Team 7: Measuregraph Inspectors

Final Report

TE 533 Spring 2024

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Overview

A manufacturer for Elevate Textiles, Burlington Finishing Plant, provides contract and decorative fabric dyeing and finishing for the apparel industry. At the plant, unfinished woven fabric travels through five distinct processes: receiving, prepping, dying, finishing, and inspection. During inspection, fabrics are given a grade corresponding to quality, and an "R" for rework corresponds to fabric that can potentially travel through the process again to fix defects.

Our group was responsible for Project 7, related to the measuregraph inspection process at Burlington. A measuregraph is an inspection device that clamps fabric across a roll and allows operators to get a closer look at defects under a light fixture. Rolls of fabric that receive a grade of "R" for rework are sent to the measuregraph frame to be further evaluated and determine if the fabric can be improved and sold as "firsts" or sold as scrap material as "seconds." The tracking and analysis of the measuregraph process is manual and distribution of this inventory information occurs twice a day through email.

Elevate requested that our group look into the material going through the measuregraph, including the type of products, the time spent between initial inspection and measuregraph, and the most common defects resulting in a "R" grade. We were provided data from the inspection stations, the measuregraph, as well as roll grade data and explanations for the data terminology. Our team consists of Suzy Szymeczek, Olivia Lowe, Dhrunal Bhimani, Parshva Amish Mehta, Vaishnavi Bhalchandra Kasar, and Chinmay Krishna Peri, and our point of contact was Shaghayegh Arangdad at Elevate.

Based on our preliminary meetings with Elevate and our site visit on March 8, 2024, our group was able to draft problem and mission statements that we presented to class, received feedback on, and revised. We determined that the overarching problem for this project was that Elevate Textiles currently does not have visibility on their measuregraph process. They do not have an understanding on how much time the fabrics spend in the queue between inspection and the measuregraph station, resulting in the inability to track inventory being held, costing them up to 13% of rework profits, since rework represents that portion of overall fabric grades. In order to address this issue, by April 19, 2024, our team intends to provide visibility of the measuregraph queuing process and create a priority index in order to improve measuregraph utilization to increase potential rework profits by a maximum of 13%.

Define Stage

During the Define Stage, it was important that our team had a clear understanding of the problem, the factors contributing to it, and the data involved. The majority of our questions were answered during our site visit to Burlington Finishing Plant, where we were able to watch the measuregraph and inspection processes, understand queuing and storage of the fabric rolls, and speak with Elevate employees who clarified any confusion about the processes. Following our visit, we relied on a Fishbone Cause-and-Effect diagram (*Figure 1*) to help brainstorm possible

causes of the issue and sort our ideas based on the 5 Ms: machine, method, material, manpower, and measurement (as well as money).

A few of the key causes were outdated communication and equipment, budget constraints, lack of standardized measurement tools, poor quality of fabric, and inadequate inventory management leading to delays. All of these factors and more were potential causes contributing to a clear lack of visibility in inspection of fabrics at the measuregraph station. This lack of visibility is causing a significant decrease in the potential sales of rework fabrics that could have been improved and shipped out sooner.

