REDUCING REWORK IN VISUAL INSPECTION BY ADDRESSING EXCESS RESIN IN DEVICE X

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ABSTRACT

Trim, Form and Singulation process of integrated circuit ensures that the unit conforms on define package outline dimension of the product. Package outline dimension of the unit was made through good trimming of dam bars, precise forming of leads and smooth cutting of resin debris. Among these three, cutting mold debris plays a crucial role which may lead to an excess resin if not controlled properly.

Excess resin is a phenomenon wherein the excess mold debris of package was not totally cut during singulation. If measurement exceeds the allowable limit, it would be rejected and subject for rework. This reworking activity prolongs the cycle time of the product and results in delays in delivery. This technical paper aims to eliminate the excess resin issue to remove rework activity.

The A3 methodology was employed in this study to accurately understand the issue. Plausible root causes were examined and validated to attain improvement actions vibrant to eliminate the excess resin issue during singulation process.

1. 0 INTRODUCTION

1.1 Historical Background

Of all the devices processed on LSI Business Unit (BU), DEVICE X mostly experienced a delay in delivery. Digging a little deeper into the issue, an alarming circumstance was found out that the Cycle time of Device X was not consistently met as shown on Figure 2. With this issue, the need to analyze and stop this situation has prompted.

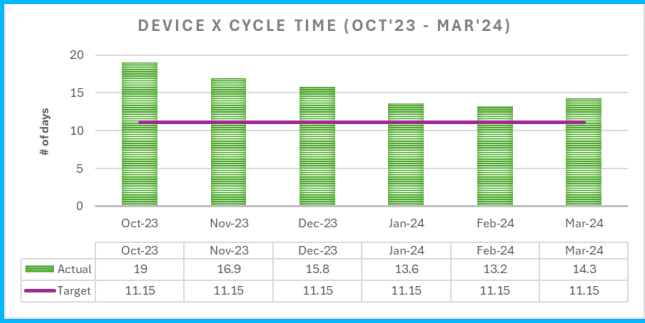


Fig.2. Device X Cycle Time Trend. Target cycle time of 11.15 days is not achieved from Oct 2023 to Mar 2024 with actual of 15.47 days.

1.2 Mold Resin Cutting

Singulation process includes mold resin cutting, unit pick and placed and air blow transport. During mold resin cutting, the mold resin was cut through up and down movement of singulation tool. Once up and down mechanism is done, the unit will be picked and placed on chute then will be blow towards the tube.

Excess resin occurs when the mold resin was not totally cut during up and down movement of singulation tool. Once there is an excess resin, affected units will be rework. Elimination of excess resin can greatly impact the cycle time since reworking will be removed.

2. 0 REVIEW OF RELATED WORK

Not Applicable.

3.0 METHODOLOGY

3.1 Define the Problem

Based on the cycle time performance of Device X, the subprocess with the highest cycle time is the removal and rework of units with excess resin (see Fig.3). From a baseline cycle time of 1148 minutes per week, the study aims to eliminate the rework activity of excess resin.

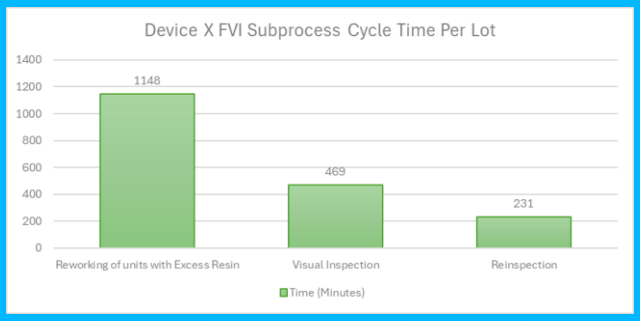


Fig.3. Subprocess Cycle time for Device X shows removal and rework of units with excess resin has the highest cycle time.

3.2 Gather Data

Used cavity mapping and process mapping to easily determine the source and behavior of excess resin.

3.2.1 Cavity mapping

Based on cavity mapping, excess resin is observed in all areas of lead frame. The data came from 200 units with excess resin mapped based on cavity number.

B01	B02	B03	B04	B05	B06	B07	B08	B09	B10	B11	B12	B13	B14	B15	B16
B17	B18	B19	B20	B21	B22	B23	B24	B25	B26	B27	B28	B29	B30	B31	B32
B33	B34	B35	B36	B37	B38	B39	B40	B41	B42	B43	B44	B45	B46	B47	B48
B49	B50	B51	B52	B53	B54	B55	B56	B57	B58	B59	B60	B61	B62	B63	B64
B65	B66	B67	B68	B69	B70	B71	B72	B73	B74	B75	B76	B77	B78	B79	B80
B81	B82	B83	B84	B85	B86	B87	B88	B89	B90	B91	B92	B93	B94	B95	B96

Fig.4. Cavity mapping of Device X with excess resin.

3.2.2 Process mapping

Based on process mapping, excess resin occurred during the singulation process. This is the process where the cutting of resin took place. Specifically, when the singulation moves up.

