straight from the FDA website. This is what is listed under the official methods of analysis and asks the reader to

research further about the proper ways of testing standards for cheese. Using these testing procedures are required when testing for: moisture content, milkfat content, and phosphotase levels in cheese. Any processing facility producing cheese for sale must use these testing procedures when using a classified cheese name, such as Cheddar.

MATERIALS AND METHODS

The Cal Poly Creamery runs quality and microbiological tests on all products made in the plant. The quality assurance/quality control (QA/QC) lab runs the tests, and the QA/QC manager records them in a computer. The computer sheet is printed out and handed to the plant manager. After the plant manager reviews the data, the hard copy is filed into a binder. The creamery has one binder for quality testing that is comprised of all different kinds of products and not organized in any specific manner. The new Excel spreadsheet will organize data by product type, date, and test. The product type and date can be entered into a pivot table on another tab of the same spreadsheet. A graph can be generated based on the specification of the product evaluated within the pivot table. These graphs show historical data of every specification the user wants to observe. This spreadsheet is user friendly, easy, and fast. The best part about this new Excel system is it can be emailed between managers, so no more hard copies are necessary. Also, information on every product entered can be retrieved by the click of a mouse if a quality issue arises.

Using Microsoft Excel, spreadsheets were formatted to accommodate data collection from tests performed on the various products made at the Cal Poly Creamery. This was accomplished by evaluating different routine QA/QC test results for products made at the Cal Poly Creamery. The products to be used in the spreadsheet are: Gouda

cheese, cheddar cheese, monterey-jack cheese, chipotle-jack cheese, ice cream mix, and chocolate milk.

The specifications that will be recorded are standards tests, which include: total solids percent, fat percent, moisture percent, salt percent, and pH levels. The specifications used for chocolate milk are: fat percent, protein percent, casein percent, lactose percent, total solids percent, solids non fat percent, pH level, sugar percent, and cocoa powder percent. For ice cream mix the specifications recorded will be: fat percent, moisture percent, total solids percent, and fat on a dry basis percent. Also microbiological tests will be recorded for every product, which include: E. coli, coliform, and aerobic plate count (APC).

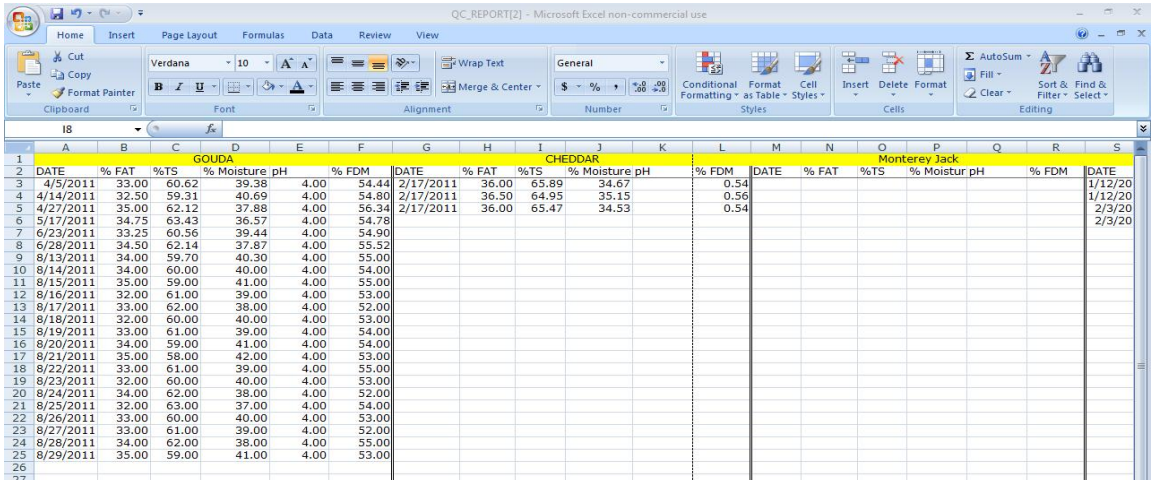
RESULTS AND DISCUSSION

When using multiple data points, as in this study, pivot tables can be a very powerful. Production Loss Accounting Systems (PLAS) were analyzed when working within the dairy processing industry. The PLAS analysis was for downtime equipment when there was a piece of machinery that broke in the plant. Operators wrote on a PLAS sheet within the plant: what piece of equipment it was, how long it was down, why it was down, and what corrective action was made, when any piece of equipment went down in the plant. The raw data was taken from the PLAS sheets and entered into a spreadsheet similar to the one used in this study. Data of which piece of equipment was causing the most downtime was found using a pivot table. The largest equipment downtime meant the highest loss in production and therefore the most loss in profits for the company. Graphs of this data were made and presented to plant managers and department directors.