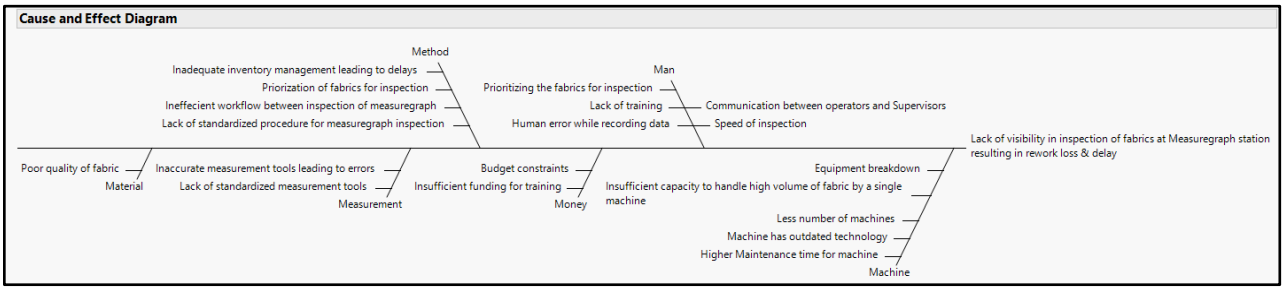


Figure 1: Fishbone Cause and Effect Diagram

Our problem statement is: Elevate Textiles currently does not have visibility on their measuregraph process. They do not have an understanding on how much time the fabrics spend in the queue between inspection and the measuregraph station, resulting in the inability to track inventory being held, costing them 13% of rework profits. Our mission statement is: By April 19, 2024, our team intends to provide visibility of the measuregraph queuing process and create a priority index in order to improve measuregraph utilization to increase potential rework profits by a maximum of 13%.

To keep our project on track and visualize our progress throughout different phases, we relied on a Gantt chart (*Figure 2*). The Gantt chart is a key six sigma project management tool that allows us to plan time to complete work and track when that work is actually accomplished. Since our project is on a fairly short timeline, our focus was on the define, measure, and analyze phases. Our goal was to be able to provide a thorough analysis of the problem and our recommended solution to Elevate, with the hopes that they will choose to implement those strategies to improve and control the measuregraph system. For each section, we identified several important tasks, assigned them to a member of the team, noted the intended start and end date, the duration, and the current percentage of the task completed. On the right hand side, we organized each day of progress into three phases and filled in day blocks corresponding to time spent on each task. This project plan helped us understand and prioritize tasks, delegate responsibilities, and provided a great overview of our work upon completion.

Team 7 Gantt Chart

PROJECT TITLE	Measuregraph Inspectors	COMPANY NAME	Elevate Textiles
TEAM MEMBERS		DATE	2/26/2024 Start Date

WBS NUMBER	TASK TITLE	TASK OWNER	START DATE	DUE DATE	DURATION	PCT OF TASK COMPLETE
1	**Define and Measure**					
1.1	Initial Meeting	All	2/26/24	2/26/24	0	100%
1.1.1	Site Visit	All	3/8/24	3/8/24	0	100%
1.2	Problem/Mission Statement	All	3/20/24	4/4/24	14	100%
1.3	Gantt Chart	Olivia	4/4/24	4/19/24	15	80%
1.4	Initial Data Cleaning	All	3/25/24	3/25/24	0	90%
1.6						
2	**Analyze (JMP)**					
2.1	Hypothesis Testing	Suzy	4/3/24	04/19/24	16	100%
2.2	Attributes Analysis	Suzy	4/3/24	4/19/24	16	100%
2.3	Root Cause Analysis	Vaishnavi	4/3/24	4/19/24	16	5%
2.4	Fishbone Diagram	Vaishnavi, Chinmay	4/3/24	4/19/24	16	5%
3	**Analyze (Excel and Tableau)**					
3.1	Finalize Data Cleaning	Dhrunal	4/3/24	04/19/24	16	100%
3.2	Analyze Outliers	Chinmay	4/3/24	4/19/24	16	90%
3.2.2	Tableau Dashboard	Dhrunal, Chinmay	4/12/24	4/19/24	16	75%
4	**Project Performance / Reporting**					
4.1	Final Presentation Slides (in class)	Parshva	4/12/24	04/26/24	0	0%
4.2	Final Report	Olivia	4/9/24	04/26/24	0	10%
4.3	Deliverables for Elevate		4/3/24	04/26/24	0	0%
4.4	Performance Review		4/3/24	04/26/24	0	0%

PHASE ONE: 2/26 - 3/18 | PHASE TWO: 3/18 - 4/8 | PHASE THREE 4/8-4/19

WEEK 1 | WEEK 2 | WEEK 3 | WEEK 4 | WEEK 5 | WEEK 6 | WEEK 7 | WEEK 8

M T W R F M T W R F M T W R F M T W R F M T W R F M T W R F M T W R F M T W R F

Figure 2: Gantt Chart

Measurement Stage

Our measurement stage relied heavily on the data we were provided from Elevate and set the stage for our in-depth analysis. Although we understood what the measuregraph and inspection processes looked like, we needed to see how that process lined up with the datasets we received. We were given three excel sheets (Measuregraph, Inspection, and Roll Grade) as well as a sheet that gave descriptions of the data fields. One challenge we faced was that the dates for the data provided in each sheet did not necessarily match up, nor did the column titles. For example, the inspection data provided a unique MO No., an internal lot number to track a piece of fabric throughout the plant. The measuregraph data had two separate columns for MO and line number, which we needed to concatenate in order to match data across the two datasets. Furthermore, the measuregraph data was particularly overwhelming, as the column for defects in the fabric allowed for free text with lots of mistypes and misspellings.

