ENHANCING ATS646LSG-T CAPACITY THROUGH AUTOMATION, PROCESS OPTIMIZATION AND INTEGRATION OF ASSEMBLY OPERATIONS

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ABSTRACT

Gear Tooth Sensor (GTS) device ATS646LSG-T is one of Allegro Mircosystems' major products sold in the automotive market. GTS has a volume of about 564M units in FY24 where 60% is ATS646LSG-T. Among the process stations of GTS, Capping / Profiling manual process was observed to be the bottleneck station in Assembly. This was due to its limited capacity per week against the target weekly demand[1].

Cross-functional team was formed in Allegro MicroSystems to automate critical processes that influence parting line flash like Mold and Mechanical Deflesh. Optimizing the parting line flash removal at Plating process was also studied. The Team aimed to increase the capacity of this product by 40%. The team was composed of diversified knowledgeable experts in their field to guard against only identifying technical risks[2]. By analyzing the process elements at Mold, Mechanical Deflash, Plating and Capping/ Profiling, it was confirmed that the bottleneck were on the actual subprocesses capping and profiling. The focus therefore would not only be in automating the manual processes of Mold and Mechanical Deflash but also on these subprocesses to reduce its processing time eventually increasing the capacity. The team came up with an idea of combining these two processes into one which was achieved through the integration of the jigs used for capping and profiling.

Trials were made on the integrated jigs of capping and profiling with initial results observed to be 24.8% improvement on the UPH (units per hour) production. Ergonomics was also considered for the end-users (production operators) for efficient work – jigs made for right and left handed personnel. Since this is a manual process, the team considered that the improvement on capacity would be gradual as operators get used to in utilizing the integrated jigs.

Interval time studies were performed to determine the improvement in skill and the resulting increase in capacity. As expected, UPH increased by 36.30%, 67.82% and 80.56% based on time studies performed. By the end of the mass production qualification for the integrated jig, capacity of GTS for capping-profiling increased by 63.57% .exceeding the target of 40%.

1. 0 INTRODUCTION

Allegro MicroSystems device ATS646LSG-T is being assembled by its customer through insertion in a cap-like jig then overmolded. It would be difficult for the customer to assemble this device in their jig if there are thick parting line flashes. The said parting line flashes were finally remove during capping process.

This project aims to improve the productivity of ATS646LSG-T through the increase of capacity by about 40% while maintaining good quality. Good quality means that there should still be passing parting line flash based on the specifications

Process elements to be considered are the work, inspection, transportation[3] and delay to determine the bottleneck process or subprocess within the main stations.

2. 0 REVIEW OF RELATED WORK

Refer to 1.0 INTRODUCTION

3.0 METHODOLOGY

The project started in forming a cross functional team composed of Assembly Process Engineering, Production, Maintenance, Quality Engineering, Industrial Engineering, Tool & Die, Equipment Engineering, Production Planning, Finance and Lean Manufacturing.

The team determined the elements of the process from input to output then performed the initial time study to determine the bottleneck subprocess.

Once the bottleneck subprocess is determined, the team decided on how to reduce the overprocessing, waiting time and other factors that affect the cycle time. In the case of this project, we used the existing jigs and tried to modify to integrate two processes into one. There would be an initial test of these jigs for its useability with the operators. The final step would be a mass production evaluation then documentation.