This data and the graphs presented were the first step in researching if the piece of equipment needed to be replaced for continuous downtime.

In creating the spreadsheet used in this study ideas were taken from the PLAS Excel spreadsheet. Standards and microbiological data are much different than PLAS data so format changes were needed to accommodate the special needs of the Cal Poly Creamery.

By opening Microsoft Excel on a computer, a spreadsheet can be created to be used for the record keeping procedure in this study. This spreadsheet can be opened and edited on any computer, Mac or PC. Titles are placed at the top of the columns for every product as shown in the figure below. Raw data that is collected for evaluation is entered into the appropriate column in the spreadsheet. Product standards and product microbiological tests are under separate tabs for organizational purposes. The pivot charts used in the spreadsheet are linked to the corresponding raw data tables for standards and microbiological tests, which will be shown later. Under the title of the product, the various specifications are recorded, starting with the date so historical data can be acquired over time.



	GOUDA						CHEDDAR						Monterey Jack						
DATE	% FAT	%TS	% Moisture	pH	% FDM	DATE	% FAT	%TS	% Moisture	pH	% FDM	DATE	% FAT	%TS	% Moistur	pH	% FDM	DATE
4/5/2011	33.00	60.62	39.38	4.00	54.44	2/17/2011	36.00	65.89	34.67		0.54							1/12/20
4/14/2011	32.50	59.31	40.69	4.00	54.80	2/17/2011	36.50	64.95	35.15		0.56							1/12/20
4/27/2011	35.00	62.12	37.88	4.00	56.34	2/17/2011	36.00	65.47	34.53		0.54							2/3/20
5/17/2011	34.75	63.43	36.57	4.00	54.78													2/3/20
6/23/2011	33.25	60.56	39.44	4.00	54.90													
6/28/2011	34.50	62.14	37.87	4.00	55.52													
8/13/2011	34.00	59.70	40.30	4.00	55.00													
8/14/2011	34.00	60.00	40.00	4.00	54.00													
8/15/2011	35.00	59.00	41.00	4.00	55.00													
8/16/2011	32.00	61.00	39.00	4.00	53.00													
8/17/2011	33.00	62.00	38.00	4.00	52.00													
8/18/2011	32.00	60.00	40.00	4.00	53.00													
8/19/2011	33.00	61.00	39.00	4.00	54.00													
8/20/2011	34.00	59.00	41.00	4.00	54.00													
8/21/2011	35.00	58.00	42.00	4.00	53.00													
8/22/2011	33.00	61.00	39.00	4.00	55.00													
8/23/2011	32.00	60.00	40.00	4.00	53.00													
8/24/2011	34.00	62.00	38.00	4.00	52.00													
8/25/2011	32.00	63.00	37.00	4.00	54.00													
8/26/2011	33.00	60.00	40.00	4.00	53.00													
8/27/2011	33.00	61.00	39.00	4.00	52.00													
8/28/2011	34.00	62.00	38.00	4.00	55.00													
8/29/2011	35.00	59.00	41.00	4.00	53.00													

Figure 1. Raw data tab where test data is entered into the spreadsheet.

After entering new data into the Standards or Micro Raw Data tab you must first refresh the spreadsheet. To do this, first click on the refresh data button in the Standards or Micro Pivot Chart tab. The refresh button is in the Data menu on the task pane at the top of the spreadsheet as shown in the figure below. After refreshing the data the table is ready for use.