Before we could begin any analysis, we merged the data from inspection and measuregraph, cleaned it by removing duplicates and mistypes, and matched rows with corresponding MO No. and MO and line number. We then chose the data fields we wanted to include in our merged data, namely Mo-Line-No, Defect, Report Date (from the measuregraph sheet), Inspection Start Time, Inspection End Time, and Grade from Inspection (either 1st, 2nds, Swatch, Waste, or Rework). We relied on the XLOOKUP function to match these values, and then created a new column representing the days spent in queue between the end of first inspection and measuregraph inspection. This data was important to our analysis, as it gave us an idea of which fabrics, which lines, and which defects seemed to spend the most time in queue and resulted in rework losses. Another challenge we experienced was data mismatch, as there were many distinct values coming from the inspection sheet that did not appear in the measuregraph sheet. The measuregraph data had 4,040 rows and inspection data had 180,728, so after our data merging and cleaning we were left with 1,330 data points.

Our group would have liked to conduct a full measurement system analysis on the data received, particularly because it was a mix of manual and automated input. However, we learned there is only one operator who records data from the measuregraph and distributes that information in a twice-daily email to the team. Additionally, we were interested in comparing differences in the unfinished woven fabric that Burlington receives from two plants, one in Richmond County and one in Casamiras, Mexico. We did not have access to sufficient data during this project timeframe between the data sheets provided, but we would include it as part of this project's continuation.

Analysis Stage

As seen in our Gantt chart, the analysis stage involved work in both JMP and Excel (and Tableau) filled a significant portion of our work time. Once the data was sufficiently cleaned and organized, we began an outliers analysis in JMP (*Figure 3 and Figure 4*) to determine if outlier data points related to the days between inspection and measuregraph were significant or could be removed. Figure 4 showed that the vast majority of the 1,330 points were centered around the mean of 6.93 days, but there were several extreme outliers of up to 165 days in queue. We decided to keep all data points within two times the Interquartile Range and discarded a total of 71 outliers that had a difference of above 18.9 days.