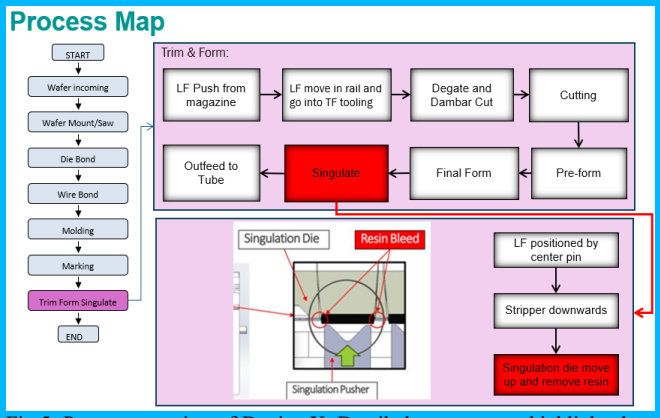


Fig.5. Process mapping of Device X. Detailed process step highlighted on red are the critical processes on the occurrence of excess resin.

3.3 Identify Root Causes

To identify the potential root causes, Ishikawa diagram was used. Out of 8 potential causes, 2 were identify as true root causes.

3.3.1 No bleed clamp support during singulation

Based on the design review of singulation tool, there is a weakness observed on the clamping of portion of lead frame with resin flash. There is no support at the bottom where the part of lead frame with resin flash is located. Thus, this clearance was considered critical.

Historically, there were reports that since the endorsement of the device A to current site, excess resin already observed. Operators tend to rework.

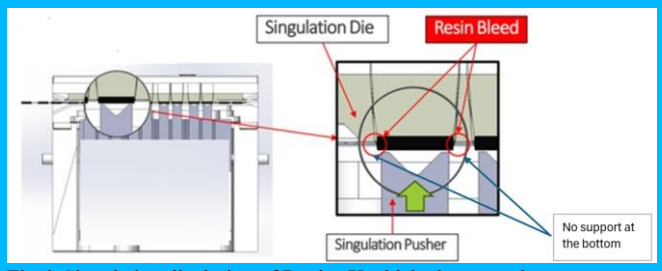


Fig.6. Singulation die design of Device X which observe to have no support at the bottom where the resin flash/bleed located.

Descriptive Statistics

N	Mean	StDev	SE Mean	95% Lower Bound for μ
30	0.16697	0.01743	0.00318	0.16156

μ: population mean of Excess Resin

Test

Null hypothesis $H_0: \mu = 0.15$
Alternative hypothesis $H_1: \mu > 0.15$

T-Value	P-Value
5.33	0.000

Fig.6. Sample t test of excess resin shows significant difference on current tool design since p-value is less than 0.05.

3.3.2 Over judgement of excess resin

Decision making during visual inspection plays a vital role in judging the excess resin. Based on validation, operators tend to judge the excess resin as no good but as per requirement still passed.

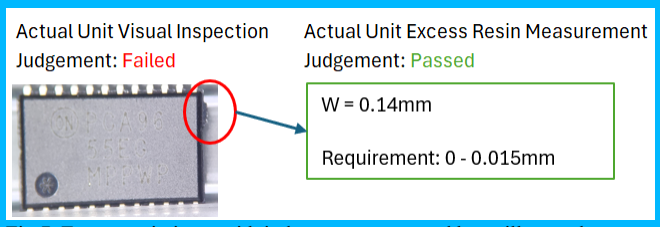


Fig.7. Excess resin issue with judgement as no good but still passed.

Attribute Agreement Analysis

Assessment Agreement

Appraiser	# Inspected	# Matched	Percent	95% CI
Joy	30	27	90.00	(73.47, 97.89)
Yolly	30	25	83.33	(65.28, 94.36)
Jenny	30	28	93.33	(77.93, 99.18)
Jocelyn	30	27	90.00	(73.47, 97.89)
Geraldine	30	26	86.67	(69.28, 96.24)
Merry	30	28	93.33	(77.93, 99.18)

 # Matched: Appraiser's assessment across trials agrees with the known standard.

Fig.8. Attribute agreement analysis shows that all operators did not meet the 100% match on inspected units.

Assessment Disagreement

Appraiser	# R / A	Percent	# A / R	Percent	# Mixed	Percent
Joy	3	20.00	0	0.00	0	0.00
Yolly	5	33.33	0	0.00	0	0.00
Jenny	2	13.33	0	0.00	0	0.00
Jocelyn	3	20.00	0	0.00	0	0.00
Geraldine	4	26.67	0	0.00	0	0.00
Merry	2	13.33	0	0.00	0	0.00

 # R / A: Assessments across trials = R / standard = A.
 # A / R: Assessments across trials = A / standard = R.
 # Mixed: Assessments across trials are not identical.

Fig.9. Attribute agreement analysis shows that all operators has cases that some good units were rejected.

4.0 RESULTS AND DISCUSSION

4.1 Develop Solutions

The goal of this section is to develop a solution that addresses the root causes of the problem and prevents it from recurring.

