# REDUCTION OF MODULE 2 DETAPE RATE

**Odelon C. Garing**
**Ryan C. Mendoza**
**Dave V. Dalisay**

Process Engineering, Maintenance
ams OSRAM, #2 Makiling Drive, CIP2, Brgy. Milagrosa, Calamba City, Laguna
odelon.garing@ams-osram.com; Ryan.Mendoza@ams-osram.com; Dave.Dalisay@ams-osram.com

## *ABSTRACT*

The electronics industry is making a remarkable investment in surface mount technology. In Figure 1, Integrated Test to Reel machine can pick and place thousands of units per hour with a very high degree of accuracy. The ideal packing material available today for these demands is tape and reel.

In the tape and reel format, the units are placed in specifically designed pockets embossed in plastic carrier tape. The cover tape is sealed to the carrier tape to keep the parts in place in these pockets.

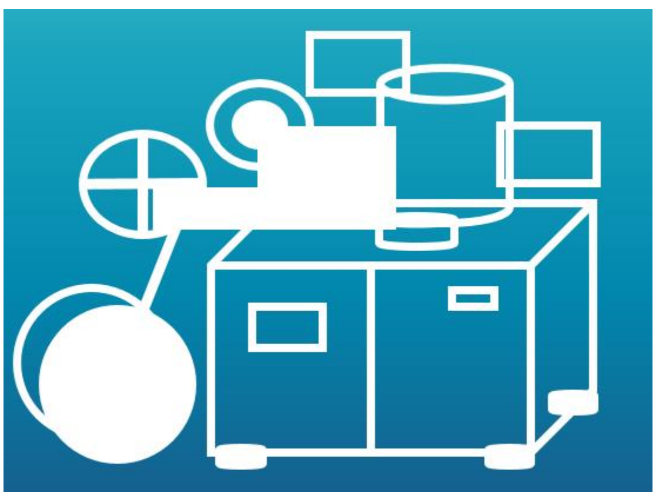

Figure 1. Integrated Test to Reel Machine

With the high volume forecast for 2022 (25% increase vs 2021), it will cost an additional $$$K USD for the Detape process if improvement has not been done. Once the target is met (80% reduction), approximately $$$K USD will be saved per year.

## 1. 0 INTRODUCTION

With the current semiconductor industry packaging, the die size and also the carrier tape are getting smaller and smaller and the reel size will increase as well the units per reel. This means the more units in the reel the more the units will be shipped to the customer but if the reel is damaged, more units will be held for Detape process.

Defect characteristics:

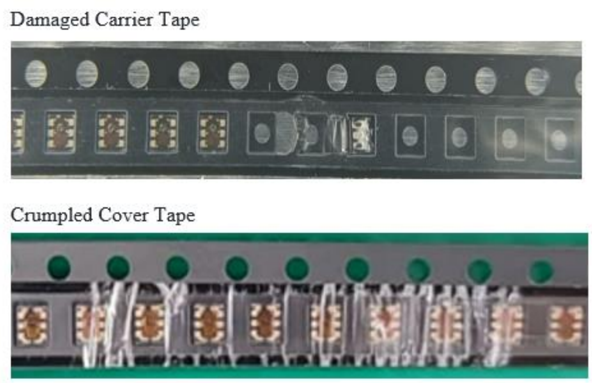


Figure 2. Damaged Carrier Tape and Crumpled Cover Tape

What is Detape process? If there is a damaged carrier tape or crumpled cover tape material that is carrying the units, it cannot be shipped to the customer! To make this a shippable material, it needs to be transferred from damaged carrier tape going to good carrier tape using a reworker machine, and that is a Detape process.

Now, this is the problem of the Module 2 line, for the 2nd half of the year 2021 about 1.7M units out of 363M units, or 0.48% were moved Detape process. It needs additional 3 Reworker machines, 4 manpower, and material wastage which gives an additional $$$K USD cost of rework.