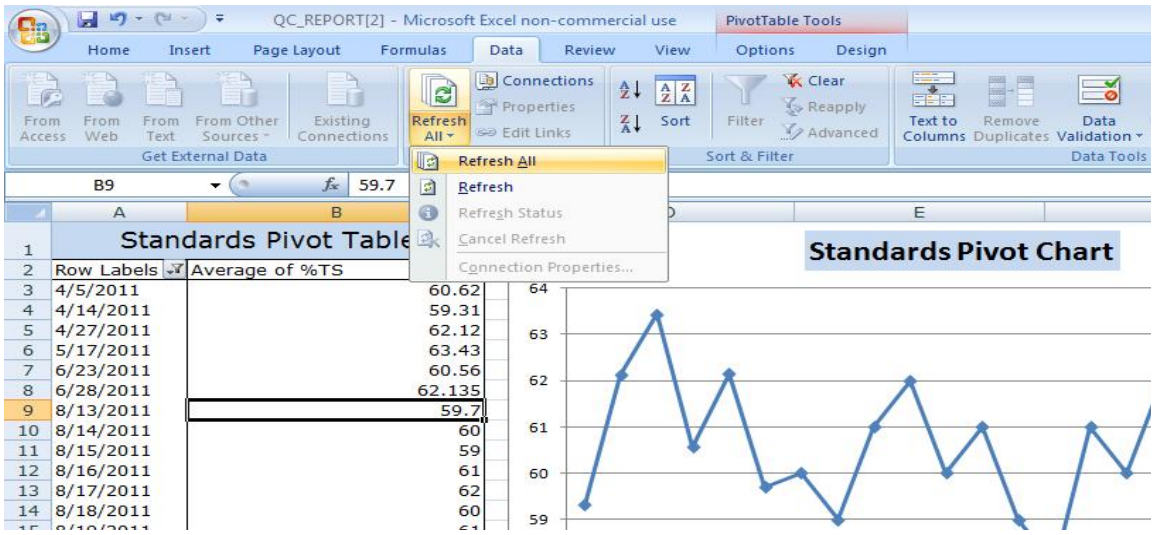


Figure 2. Refreshing the Pivot Table so new data entered in the spreadsheet will be included in the Pivot Chart.

The pivot tables used in the spreadsheet are good for sorting large amounts of data. Tabs labeled Standards Pivot Chart, and Micro Pivot Chart are the pivot tables where the raw data will be sorted. The Standards Raw Data tab is linked with the Standards Pivot Table and the Micro Raw Data tab is linked to the Micro Pivot Table. In order to look at a product you must first locate it in the Pivot Table Field List on the right side of the spreadsheet. The date must be entered into the Row Labels box within the Pivot Table Field list. Next, the specification you want to examine must be entered into the Values box within the Pivot Table Field list. The Row Labels and Values boxes are at the very bottom right corner of the spreadsheet. These instructions can be seen in the

figure below. The two values entered into the appropriate boxes make up your X and Y-axis of the pivot chart.

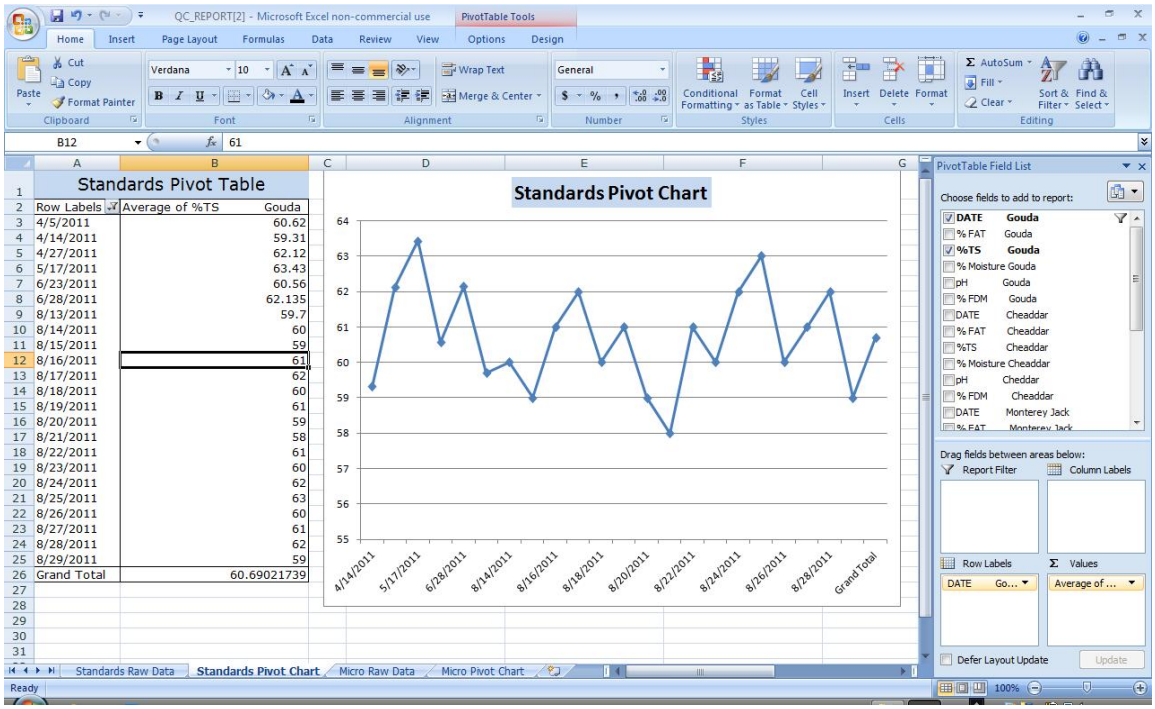


Figure 3. Demonstration of the Pivot Table Field List on the right side of the figure and how to change a specification.

