Study of a Special Finishing Flow: Analysis and Improvement of Process Quality

Eduardo Alvim Marinato[1], Tiago Bittencourt Nazaré[2]
[1]Student of Industrial Engineering, Faculdades Integradas de Cataguases-FIC/UNIS
[2]Master in Engineering systems management, Universidade Católica de Petrópolis-UCP

Abstract

This paper is a field study that investigated the causes of the occurrence of a defect in the manufacturing process of a special textile finishing, to propose a corrective action for the problem. This work used data surveys, which were analyzed in graphical tools and tables with the purpose of facilitating the understanding; and the study of the flow process using a flowchart to verify the main point of the process and propose corrections. Ten tests were carried out to confirm the effectiveness of the correction proposal with no failures of the textile substrate, making it clear that the action is effective, not causing any time or cost losses for the company.

Keywords — *Process Flow, Quality, Flowchart, Process, Textile.*

I. INTRODUCTION

With the constant changes in the economy and consumer behavior associated with the globalization, which accelerates information and makes the relationship between customer and supplier easier, companies increasingly become more competitive. Actions for succeeding in the marketplace range from innovation to process control, waste reduction and quality improvement among other actions, which allow the company to satisfy the customer with lower costs.

Customer fidelity becomes more difficult, given the increasing offer, easy access to a great variety of virtual stores and sales channels on social networks, which bombard the customer with the most varied products, therefore making them increasingly demanding buyers.

A survey conducted by Accenture management, information technology and outsourcing consulting firm, published in April 2017, points out that 80% of Brazilians are reducing brand and business loyalty. Another study done by the same company and published in the Exame Magazine of April 2016 shows that Brazilian companies together lost about 217 billion dollars with clients who change brand or company.

A Salesforce study, published on the E-commerce Brazil website, found that 80% of customers around the world consider brand experience as important as product and service quality, and that 57% of the same participants would stop buying products of a certain brand to buy better ones of the competitors.

The objective of this work is to analyze the productive process flow of a special textile finish, identifying the fault that causes low resistance in the fabric, proposing an improvement action, which will be able to correct such defect, preventing it from frustrating the customers with the quality delivered.

II. LITERATURE REVIEW

A. Production Systems

This literary review seeks to conceptualize the idea of a productive system in general, pointing out the production, process and other items that make up this system. Reference [11], production is a network of processes and operations; on the other hand, [6] defines the "production system" as the set of interrelated activities and operations involved in the production of goods, in the case of industries, or the offer of services.

In organizations the inputs are raw materials, workers, etc. The transformations involve the operational sequence of each productive stream; outputs include finished products or services placed on the market [2].

B. Process

In general, a manufacturing system receives a set of inputs, from which the materials will be physically processed and acquire added value due to the use of a complex set of elements, which will result in output: finished products, destined directly to consumers, or semi-finished products that will be used by customers to make other finished products. [1].

value to it, and provides output to a specific customer. These processes use the organization's resources to deliver significant results to their customers [3].

Reference [4] states that, for a number of cases, the calculation of the sample size will guarantee statistical significance, with the minimum difference found, and for samples with known size the calculation to be used will be: $n = \frac{\rho.(1-\rho)Z^2.N}{e^2.(N-1)+Z^2.\rho.(1-\rho)}$ in which n is the sample calculated, N is the population, Z is the standard normal variable associated with the confidence level,

p true probability of the event and e the sampling error.

C. Mapping and Process Analysis

Reference [11] the analysis of the process examines the flow of material or product, while the analysis of operations examines the work performed by the products, by the worker, and by the machine. According to the same author, to make significant improvements in the production process it is necessary to distinguish the product flow from the work flow. Process mapping is a communication and an analytical management tool which intends to help improve existing processes or to deploy a new process-driven structure [12]. Its structured analysis also allows the reduction of costs in the development of products and services, the reduction in the failures of integration among systems, and the improvement of the performance of the organization. Moreover, it provides a better understanding of the current processes and eliminate or simplify those processes that need to be changed [12]. According to [5] there are at least seventy-two techniques for mapping the process, among them the flowchart, used in this article.