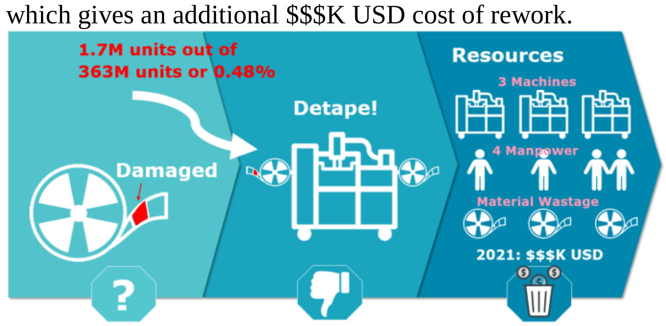


Figure 3. Problem Statement

This study will focus on how to prevent damaged carrier tape and crumpled cover tape during the integrated test reel process of Module 2 line.

The target for Detape rate is 0.10% against the baseline of 0.48%, this is an 80% reduction, for the cycle time the target is <3.33 days.

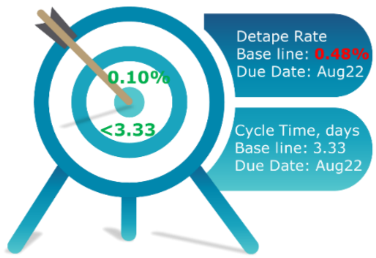


Figure 4. Project Goals

## 2. 0 REVIEW OF RELATED WORK

"Not Applicable.".

## 3.0 METHODOLOGY

3.1 Using Pareto Analysis, 80% of Detape parts are coming from Module 2 line which has 76% machine induced.

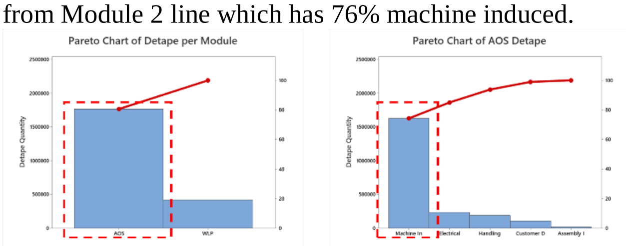


Figure 5. Pareto Analysis

3.2 In the Module 2 device process flow, it will only focus on the integrated test-to-reel process where the damaged carrier tape and crumpled cover tape are being encountered and the next 2 succeeding process steps are both detection point, the 100% manual QA FVI (Final Visual Inspection) and Post Seal Inspection (PSI).

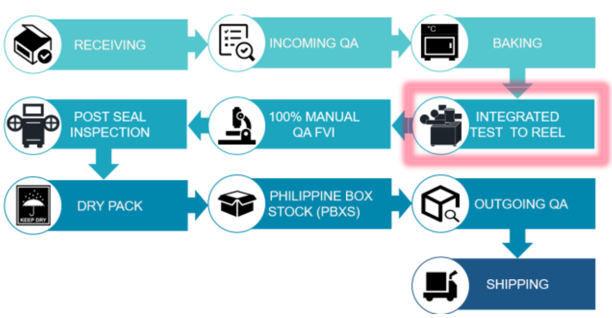


Figure 6. Module 2 Device Process Flow

Below is the process flow of unit in the handler, untested units will be placed at the bowl feeder then the rotator assembly will handle the units moving to test sites, AOI, and taping track. In the taping track, this is where the damaged carrier tape and crumpled cover tape are encountered.

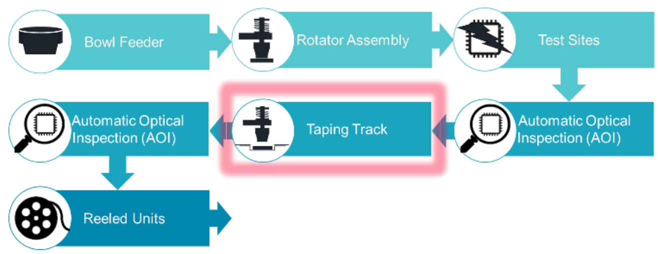


Figure 7. Process Flow of Unit at Handler

Using Minitab, agreement analysis are run for QA FVI and PSI machine, and the assessment agreement within the appraiser and Appraiser vs. standard are both 100% acceptable. Therefore the current measurement system is capable

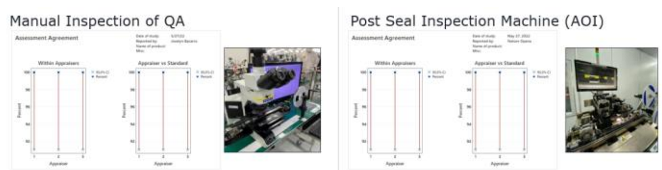


Figure 8. Agreement Analysis Results

Using Laney P' Chart, The process is statistically in control. However the average % defective is 0.45%, which is above the target of 0.10%. This process cannot meet the goal requirement and is not acceptable!