In the pivot table, after entering your specifications to be examined, the data can be summarized into several different ways. The data numbers can be organized into: sum, count, average, max, min, and product. To get the most accurate graph, the average summarization function needs to be used. The figure below illustrates how this will be done. To use the average summarization function, right click on one of the specification numbers in the pivot table, which will be in the “B” column. After right clicking on a number, highlight Summarize Data By, with your mouse and click on, Average. The pivot table now has the date in the “A” column and your specification in the “B” column with these numbers reflected in the pivot chart graph. The graph can now be copy and pasted into another document for presentation purposes. The same procedure can be done for other specifications so you can look at multiple graphs of different figures.

If you want to change the specification to get a new graph, uncheck the specification in the Pivot Table Field list and drag the new specification into the Values box. After entering a new product date or specification in the Pivot Table Field List box, you must go through the previous steps listed above to have the data summarized by the average.

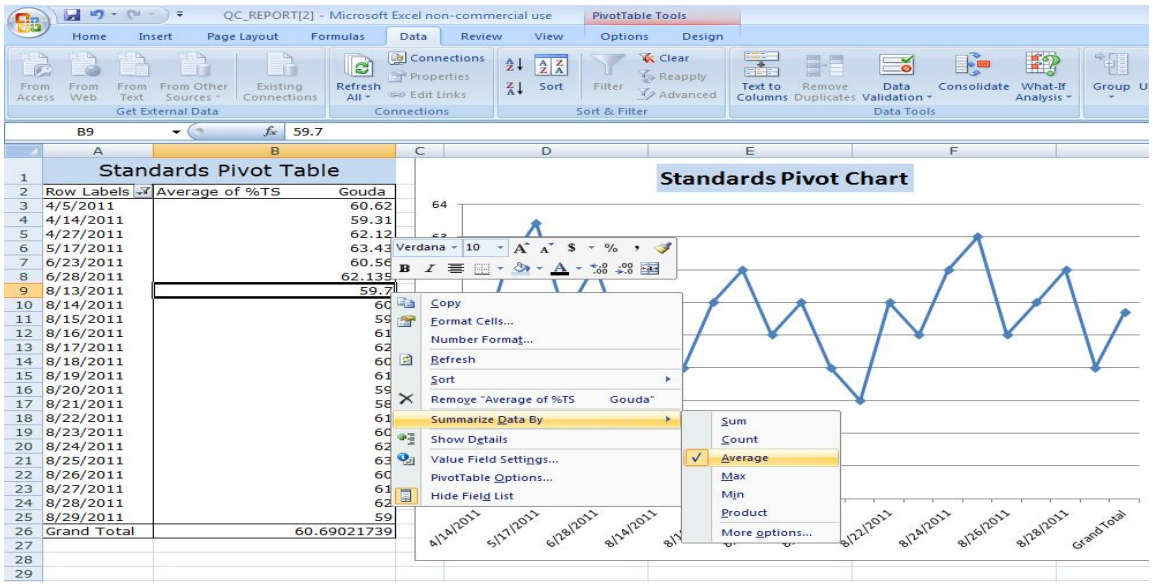


Figure 4. Summarizing data by the average.

If there is a specification you see is an outlier from the rest in the graph you can go to the pivot table and double-click on the date the specification was entered. This will bring up a new tab showing all the information of the product on that date which is shown in the figure below. This new tab allows you to see if any other specifications are outliers to determine the reasoning for the out of spec product. This procedure can become quick with practice in using the program.

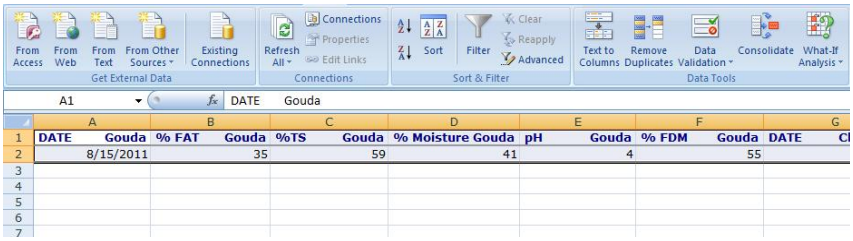


Figure 5. All specifications entered for a product on the date requested.