III.METHODOLOGY

This is an explanatory nature research, that is, it aims to collect data in order to define the causes and effects of the phenomenon studied, which is a failure in the special brushed finishing process.

Reference [10] the explanatory studies overlap the description of concepts or establishment of relationships between them, being therefore responsible for the causes of the respective phenomenon under analysis.

Based on these facts, this study sought to determine the cause or causes of the nonconformity presented during the improvement process of the fabric in the special brushed finish that can lead to the destruction of the fabric after brushing.

The researches involve literature review, with researches in books, scientific articles and journals, in addition to the field work carried out in the period from 05/02/2018 to 06/06/2018 in a textile company in the Zona da Mata Mineira; analysis of the results of the research in a quantitative character making it possible to collect numbers that will help in the analysis of such causes and results. Reference [9] a quantitative research aims to reach explanatory principles and generalizations.

In this research a study was carried out on a defect of the process before and after a change of the process flow of the brushed fabric, such defect was classified by the company as a low resistance problem. Since it is a defect that decreases the quality of the product, and directly impacts the financial results, it was extremely important to highlight the quantity of this loss in this article.

The figures source of this research is centered on the production application management software developed by the company itself to control and analyze its process. For laboratory quality control tests performed on its fabrics, the company follows standards set forth in specific patterns for manufacturing this product.

In this study two standards that regulate the resistance tests were used, they are: NBR 11912 Brazilian Regulatory Norms, approved by ABNT, Brazilian Association of Technical Standards, which determines the methods for carrying out the tensile strength test, determining the equipment to be used and models for preparing the sample to be tested, in addition to the procedures for analysis; and finally ISO 13937-1: 2000, a norm of ISO standards, International Organization for Standardization, which in this case governs the performance and analysis of tearing resistance tests. This norm also indicates the procedures for preparing the samples and the machinery to be used, and how to proceed in the analysis of the results. None of the standards determine the minimum or maximum value expected for the results found, the company is the one that determines the value for the resistance of its product, according to the manufactured fabric, specifying this value in the technical file sent to the customer at the time of purchase.

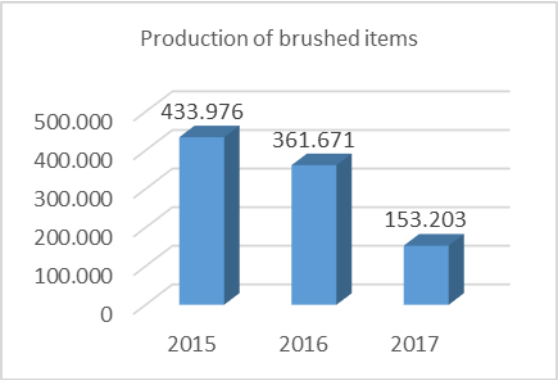
The figures regarding the anomaly and production volumes were analyzed in bar graphs, to facilitate the visualization and evaluation of the data found.

The low-quality fabric footage was divided into macro levels and analyzed on a pie chart, to facilitate the visualization of the one which presented the biggest defect: finally, the volumes of production of the fabric that presented the greatest volume of defect were observed in a line graph facilitating the recognition of the larger volumes produced. Tables were also used to show the results of the averages of the 216 batches produced to verify defective fabric within the macro level white TP. The lots manufactured from one of the articles were analyzed in the control chart, seeking to understand the variations between batches and the control of the process.

The number of lots analyzed in the control chart was determined using the formula of the sample size calculation, using 99% confidence level and 5% sample error, the value of the sample error was defined based on the highest index of second quality allowed by the company, which is 5% of the total produced.