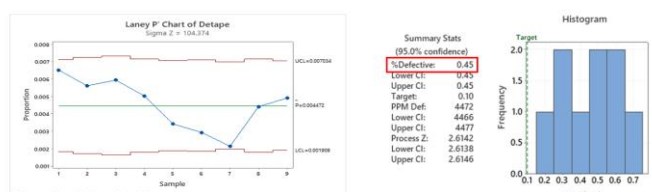


Figure 9. Process Capability

3.3 Based on Fishbone Diagram, there are identified 3 factors contributing to a high detape rate under the machine. These are the Rotator Assembly, Taping Track, and Cover tape input assembly.

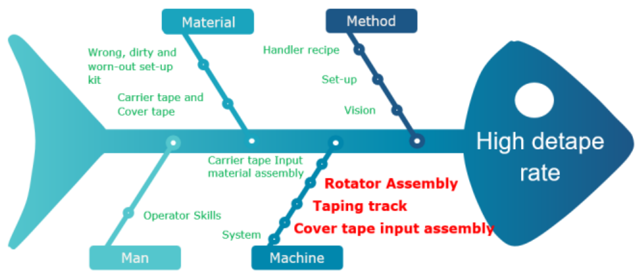


Figure 10. Fishbone Diagram

From the fishbone diagram identified factors, 4 Key Process Input Variables (KPIV) are needed to evaluate, these are the drop height, tape entry vacuum pressure, tape entry purge pressure, and cover tape stopper. The process is Integrated Test to Reel and the output is % damaged carrier tape and jams.

The first key process input variable (KPIV) that was analyzed is the drop height from the rotator assembly, it is the distance of the unit to the carrier tape pocket before the drop. Inconsistent drop heights like too high or too low can cause a damaged carrier tape pocket/jamming. In the illustration below, the drop height is high and it shows the unit hitting the top plate and eventually damaging the carrier tape pocket.

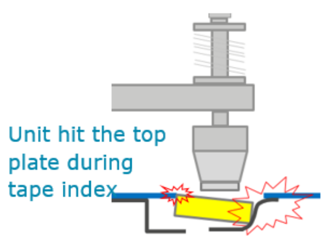


Figure 11. Drop Height Simulation

During the drop height investigation, it was also observed that there is wrong timing of the vacuum sequence. Corrective action will be addressed at improve phase.

To further validate the hypothesis, a 2 sample % defective test is performed, the P value is less than 0.05, it is therefore concluded that the alternative hypothesis is true. The drop height is a significant factor in the damaged pocket and carrier tape jam.

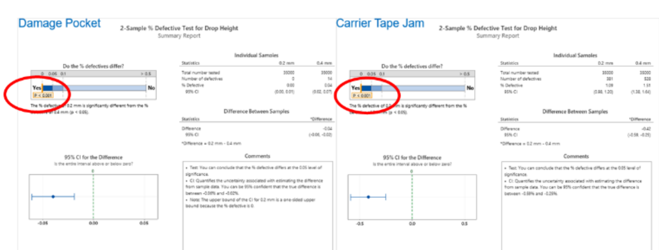


Figure 12. 2 Sample % Defective Test Results - Drop Height

The second KPIV that has undergone investigation is the Tape Entry vacuum pressure from the Taping Track, which holds the unit during the tape index. Weak vacuum pressure from tape entry will make the unit unstable from the carrier tape pocket during tape index and can hit the pick-up head or the top plate window and eventually damage the carrier tape and encounter a machine jam. In the illustration below, the unit with weak vacuum pressure hit the pick-up head during the tape index

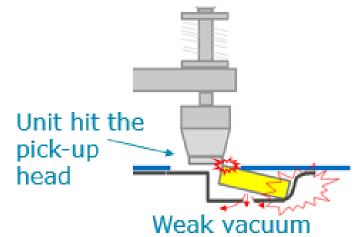


Figure 13. Tape Entry Vacuum Pressure Simulation

Using statistical analysis, the Tape entry vacuum pressure is a significant factor in the damaged pocket and carrier tape jam.