4.1.1 No bleed clamp support during singulation

To address the no bleed clamp support during the singulation process, a new design for singulation tool was made which include an additional clamp at the bottom of lead frame where the resin flash is located. This will provide a more stable cutting of resin flash. Also, define a tool life for this new design as part of preventive action.

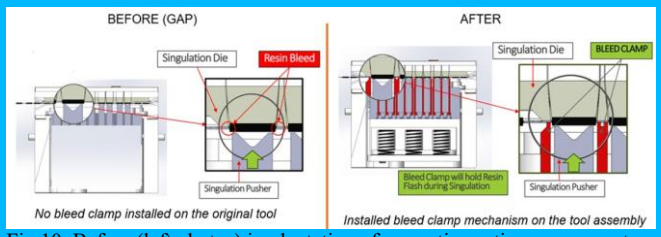


Fig.10. Before (left photos) implantation of corrective action, no support on bottom part of lead frame. After (right photos) shows with bleed clamp support at the bottom of lead frame.

Descriptive Statistics

N	Mean	StDev	SE Mean	95% Lower Bound for μ
30	0.07030	0.02232	0.00407	0.06338

μ: population mean of Excess Resin

Test

Null hypothesis H_0: μ = 0.15
Alternative hypothesis H_1: μ > 0.15

T-Value	P-Value
-19.56	1.000

Fig.11. Sample t test of excess resin shows no significant difference on new tool design since p-value is greater than 0.05.

Regression Equation

Excess Resin = 0.01576 + 0.000000 Shot count

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	0.01576	0.00117	13.44	0.000	
Shot count	0.000000	0.000000	14.36	0.000	1.00

Settings

Variable	Setting
Shot count	500000

Prediction

Fit	SE Fit	95% CI	95% PI	
0.124767	0.0066055	(0.111754, 0.137779)	(0.102466, 0.147067)	XX

XX denotes an extremely unusual point relative to predictor levels used to fit the model.

Fig.11. Regression analysis on new tool design. Tool life limit is 500kshots based on prediction.

4.1.2 Over judgement of excess resin

From the validation and verification made, the corrective action identified is to provide a reticle or eyepiece micrometer on microscope. This will ensure that if the operator is in doubt they can verify it easily. However, current action was on going budget approval. As back-up action, we define OCAP that when there is any doubt on excess resin judgement, operator will call PE for measurement.

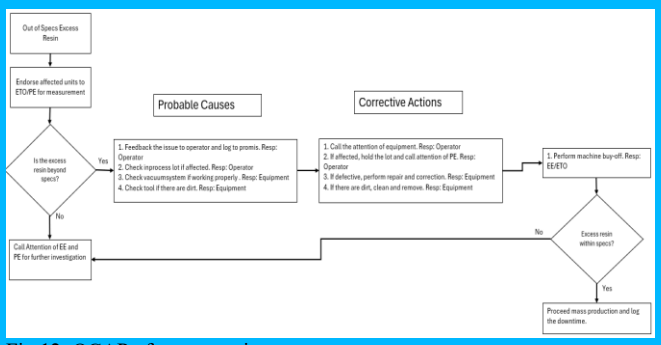


Fig.12. OCAP of excess resin.

4.2 Implement Solutions

To ensure completed actions are permanent, all are reflected on work instructions with alignment on PFMEA and control plan.

5.0 CONCLUSION

After completion of the study, the rework activity was eliminated. The cycle time of Device X was improved from 15.5 days to 10.8 days 9 months after implementation of corrective actions.

6.0 RECOMMENDATIONS

The actions to correct the excess resin can also be benchmark to other devices with the same singulation tool concept`.

7.0 ACKNOWLEDGMENT

The author would like to thank the tooling and equipment team for their support in completing the study. My previous colleague, for mentoring and guidance on the duration of the study. To the team members of this project who generously offered their efforts and time.

8.0 REFERENCES

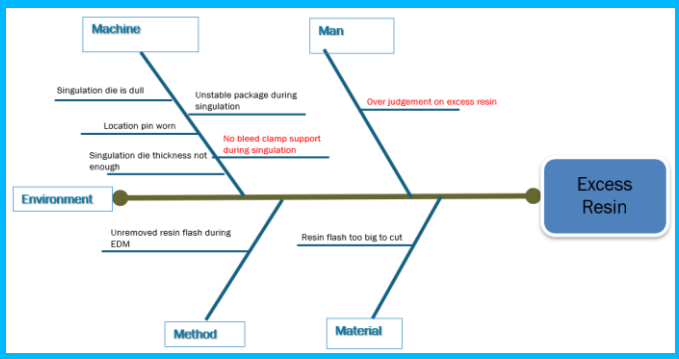
1. A Step-by-Step Guide to A3 Problem Solving Methodology
Daniel Croft

9.0 ABOUT THE AUTHORS

Emmanuel S. Huliganga is a graduate of BSECE from Technological University of the Philippines – Taguig Campus. He joined the Onsemi 2 years ago as a process engineer for the end of line assembly department. At present, his role is team leader for marking, trim and form and package saw process.

10.0 APPENDIX

Appendix A – Ishikawa Diagram



Appendix B – Device X Cycle Time