OneDay Toric Yield Improvement

Jonathan M. Rivera Rios
Master in Engineering Management
Héctor J. Cruzado, PhD
Department of Civil & Environmental Engineering and Land Surveying
Polytechnic University of Puerto Rico

Abstract *— This project was developed in CooperVision, Juana Diaz Site, specifically for the OneDay Toric product. It is focused on the Wet Process of the product life cycle. There was a gap between two manufacturing technologies that manufacture the same product. The gap was around 5% in wet yield, given by the data from January 2021 to March 2021. In order to understand the difference better, the project was worked through the DMAIC methodology. Statistical tools were used to measure and analyze the process, and then brainstorming strategies were done in order to provide plausible solutions. An opportunity was identified in configuration file of the GenII+ vision system. The issue was addressed, and false rejects were reduced by 93%, thus increasing the product wet yield.*

Key Terms – *Yield, Continuous Improvement, Vision Systems, Contact Lens*

INTRODUCTION

The OneDay Toric yield Improvement project was focused in the toric lens product on the Hydrogels Business Unit of CooperVision, Puerto Rico. The objective of this project was to reduce the gap between the two different technologies in the wet platform that manufacture the same product, One Day Toric. A difference of 5% was identified between the Wet Yield of GenII and GenII+ machines. The reduction of this gap will translate to a yield increase of the product, thus lowering the product cost to manufacture.

LITERATURE REVIEW

One of the most important phases in the project was establishing the correct problem-solving methodology [1]. The wet yield is composed of three variables: Demoulding Yield, Cosmetic Yield and Process Yield. In the measure stage, these variables were measured and analyzed using statistical tools to determine the area of opportunity [2]. In order to provide a reliable solution, a robust solution needed be achieved, even if it meant redesigning some key aspect of the process [3]. Tools such as a Design of Experiment can ensure that the optimal and most reliable solution is achieved [4]. Once the solution was implemented, the process needed to be measured in the control phase to ensure the effectiveness of the Improvement.

MEASURE STAGE

The wet yield for the OneDay Toric product was 84.74 % in ST01 (GenII Technology), 77.99% in ST04 (GenII+ Technology) and 78.61% in ST20 (GenII+ Technology). The wet yield is composed of demoulding yield times the cosmetic yield times the process yield. Clearly, there was a difference in the cosmetic yield between technologies. The Gen II+ machines had a lower cosmetic yield than the Gen II line (ST01). The Project was focused on understanding and eliminating that cosmetic yield gap. The breakdown of the Wet Yield is presented in Figures 1, 2 and 3.

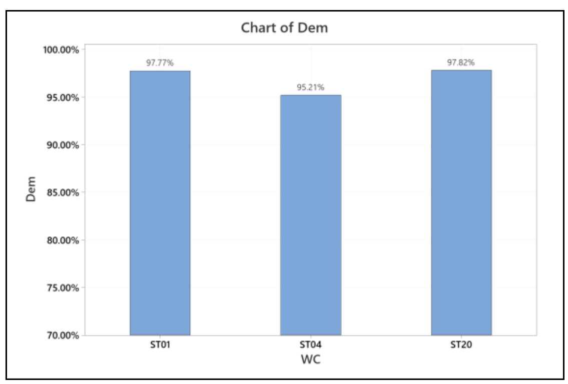

Figure 1
Demoulding Yield

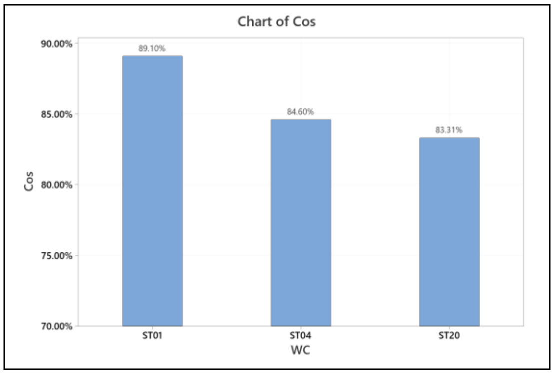

Figure 2
Cosmetic Yield

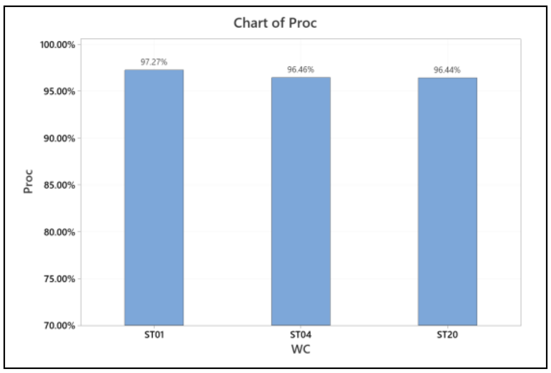

Figure 3
Process Yield

To understand the potential solutions for the project, a problem-solving exercise was done. The exercise was documented as a Fishbone diagram. As a result of the exercise, the configuration file for the vision system was further investigated.

Vision System Analysis

On all Sortimat systems with GENII+ technologies, the arrangement of the computer is one computer to control station 13 and a second to control station 14. The GenII+ software captures the image and passes it to the algorithms and receives the results. The captured image is displayed, and the user interface indicates whether that image passed or failed.