CONCLUSION

In conclusion, the newly proposed data evaluation system records and stores data that can be retrieved to see if contaminations occurred within the plant or outside the plant. When acquiring a new customer, the company might want to perform an audit of your processing facility and would want to look at your historical data in order to see how consistent you are with your required specifications. The Cal Poly Creamery will now be able to show historical data of how the plant is operating by the click of a mouse.

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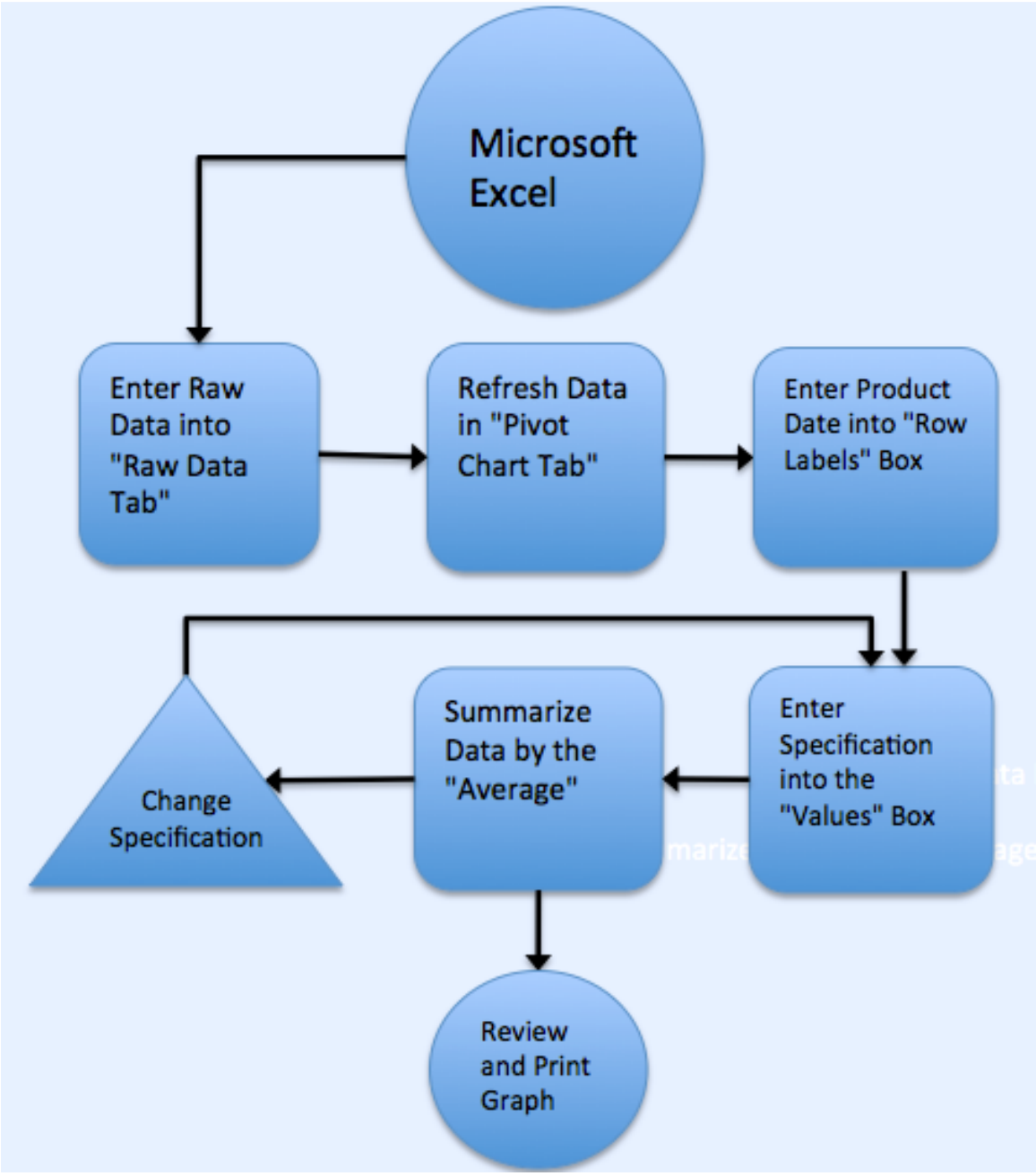
APPENDIX 1

Flow Chart Diagram



Appendix 1. This is a Flow chart diagram of the process of entering data into the spreadsheet in order to obtain a graph. This will be used as a training tool during the implementation of process.