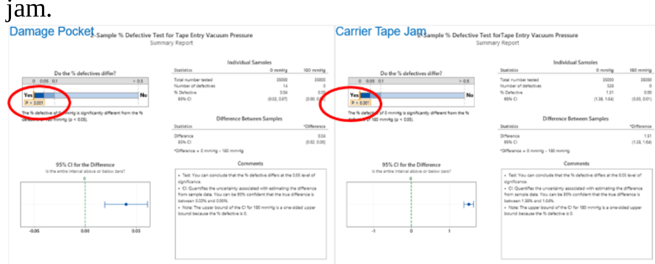


Figure 14. 2 Sample % Defective Test Results – Tape Entry Vacuum Pressure

The 3rd KPIV is the tape entry purge pressure, it is used to release the rejected unit by the Automatic Optical Inspection (AOI) from the carrier tape pocket during the auto rollback (AR) sequence, unoptimized purge pressure from tape entry can cause a carrier tape jam and possibly damage carrier tape. In the illustration below, the replacement unit just bounced upon being dropped, the trapped purge pressure pushes the unit and upon tape index, it hit the top plate.

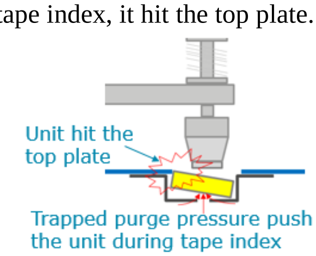


Figure 15. Purge Pressure Simulation

Using statistical analysis, the Tape entry purge pressure is a significant factor in carrier tape jam

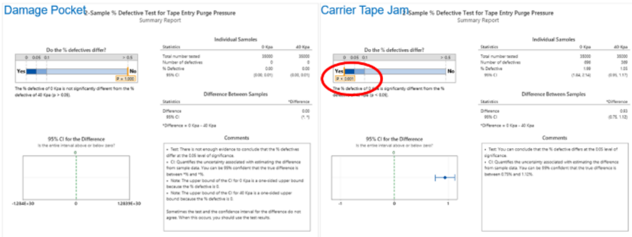


Figure 16. 2 Sample % Defective Test Results – Purge Pressure

The last KPIV is the cover tape stopper pressure, it stops the cover tape supply during the auto rollback sequence. A gap or weak pressure from this will continue a supply of cover tape during the auto rollback sequence that will lead to a loose tension and will cause crumpled cover tape and carrier tape jam


Figure 17. Cover Tape Stopper

Using statistical analysis, the Cover tape stopper pressure is a significant factor in crumpled cover tape and carrier tape jam.

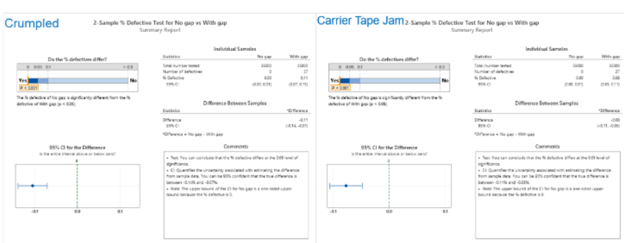


Figure 17. 2 Sample % Defective Test Results – Cover Tape Stopper

To summarize the analyze phase, there are 4 significant factors identified, the Drop Height, Tape Entry Vacuum Pressure, Tape Entry Purge Pressure, Cover Tape Stopper Pressure. Three significant factors are the Inpocket vacuum pressure, Ionizer pressure, and cover tape stopper design/material which are all not discussed in this report.