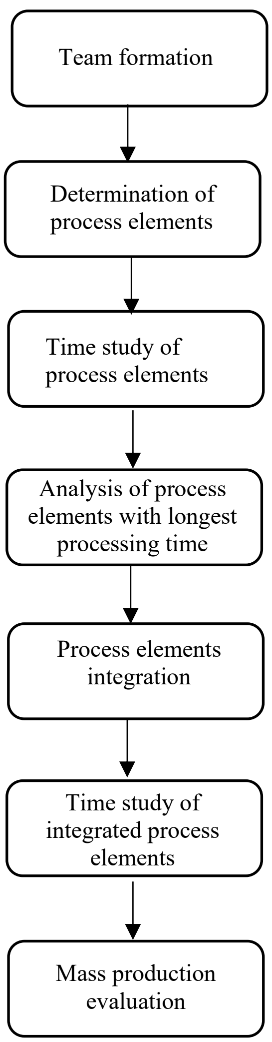


Fig. 1.0

4.0 RESULTS AND DISCUSSION

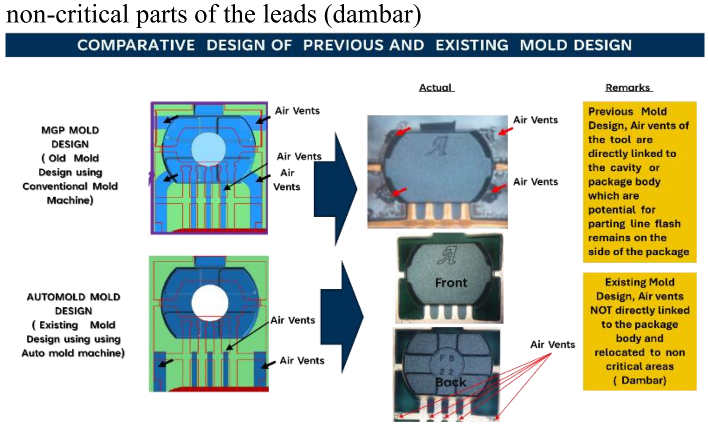
4.1 Process Automation of Mold and Mechanical Deflash

Improvements to maintain parting line flash within specification were in place at Mold, Mechanical Deflash and Plating process before the capacity improvement related to capping process.

4.1.1 Mold Process

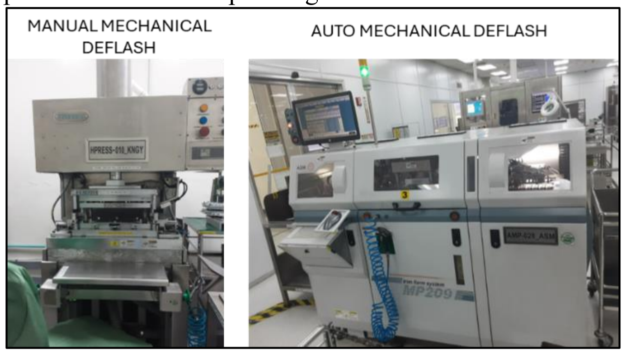
Mold machine was upgraded from Conventional to Automold 3G with capability to perform molding process simultaneously with multiple press using 1 system. Automold 3G is connected to a cell controller wherein parameters are well controlled.

From conventional to automold 3G, the mold chase layout was modified from 8 to 2 strips per chase improving the planarity and equal distribution of clamping pressure creating thin to none flashes around the package. Another improvement at mold process is the modification of air vent flash 4 sides of the package to non-critical parts of the leads (dambar)

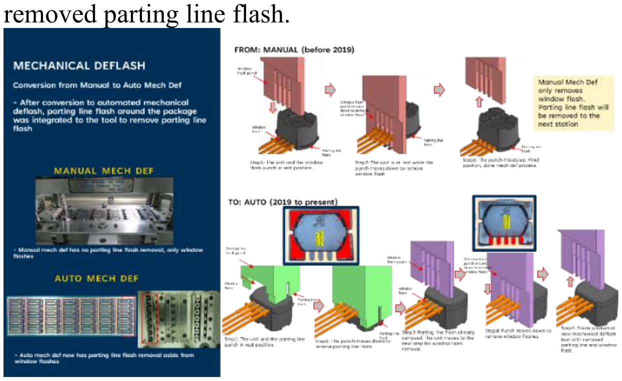


4.1.2 Mechanical Deflash Process

Machine was converted from manual to autoloading wherein the position of strip is more precise with location pins that hold the strip during deflash.

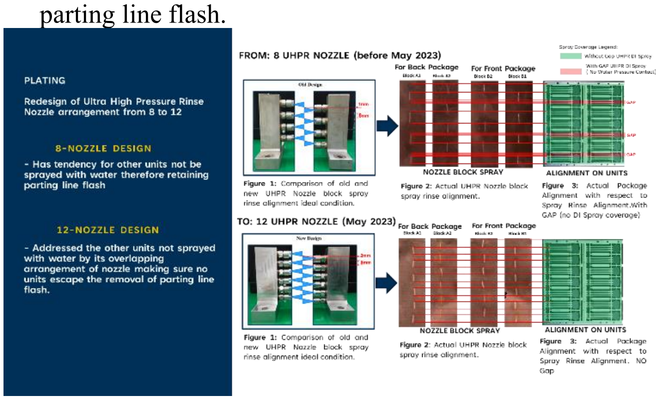


Deflash punch tool around the package was also incorporated to the tool so that it weakens the parting line flash as a preparation for the next process of plating wherein there in Ultra-High-Pressure-Rinse to totally removed parting line flash.



4.1.3 Plating Process

The quantity of nozzle sprays of Plating Ultra-High-Pressure Rinse was increased from 8 to 12 sets to ensure full contacts of water spray on package and eliminates parting line flash.