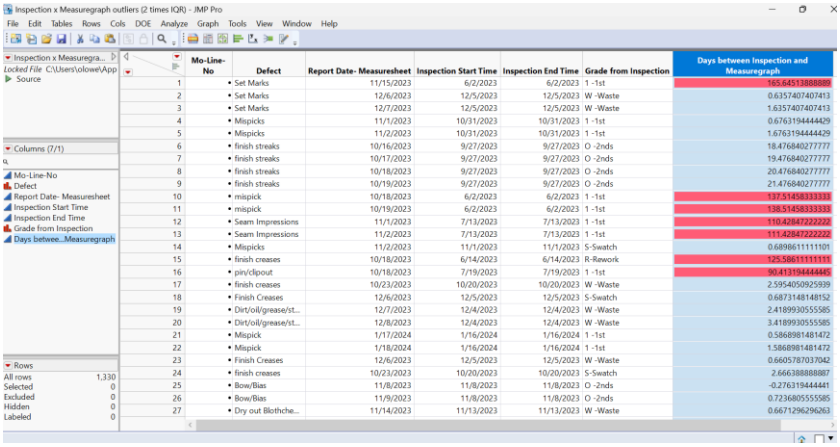


Figure 3: JMP Days in Queue Outliers Analysis

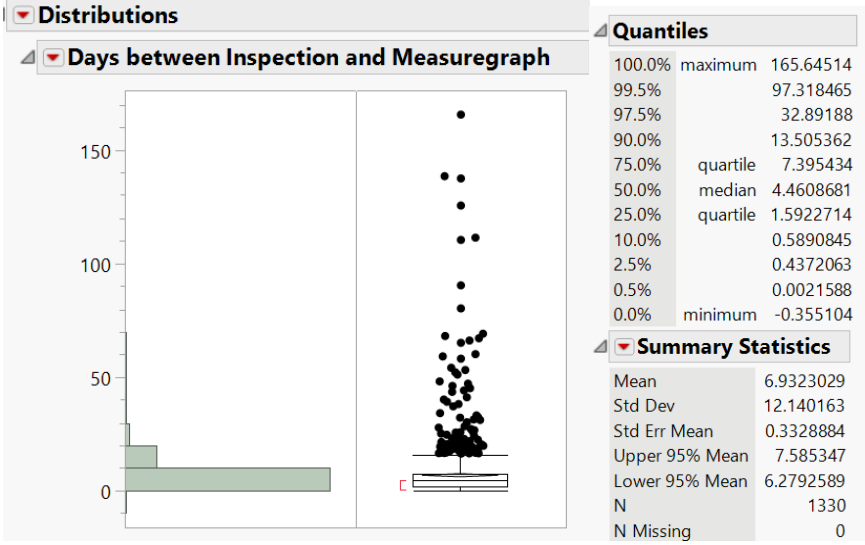


Figure 4: Distribution and Quantile Range for Days in Queue - JMP

Once outliers were removed we were able to begin a full analysis and visualization of the data in Tableau (*Figure 5*). Our hope is that Elevate Textiles relies on this dashboard going forward to understand details about queuing delays, common defects, and which lines see the most defects. The cleaned excel data was linked to Tableau in order to design five important graphs. On the homepage of the dashboard, the average days between inspection and measuregraph is organized into five sections for Rework, Waste, 1st, 2nds, and Swatch.

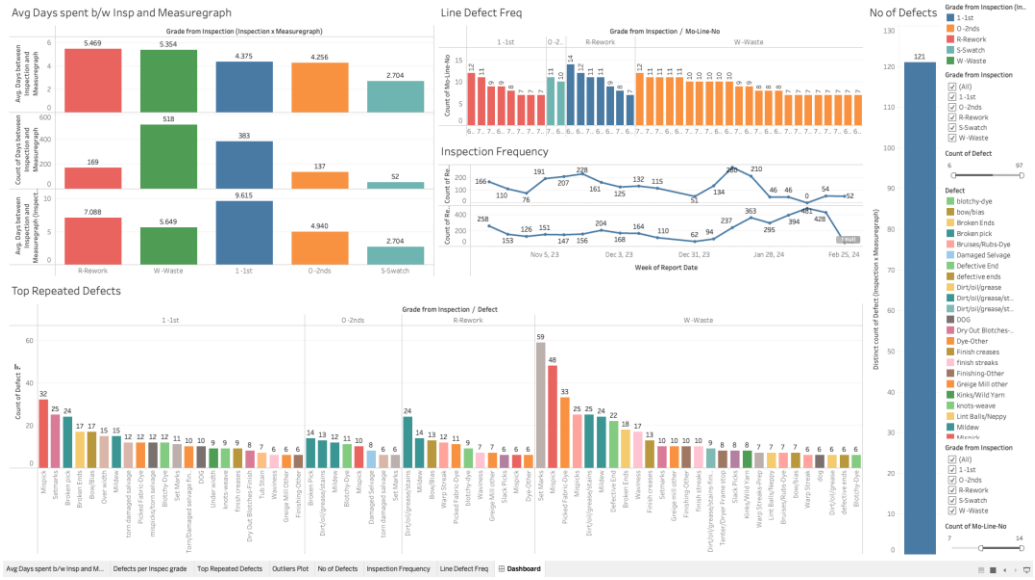


Figure 5: Full Tableau Dashboard

When a user selects any one of these filters by clicking on the color in the graph, the entire dashboard will adjust to reflect only data from that particular grade. Filtered snapshots of the dashboards for Waste, 1sts, 2nds, and Swatch are attached in Appendix A. In the upper right-hand corner, line defect frequency shows the line numbers with the highest count of defects from each

roll grade. Also, inspection frequency shows the count of inspections during each week of the past year or so of data. We see significant increases during busier weeks and a lull near Christmas time. On the far right, a single bar graph shows the total number of defects identified. The bottom of the dashboard displays the most commonly seen defects for each roll grade. For example, a roll grade of R sees a lot of dirt/oil/grease stain defects, followed by mildew, bow/bias, and war streak.