3.4 To begin with the Improve Phase, identified actions and improvement plan have been reviewed and all are 100% closed.

| | KPIV | Detail | Action / Improvement Plan | Person-in-charge | Start Date | Due Date | Status |
|---|---|---|---|---|---|---|---|
| 1 | KPIV 1 Drop Height | During placing of the unit to carrier tape pocket, drop height is the critical and the PUH vacuum sequence | Evaluate the recommended drop height and correct the PUH vacuum sequence to prevent the carrier tape damage and carrier tape jam | Ryan Mendoza/ Dave Dalisay/ Odelon Garing | 05/02/2022 | 05/31/2022 | Closed |
| 2 | KPIV 2 Tape Entry Vacuum Pressure | During placing of the unit to carrier tape pocket, tape entry vacuum pressure hold the unit upon placing on it | Evaluate the recommended vacuum pressure to prevent the carrier tape damage and carrier tape jam | Ryan Mendoza/ Dave Dalisay/ Odelon Garing | 05/02/2022 | 05/31/2022 | Closed |
| 3 | KPIV 3 Tape Entry Purge Pressure | During replacement of reject unit the tape entry purge the unit for drop | Evaluate the optimum settings of tape entry purge pressure to prevent a carrier tape jam or carrier tape damage | Ryan Mendoza/ Dave Dalisay/ Odelon Garing | 7/11/2022 | 8/12/2022 | Closed |
| 4 | KPIV 4 Cover Tape StopperPressure | Weak pressure from cover tape during auto-roll back sequence will lead to loose tension of cover tape and will lead to a crumpled cover tape | Provide a set-up jig during set-up of cover tape stopper | Ryan Mendoza/ Odelon Garing | 07/11/2022 | 087/12/2022 | Closed |

Figure 18. Improve and Action Plan Summary

As observed from the analyze phase, it was discovered that there was a wrong timing on the vacuum sequence during the unit drop. Action#1 is the installation of a Neutralizer. Before, not enough pressure from valve B to neutralize the trapped vacuum pressure in the line, this is why the unit is being sucked again by the pick-up head. To correct this, a new line from valve B was installed applying a small amount of pressure to neutralize the vacuum.

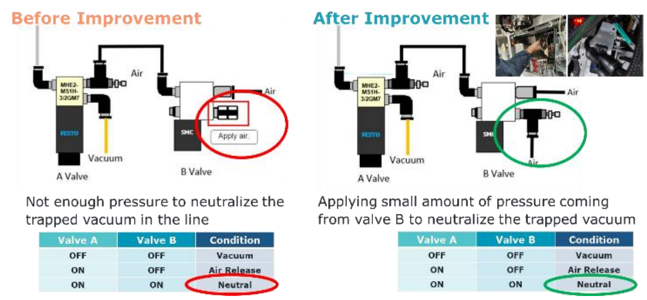


Figure 19. Installation of Neutralizer

The second action is the installation and linking of the sensor to the handler software for real-time monitoring, to have an alarm, and to stop the machine when the vacuum pressure is below the requirement


Figure 20. Linking of vacuum sensors to handler system

To have optimum settings of drop height and taping entry vacuum pressure, Design of Experiment (DOE) was performed using a full factorial design. The high and low for drop height is 0.5 and 0.2 mm and the high and low for vacuum pressure is 190 and 10 mmHg. The output response is damaged carrier tape and jams.

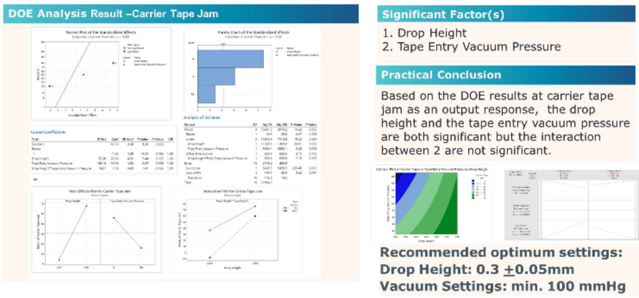


Figure 21. DOE Analysis Results – Carrier Tape Jam

Based on the DOE results above for the carrier tape jam - the output response, the drop height, and the tape entry vacuum pressure are both significant factors but the interaction between 2 is not significant.
Recommended optimum settings:
Drop Height: 0.3 +0.05mm
Vacuum Settings: min of 100mmHg