4.1.4 Capping Process

Based on initial time study, capping and profiling have the longest activity time which composed of 80.6% of the process time which is 145 secs. Capping is at 95 secs per cycle (54.7%) while profiling is at 25.9%.

MACHINE PROCESS ELEMENTS

	SEC/ELEM	OCC/CYCLE	SECS/CYCLE
1. Capping			
a. Get tubes for capping and transfer it into the worktable. Arrange 5 shipping tubes on the table.	15.00	15 / 73	3.08
b. Transfer units for capping from the tube into the inspection jig. Place empty tube on tote box.	8.00	1 / 1	8.00
c. Perform capping using metal jig.	95.00	1 / 1	95.00
2. Profiling			
a. Arrange work area for profiling.	10.00	15 / 73	2.05
b. Remove profiling jig and insert black end plugs on every completed	15.00	1 / 1	15.00
c. Push each units through profiler. Check for any deformed/ bent leads during profiler loading.	45.00	1 / 1	45.00
d. Bundle 10 tubes using rubber band. Push black end plugs and place the tubes in the output tote box with white end plugs up.	50.00	8 / 73	5.48
Operator Process Elements Time Per Cycle:			**173.62**
TOTAL OPERATOR PROCESS TIME PER CYCLE (With 10% Fatigue Allowance):			**190.98**
Machine Cycle per Hour (Tubes per hour):			**18.85**
UPH:			**1112**

4.2 Integration of Capping and Profiling Process

Integration of capping and profiling jigs had no functional issue during initial trial:

Fig. 2.0

4.3 Functional Test of Integrated Jig

It was observed that the work done by the operator of capping and profiling was reduced from 2 to 1. Figure 2.1 shows that there are two separate processes (or work) if the jigs are not integrated. Whereas there would be only 1 work once these jigs are integrated, see Fig. 2.2.

Fig. 2.1

Fig. 2.2

4.4 Time Study After Process Integration

Initial time study for the integrated process elements of capping and profiling resulted to a decreased processing time per run to 25.4% in the initial stage. This is from 3.5 hours (**Fig. 3.0**) to 2.61 hours (**Fig.3.1**). This also translates to an increased number of units produced per

MACHINE & LABOR STD UPH COMPUTATION

ALLEGRO microsystems

GENERAL INFO

Operation:	Capping	Operator:	
Package:	GTS-HD	Area:	EOL Bldg2
Device:		Date:	2/14/2024
Lot #:			
Machine Model:	N/A (Visual by human)		
Machine ID:	CAPPING-002_TABLE_B		

LABOR UPH CALCULATION

	SECS/SHIFT
Total Time/Cycle	12,223
Total Allowances (10% Personal Allowance of the Operator)	67
total time per run (secs):	12,289
total time per run (hrs):	3.41
time per unit (secs):	2.49
Labor UPH:	1,423

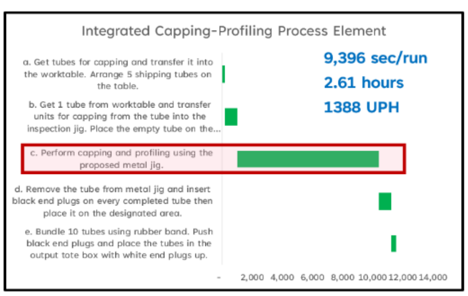


Fig. 3.1

4.5 Ergonomic Improvement

To help the operators in the usage of the integrated jigs some were fabricated to cater both right and left handed Fig. 4.0 shows that there were 2 left handed operators while 7 were right handed.

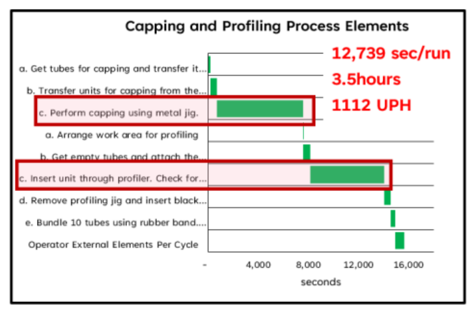
Fig. 4.0

4.6 Mass Production Evaluation

Interval time studies were performed to determine the improved capacity as the operators improved their skills in using the integrated jigs.

4.6.1 First Time Study

Performed last February 14, 2024 with initial improvement seen of **36.30%** in terms of UPH. This is translated from 1,112 unit to 1,423 units produced per hour.



4.6.2 Second Time Study

Comparing to the original units produced per hour, there is already an increase of **67.82%** after 8 months.