Particularly because Elevate asked for an overall analysis of factors contributing to delays and defects rather than an investigation into a specific piece of the data, our dashboard should be able to give them both an overall snapshot of the current situation as well as the ability to narrow into a particular concern. Tableau is also valuable because it can be updated easily in real time as long as new data is loaded into the dashboard. The one challenge with this is that Elevate will have to reclean and reorganize the data each time they load it into Tableau, or alternatively they could streamline this process by collecting data specific to the way we organized it.

Improvement Stage

Our improvement stage was somewhat theoretical, as we did not have time to actually implement any changes at Elevate or see the results of those changes. However, we believe our dashboard represents a significant improvement in the ability of the Elevate team to visualize the data they are collecting, identify issues such as long queue times and common defects, and monetize the amount they are losing as a result of these issues. Upon implementation of this dashboard, we hope that Elevate will rely on this strategy going forward and adjust their data collection strategy accordingly. Automatic data upload into Tableau is fairly straightforward if Elevate utilizes the same data outline and data fields that we designed throughout our analysis. Ideally we would have Elevate implement this dashboard for a few weeks, get their feedback, and then adjust the dashboard to include all the visualizations that are most helpful to them.

Summary and Continuation

Throughout this project, our team faced significant challenges related to defining Elevate's problem in the sense of a six sigma project and applying the JMP analysis we learned in class. Designing a problem and mission statement without a clear understanding of the profits or losses involved in the measuregraph station was difficult. Because 2nds fabrics are sold for scrap, all we were told from Elevate was that profits were fairly minimal unless an item marked rework was able to be fully refinished and sold as 1sts. We could have better defined the project if we had asked more questions about financial impact and requested more data from Elevate. We also struggled with using JMP and the analysis techniques we had learned in class for our data, since it seemed the majority of our work was done fastest in Excel and later Tableau. As far as our interaction with our sponsor, we would've liked to have more consistent data (without varying date ranges, mismatched data fields, and unclear headings). Ideally we would have had more time

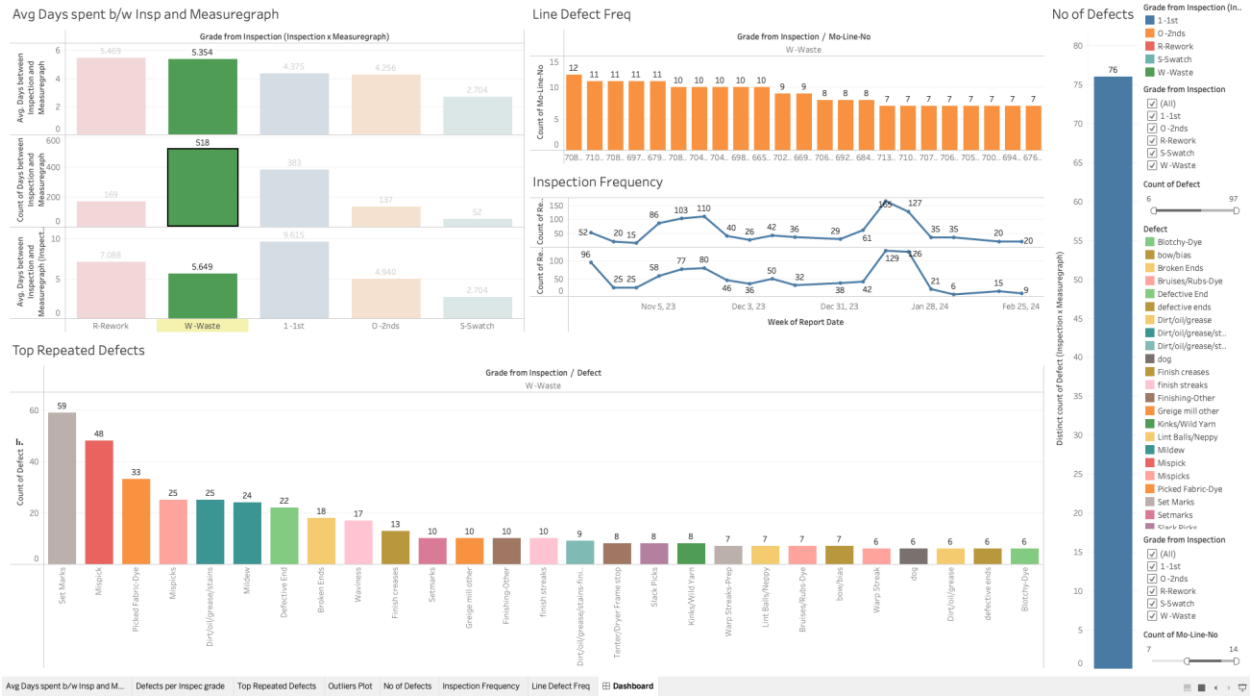
with our sponsor contacts and more time spent understanding the measuregraph process at the plant.