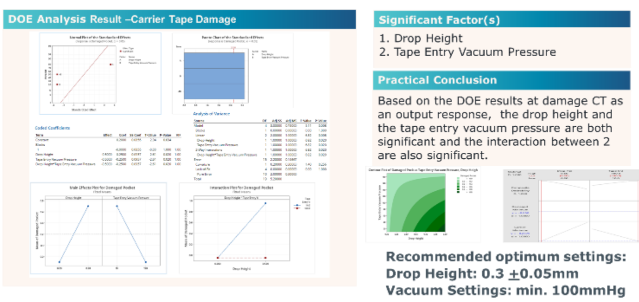


Figure 22. DOE Analysis Results – Carrier Tape Damage

Based on the DOE results for the damaged carrier tape - the output response, the drop height, and the tape entry vacuum pressure are both significant and the interaction between 2 is also significant.
Recommended optimum settings:
Drop Height: 0.3 +0.05mm
Vacuum Settings: min of 100mmHg

To have also an optimum setting for drop height with an interaction with purge pressure, DOE was performed using a full factorial design. The high and low for drop height is 0.5 and 0.2 mm and the high and low for purge pressure is 40 and 0 Kpa. The output response is carrier tape jams.

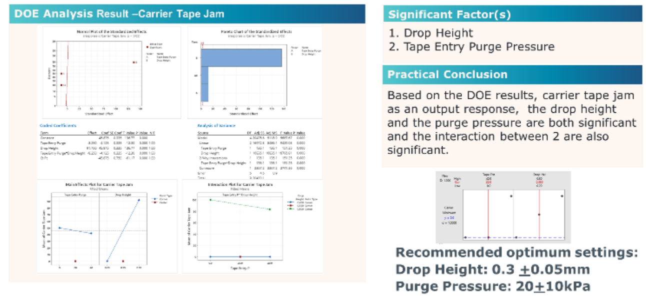


Figure 23. DOE Analysis Results – Carrier Tape Jam

Based on the DOE results for the carrier tape jams - the output response, the drop height, and the tape entry vacuum pressure are both significant and the interaction between 2 is also significant.
Recommended optimum settings:
Drop Height: 0.3 +0.05mm
Purge Pressure: 20+10kPa

To prevent the crumpled cover tape, a fabricated cover tape stopper jig is needed to use during machine set-up and machine intervention related to cover tape stopper

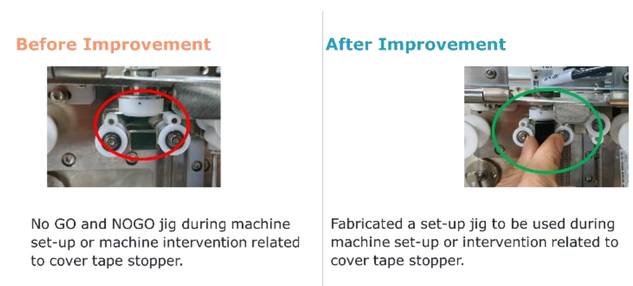


Figure 24. Cover Tape Stopper Jig

Checking the realization trend of the Detape rate, a significant improvement was observed for the past 12 months after the actions were implemented.

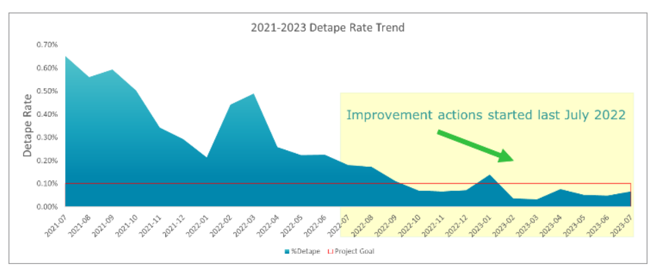


Figure 25. Detape Rate Realization Trend

3.5 List of controlled documents that have been implemented and downloaded to all stakeholders.

- Tape entry drop height set-up procedure

- Tape entry vacuum cut-off valve set-up procedure
- Cover tape stopper set-up procedure
- Out-of-Control Action Plan
- Equipment FMEA

**Lessons Learned**

**Technical**

- Understanding the different phenomena of the device upon placing carrier tape is a great thing that we discovered in this project. Weakness of the machine system has been revealed and Original Equipment Manufacturer (OEM) agreed to update and optimize it.
- Using of right tools for root cause analysis such as a high-speed camera is very essential in finding the real root cause
- Optimizing the pressure and height during the drop of the device into the carrier tape pocket will significantly prevent the damage of carrier tape.