There are several differences between both technologies. In GenII the cameras are older and communicate through firewire, while in GenII+ they communicate via Ethernet IP. In the configuration file, there are different parameter settings for defect detection. In GenII+ the orientation mark was classified as a particle and in other instances as scratch, most of these were false rejects.

Photos were taken using a graticule in ST01 and ST20 to determine the mm to pixels ratio in both technologies, as presented in Figure 4. The image samples were then analyzed in the AutoOptimizer. A millimeter was measured in each image and the measurement was repeated 5 times. The result of this exercise was that there was not significant statistical difference between technologies. The ratio to pixels was the same in both technologies.

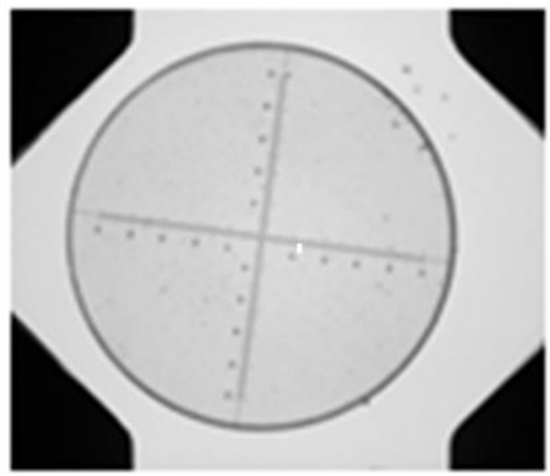

Figure 4
Graticule Photograph

The parameters of the defect detection and classification in the configuration file was different between technologies. With the results of the mm to pixels test, there was no need for that difference. Defect detection parameters had to be the same in GenII and GenII+.

Results

After the test performed, a worse case was determined. This worse case is one (1) millimeter is equal to 75 pixels. If we use 1mm = 75 pels, then 2mm = 150 pels. Therefore:

$$m = \frac{150-75}{2-1}$$

$$m = 75$$

Using the insert drawing, the maximum measurement for the orientation mark is 1.165 mm. Then, this measurement was converted to pixels as follows:

$$y = mx$$
$$y = 75 * 1.165$$
$$y = 87.375\ pixels$$

The result was that a length of 87.375 pixels was the longest that the orientation mark could be as per design.

After the orientation mark conversion, 100 failed images (by particle defect) were debugged in the auto optimizer using the calculated pixels (87.00 pixels for length) and (1850 pixels for area), as presented in Figure 5. After this exercise, the results were compared with the currently configuration files of GENII +. The results were that 93% of the images were now classified as a passed lens.

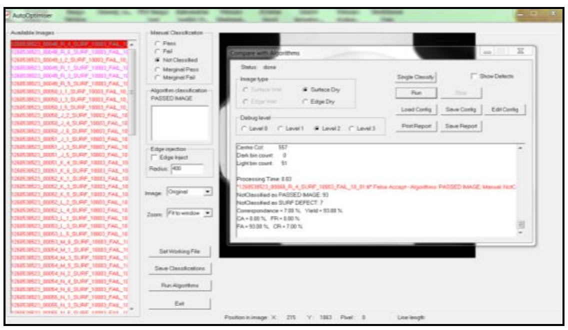

Figure 5
AutoOptimizer Results Screen

A lot with "particle defect" was identified in manufacturing. Two dry bags that were manufactured with the same insert were segregated. One Dry bag was processed on a Sortimat Wetline with the current surface configuration file, and the other Dry bag was processed with the new proposed surface configuration file. The results from the first lot with the current surface configuration file and the second lot with the proposed surface configuration file were compared, as shown on Table 1. This shows an improvement of more than 93% of the false rejects.

Table 1
Yield Results

	Total	Particle Defect	Percentage
Current surf config file	2022	172	8.506 %
Proposed surf config file	2004	10	0.499 %

Recommendations

The new configuration file was validated with an Installation and Operational Qualification (I/OQ) as well as a Product Performance Qualification (PPQ). The product was processed in the machine as it would normally be. The new configuration file was the only software that was validated. For the Product Performance Qualification, a single sampling plan was used (n=288; a=0; r=1, AQL: 0.018%, LTPD: 0.80%). This sampling was done in the QA final process after the product has been sealed and sterilized.

Conclusion

The Objective of this project was to reduce the yield gap between the two technologies that were used to manufacture the One Day Toric Product. To do this, a problem-solving exercise was done to find a possible solution to this situation. The opportunity was identified in the configuration file of the new vision system. After various test, documented under an Engineering study the new parameter set was validated. The false rejects due to the orientation mark classification were improved in more than 90%. No defect was found in the QA Final sampling for the PPQ. The new configuration file was successfully validated without any deviation. After this validation, a similar exercise can be done for other toric products manufactured in the company.

References

[1] Buie, M. (2017). Problem solving for new engineers: What every engineering manager wants you to know. Retrieved from Buie, M. (2017). ProQuest Ebook Central https://ebookcentral.proquest.com.

[2] Francesco Aggogeri, M. M. (2009). Combining Six Sigma With Lean Production to Increase the Performance Level of a Manufacturing System.

[3] Tapabrata Ray, M. A. (2015). An Approach to Identify Six Sigma Robust Solutions of Multi/Many-Objective Engineering Design Optimization Problems.

[4] Antony, J. (2014). Design of experiments for engineers and scientists. ProQuest Ebook Central.