MACHINE & LABOR STD UPH COMPUTATION

ALLEGRO microsystems

GENERAL INFO

Operation:	Capping	Operator:	M. Hernandez / J. Laguardia / M.
Package:	GTS-HD	Area:	EOL Bldg2
Device:	9146HSG-000	Date:	10/3/2024
Lot #:	2437464DDAK		
Machine Model:	N/A (Visual by human)		
Machine ID:	CAPPING-001_TABLE_B		

LABOR UPH CALCULATION

	SECS/SHIFT
Total Time/Cycle	9,931
Total Allowances (10% Personal Allowance of the Operator)	69
total time per run (secs):	10,000
total time per run (hrs):	2.78
time per unit (secs):	2.03
Labor UPH:	1,752

4.6.3 Third Time Study

Comparing to the original units produced per hour, there is already an increase of **80.56%** after 11 months.

MACHINE & LABOR STD UPH COMPUTATION

ALLEGRO microsystems

GENERAL INFO

Operation:	Capping	Operator:	M. Merilo / S. Juyad / J. Jamora
Package:	GTS-HD	Area:	EOL Bldg2
Device:	9146HSG-000	Date:	1/22/2025
Lot #:	2503465DDA		
Machine Model:	N/A (Visual by human)		
Machine ID:	CAPPING-001_TABLE_A		

LABOR UPH CALCULATION

	SECS/SHIFT
Total Time/Cycle	9,228
Total Allowances (10% Personal Allowance of the Operator)	69
total time per run (secs):	9,297
total time per run (hrs):	2.58
time per unit (secs):	1.88
Labor UPH:	1,885

4.7 Capacity Analysis

The final capacity of Capping-Profiling process increased from 310, 886 units per week to 508,514 units per week. This would translate to an improvement of **63.57%**

	CURRENT	VALIDATED	VALIDATED	VALIDATED
Qty. per run	4300	4900	4900	4900
UPH	1,112	1,388	1,735	1,878
Machine Utilization	93.11%	92.12%	90.65%	90.14%
Breaktime Factor	90.00%	90.00%	90.00%	90.00%
Yield Rate	99.29%	99.34%	99.34%	99.34%
Working Hours	168	168	168	168
Final Machine Utilization	83.80%	82.91%	81.59%	81.12%
Capacity (per week) per machine	155,443	192,053	236,239	254,257
operators:	2	2	2	2
Capacity per week (2 operators):	310,886	384,105	472,479	508,514
Capacity per shift (2 operators):	22,206	27,436	33,748	36,322
Capacity per shift (1 operator):	11,103	13,718	16,874	18,161
Delta:		*23.55%*	*51.98%*	*63.57%*

5.0 CONCLUSION

The integration of capping and profiling led to the increase in units produced per hour and actually exceeded the target increase of capacity of 40%.

6.0 RECOMMENDATIONS

It is recommended to analyze other subprocesses of Allegro Microsystems Phils., Inc. for integration as it was proven effective based on this project.

7.0 ACKNOWLEDGMENT

We are indebted to our leaders who inspired us to pursue this project namely Mr. Mark A. Diesto, Department Manager of Assembly Process Engineering, Ms. Cathie R. Rivas, Department Manager of Assembly Production and Mr. Eric H. Roxas, Director of Assembly Operations.

8.0 REFERENCES

[1]Allegro Microsystems confidential information

[2]Proactive Risk Management: Controlling Uncertainty in Product Development by Preston G. Smith, Guy M. Merritt

3 Zero Quality Control: Source Inspection and Poka-yoke System by Shigeo Shingo, translated by Andrew P. Dillon

9.0 ABOUT THE AUTHORS

Oliver H. Bindoy, graduate of Chemical Engineering from the University of Santo Tomas with 22 years of experience in Assembly Process Engineering and is currently a Section Manager for End-of-Line Assembly at Allegro MicroSystems Phils. Inc.

Laviña Orate, a graduate of Nursing Aide from the Northern Negros State College of Science and Technology with 10 years of experience on Automotive Industry and 5 years at Semicon Industry currently handling Assembly Production for GTS HD and SE front-of-line and end-of-line.

Maydel D. Javier, graduate of Mechanical Engineering from Lyceum of the Philippines (Batangas) with 18 years of experience in Assembly Process Engineering and is currently a Lead Process Engineer for Laser Mark/Deflash /Trim/Form/Singulation Process of End-of-Line Assembly at Allegro Microsystem Phils. Inc.

10.0 APPENDIX

NOT APPLICABLE