If this project were continued in the future, a team may be able to assist Elevate in implementing our prioritization and organizational recommendations and observing the results. In addition, they could receive the feedback on the dashboard, continue updating the data analysis, and streamline the process of inputting measuregraph data into Tableau. Another issue we ran into is that Elevate does not currently have data for the length of time fabric spends at the measuregraph itself. An investigation into other aspects of the measuregraph process, such as strategies for how to track time spent there, could be valuable. If Elevate chooses to integrate the use of the Tableau dashboard, it could streamline the work for the measuregraph operator and revolutionize their day-to-day work. This sort of visualization could easily be applied to other steps in the finishing process, particularly the inspection stations that may be experiencing similar delays or common defects.

Appendix A: Figures

A-1: R-Rework

A-2: W-Waste



A-3: 1-1st

A-4: O-2nds

A-5: S-Swatch


Avg Days spent b/w Insp and Measuregraph
Grade from Inspection (Inspection x Measuregraph)
Avg. Days between Inspection and Measuregraph
Count of Days between Inspection and Measuregraph
Avg. Days between Inspection and Measuregraph (Inspect...
5.469
5.354
4.375
4.256
2.704
169
518
383
137
52
7.068
5.649
9.615
4.940
2.704
R-Rework
W-Waste
1-1st
O-2nds
S-Swatch
Line Defect Freq
Grade from Inspection / Mo-Line-No
S-Swatch
Count of Mo-Line-No
5
4
4
4
4
3
3
2
2
69030-701
70983-101
70172-101
69768-103
68199-702
69577-106
68833-201
71566-103
69030-500
Inspection Frequency
Count of Re...
Nov 5, 23
Dec 3, 23
Dec 31, 23
Jan 28, 24
Feb 25, 24
Week of Report Date
No of Defects
Distinct count of Defect (Inspection x Measuregraph)
21
Grade from Inspection (In..
1-1st
O-2nds
R-Rework
S-Swatch
W-Waste
Grade from Inspection
(All)
Count of Defect
2
97
Defect
Bow/Bias
Deep Pinning
Defective Ends
Dirt/Oil/Grease
dog
Finish Creases
Finish Spots-Stains-...
Finish Streaks
finishing-other
flashed-picks
Mildew
morie
Set Marks
Count of Mo-Line-No
2
14
Top Repeated Defects
Grade from Inspection / Defect
S-Swatch
Count of Defect
5
5
4
4
4
4
4
3
3
2
2
2
2
Finish Spots-Stains-General
Finish Creases
morie
Dirt/Oil/Grease
Defective Ends
Deep Pinning
Bow/Bias
Set Marks
finishing-other
Mildew
flashed-picks
Finish Streaks
dog
Avg Days spent b/w Insp and M...
Defects per Inspec grade
Top Repeated Defects
Outliers Plot
No of Defects
Inspection Frequency
Line Defect Freq
Dashboard