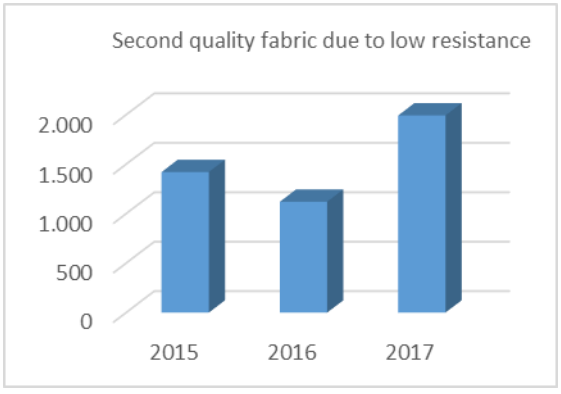
IV. RESULTS AND DISCUSSION

This research aims to analyze and identify the cause of the failure occurred in the process, proposing an improvement action to extinguish the low resistance defect found in the flow of the brushed fabric, known as low resistance, focusing on the special brushed textile finishing. The analysis of the data began with the survey of the total volume produced of the brushed finish in the last three years, as seen in 1:



Graph 1 - Brushed finishing volume of production in the last three years.

Graph 1 shows that there is an annual reduction of this kind of finishing, mainly from 2016 to 2017, when this reduction represented 57.64%. In addition to the volume of the production of the brushed finish, the evolution of the defect increased in the same period and showing, therefore, a need for further analysis regarding such behavior, as shown in graph 2:

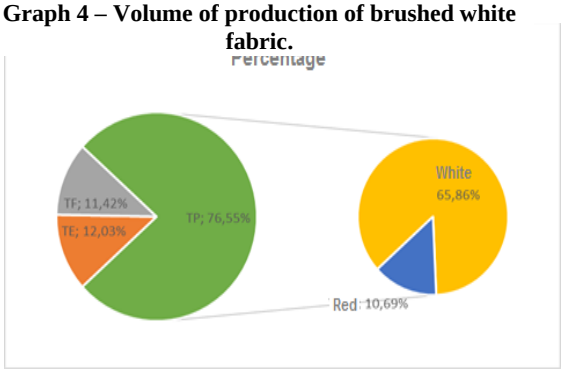


Graph 1 – Second quality due to low resistance.

Both graphs show that although the production reduces, the volume of the defect increases, that is, the problem is not related to the volume produced, since there was considerable increase of defect of the year 2016 to 2017, higher than 70%, however 2016 was better than 2015. This has shown that despite the reduction in volumes produced over the years, the defect continues to increase, leading to the assumption that it is not under control, and that there is no guarantee of the desired quality in case of a significant increase in production volume.

For a better understanding, in a second step,

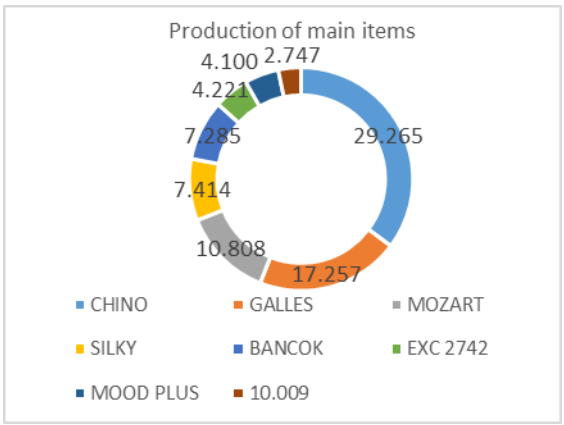
Graph 4 – Volume of production of brushed white fabric.



Graph 3 – Percentage of defect divided by macro levels

the stratification of the defect was made into macro levels from the brushed finish produced in the same period which were pointed as second quality with the classification of the defect studied. The data are expressed in graph 3.

Then, the production of TP fabrics in the white segment, produced in the brushed finish, was surveyed. Considering that the company changes its portfolio, releasing new collections according to the seasons, the survey considered the most recent collections, that is, the year 2017. Graph 4 presents the production of brushed fabrics in the year 2017 in the white segment:



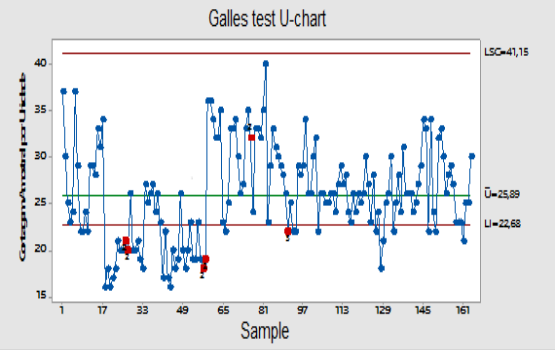
Resistance average - tension in Kgf e tearing in Gf				
Item	White		PT	
	Tearing	Tension	Tearing	Tension
Galles	736	25	768	26
Chino	>1280	36	>1280	40
Egito	>1216	38	>1280	38
Bancok	>1280	45	>1280	45
Denim	>1280	34	>1280	37
Exc 2742	>1168	26	>1020	26
Marfim	>1280	40	>1280	40

Table 1 – Comparative Tensile strength test: white and red

The item Galles presents itself as the fabric that had the greatest volume of production in the year 2017. Afterwards, it was presented a comparative study of the resistance of the fabric produced in the brush in the white and the red segment that presented lower index of failures, both originated of the macro level TP. Table 1 shows the comparison of the average found in the tests made in the lots produced in the year 2017

On average the results found attended the expectations the company. The item Galles was the one that presented less value for the tests, yet above 22.68 Kgf for tension and 720 Gf for tearing, limit established by the company to customers. Analyzing the laboratory tests individually, there were no failures in the tear resistance test, only in the tensile.

In this case, the tests of the article Galles in the period of 2017 were run in the control chart, with the help of the Minitab Software, to evaluate the sample deviation, as shown in graph 5 below:



Graph 5 – U-chart of the tests of item Galles

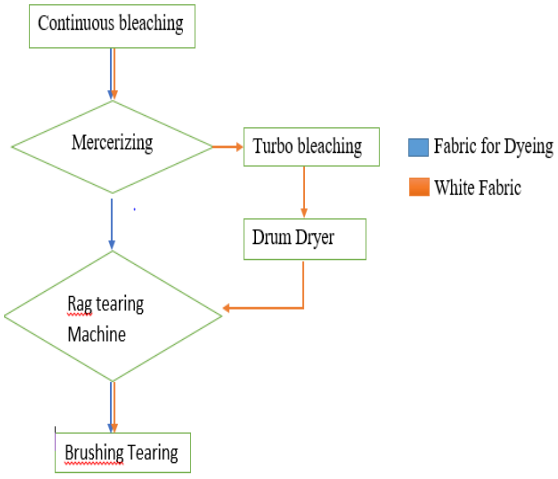
For this test, the u-chart was used since it was individual samples taken in each production batch, and there were no repetitions for group formations. There were 216 lots to be analyzed, according to the calculation of the sample size according to the equation mentioned in the methodology section. A total of 164 samples were analyzed.

Graph 5 was constructed with its lower limit of control respecting the minimum standard of the company which is 22,68. The average and upper limit were automatically stipulated.

In the control chart made in Minitab it was verified that, among the 164 tests examined, 45 samples failed to the value of 22.68 Kgf, a total of 27% of the batches measured. However, there are also samples that presented very high resistance, thus raising the average of the results, making it look within a control pattern. In the graph it is noticed that the upper limit was calculated by the Software in 41,15 Kgf with an average of 25,89 Kgf, that is, 15,26 kgf more than the average, 58% more than the calculated, which leads to a compromised assessment of table 1, where no significant variation is observed. The Minitab test also failed for more than 9 consecutive samples below the midline and 6 consecutive points above the line, confirming the lack of process control.

Thus, the article Galles was taken as a basis for the continuity of the work so that the results achieved, once positive, would be replicated in the other articles.

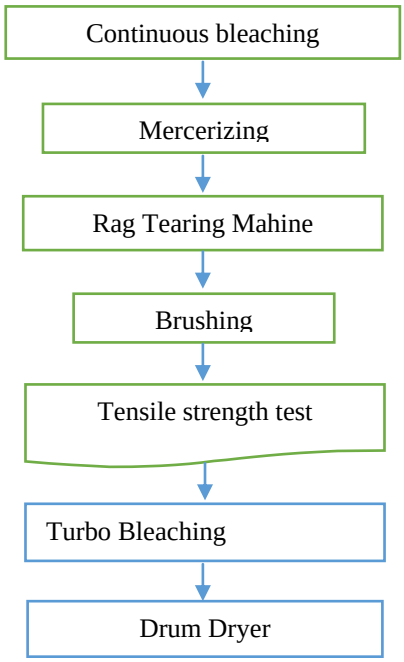
The process flow mapping of the brushed white fabric was made using the flowchart tool, analyzing from the preparation to the tests after brushing, as shown in figure 1