**Method**

- Using DMAIC, we can set up the right project, focus on what is important, validate sources of the problem to solve it creatively, and sustain the gains.
- Two simple methods used in understanding the problem, (1) simply watching the unit drop in slow motion and (2) identifying what are the critical parameters contributing to the problem.
- Used statistical tools to strengthen your analysis, know what the significant factors are, and know the optimum parameters to use.

**Behavior**

- Do not be content on significant factors early identified and validated, explore and continue to analyze what is still unknown
- Teamwork & team perseverance are key to this project. One or two doing this project is not possible, such different stakeholders and still non-team members are very valuable in the success of this project.

## 4.0 RESULTS AND DISCUSSION

As a result of the detape rate reduction, one reworker machine was shut down, and 2 manpower is reduced and prevented material wastage. One year data shows a significant improvement, the process standard deviation was reduced by 67%, and lowered the process mean

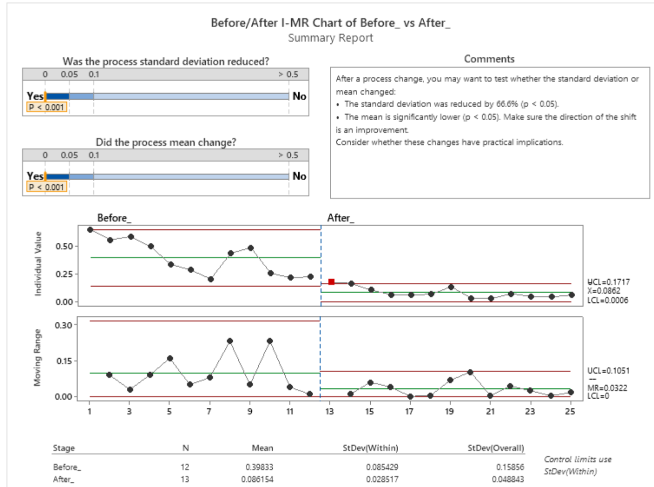


Figure 26. Before and After Chart

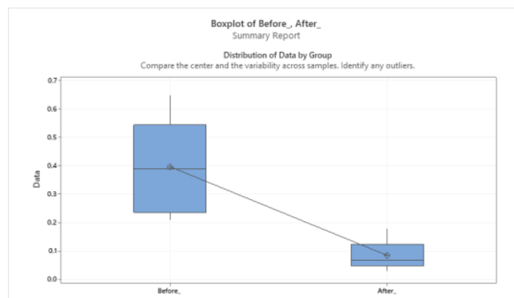


Figure 27. Before and After Box Plot

No adverse impact on cycle time as shown in Figure 28.

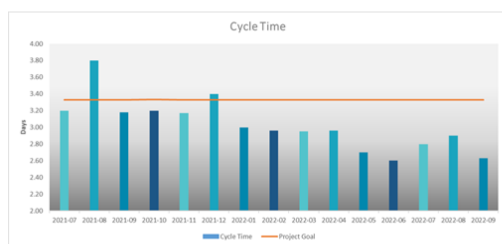


Figure 28. Cycle Time Trend

## 5.0 CONCLUSION

Based on the results, it is concluded that placing the unit in a carrier tape pocket without any anomalies could be successfully achieved by optimization of pressure and drop height.

For the purge pressure optimization, this study showed that too low or too high will cause machine jamming while setting the correct pressure will achieve a good die placement. This is the same with drop height, too high and too low is not good. While for the vacuum pressure the higher the better.

## 6.0 RECOMMENDATIONS

It is recommended to integrate the learnings on the new Module 2 handlers and to fan out all the applicable actions on the same machine using the same principle of pick and place.

## 7.0 ACKNOWLEDGMENT

The authors would like to extend their appreciation to ams OSRAM Group management and the OEM equipment Engineers, Andy Martin, and James Mendiola for the utmost support.

## 8.0 REFERENCES

1. Machine X, Test Handler System Operation Manual, www.xxx.com.my

## 9.0 ABOUT THE AUTHORS

Odelon Garing is currently the Process Engineering Team Lead at ams OSRAM Group. Certified Lean Six Sigma Black Belt.

Ryan Mendoza is a Staff Engineer, an in-house machine expert with 15 years of experience in Repair and Preventive Maintenance and Line Sustaining.

Dave Dalisay is a Process Engineering Technician with 6 years of experience in handling AOI and Tape and Reel machines