Picture 1 - Comparative flow: red and white process

The study shows a significant variation in the flow of the processes, the flow of the white tissue has an extra bleaching in its preparation. The textile bleaching is used to achieve whiteness and fiber cleaning, based on a chemical compound based on caustic soda and hydrogen peroxide, which makes it more sensitive to the brushing process.

With this information a change in the flow was proposed, making the bleaching after the brushing, so that the tissue would have the same flow of the red fabric in the part of preparation, according to figure 2 a below:

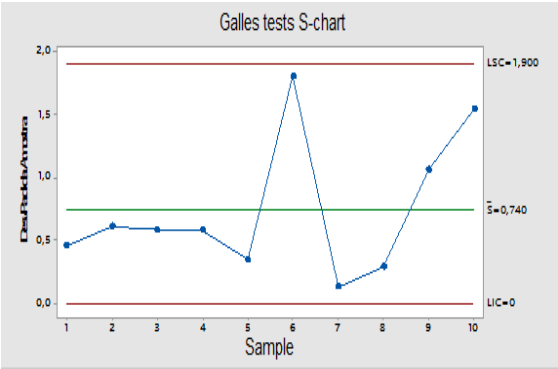


Picture 2 – Proposal of flow for the white brushed fabric

Tests were carried out in different batches at different times, observing the result of the previous batch before starting the new process, in total the company allowed to test 10 batches.

In this way, ten tests were performed on different production lots, according to the proposed flow, the tests were applied according to the standards previously mentioned. There were no tests with values lower than the standard of the company which is 22,68 Kgf, ranging from 22,93 Kgf to 37,09 kgf. It is important to emphasize that for the purpose of the fabric, the resistance with high values is valuable, in the case of this study only the values below the stipulated influence on the result, making it weaker, thus favoring tear more easily.

Thus, the results were analyzed in the S-chart to verify the standard deviation, since there were no tests with results below the limit. Graph 6 shows the standard deviation test:



Graph 6 - Standard deviation graph of tested samples

Graph 6 shows that among ten tests performed, there is a control, since the value found for the deviation is less than 1, even with peaks at points 6 and 10, the graph tends to be normal. It should be noted that tests with high strength values are valuable to the process because they diminish the possibility of the fabric tearing during the manufacturing process or even after the finished part. The variations of elevation of resistance do not influence in the quality of the product, the important thing is that the minimum limit will not be exceeded; such result was found in the ten samples tested.

V. CONCLUSION

The research showed a higher incidence of the problem concentrated in the brushed articles, at the macro level TP in the white segment, with approximately 65% of the occurrences verified, whereas the red segment presented only 10% of the problem in the same process. Even with a reduction of 57% in production from 2016 to 2017, the low fabric resistance defect cases increased 70% in the same period.

The study made with the flowchart tool in the brushed fabric process, observing it since preparation until the brushing part, comparing the fabric of the macro level TP of the white and the red segment, found a difference in the processes: in the preparation part, but specifically at the application of the second bleaching, in the case of white fabric.

Proposing bleaching after brushing the fabric neither added more processes to the flow nor decreased, as can be seen in Figures 1 and 2. The position of the bleaching was changed in the flow, so the duration of the process also remained the same.

All ten tests made with the company's authorization, applying the change in flow, showed results for the resistance test higher than 22.68 Kgf, showing that it is possible to control the problem. The fact that the base reaches the brush without the second bleaching gives the fabric the ideal characteristic for the brushing process, without necessarily compromising the fabric resistance, as found in the batches produced before this change.

The change in the process flow of the brushed white fabric reduced the low-quality indexes and presented a normal process, according to graph 5. Based on the analysis made, it was concluded that the change in the flow can correct the problem, which was mainly caused by bleaching the fabric before the brushing process.

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