Failure Analysis of Module Assembly on Combi Machine (Gluing and Riveting)

Final Project Proposal

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Approval

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Module Assembly Failure on Combi Machines (Gluing and Riveting)

Abstract

PT Infineon Technologies Cegled is a company operating in the semiconductor sector, PT Infineon Technologies Cegled was founded in 1996. PT Infineon Technologies Cegled produces high-power semiconductor modules to support the advancement of various technologies, such as electric cars and environmentally friendly turbines. In assembling a module, there are various process stages that go through, one of the processes is frame assembly. Several stages in the frame assembly process, namely Chip Attachment - PCB Wire Assembly - X-ray - AOI - Glue - Frame Installation - Riveting. During the module assembly process, there were several product failures caused by imperfect glue on the packaging and poor clamp installation. This results in the module not meeting the company's quality standards, where the company has good or appropriate product quality standards.

Keywords: *Frame Assembly, Gluing, and Riveting Process.*

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Chapter 1. Introduction

1.1. Background

Frame assembly is one of the module manufacturing processes produced by PT. Infineon Cegled Technology. In the Frame Assembly section there are 5 process stages that are followed, namely; Xray, AOI, Gluing, packing installation, and Riveting. In the Xray section, check the soldering of the chips on the PCB and AOI checks the bonds between the cables on the PCB through the machine. Gluing is installing glue on the baseplate surface, packaging installation is installing the frame on the baseplate using a robot pick-up tool, and riveting is a tool for tightening joints using a clamping process. In the gluing, packaging installation and riveting processes, a combination machine is used. The combination machine is specifically designed to support product processing speed by PT. Infineon Cegled Technology. And when using a combination machine, there are several product failures, such as gluing which has bubbles and riveting which experiences failure, such as due to the connection not being tied smoothly, there is damage to the baseplate. Resulting in some products failing and unable to proceed to the following process.

1.2. Problems

1.2 How to prevent bubbles from forming during the glue process?

2.2 What is the solution to prevent bad clamping results?

1.3. Objectives

1.2 To prevent damage to the glue assembly, caused by glue failure. Such as bubbles, and the diameter of the glue is not in accordance with the design.
2.2 To prevent damage to the clamp, this can be done by checking the rivets and dirt around the clamp area.

1.4. Advantages

1. Know how to repair glue that contains bubbles.
2. Can find out the cause of damage to the clamping part.
3. Knowing how to control product quality remains good.

1. 5. Limitations

1. The research focuses on discussing the gluing and riveting processes in frame assembly.
2. This research is not supported by company data information.
3. This research only displays limited data and images.

Chapter 2. Literature Review

2.1 Frame Assembly Process

Frame Assembly is the process of assembling a series of products through various processes, using machine tools and requiring parameters for certain machine parts. To produce good module products, routine machine maintenance is required to anticipate machine errors. The following is the sequence of the Frame Assembly process.

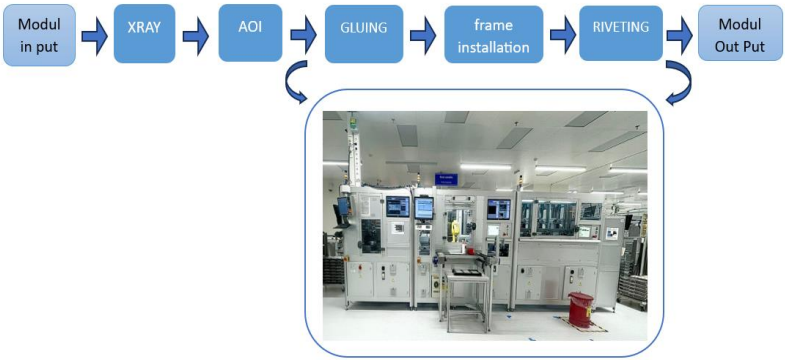


Figure 1. Frame Assembly Process

Figure 1 is a combination gluing and rivet clamping machine, which is used in module assembly. With the feasibility standard of good process results and no defects in module products [2].

2.1.1 In Put

The module will continue the Frame Assembly process after the process of attaching the chip to the PCB which is carried out in the Vadu area using a Loop Tool and Soldering Machine.

2.1.2 X-RAY

X-ray is a tool that uses X-rays as a type of radiation called electromagnetic waves. The use of X-ray in Frame Assembly is to check the bubble attachment of the chip to the baseplate using soldering.

2.1.3 AOI

Automated Optical Inspection (AOI) is an automatic visual inspection tool in the manufacture of PCBs or LCDs, transistors in modules. Where the camera independently scans the device being tested to detect bots. Damage to the wayer will be displayed on the monitor and then we can repair the wayer that was detected by the camera.

2.1.4 Gluing

Gluing is the process of installing glue on the module baseplate to attach the package to the baseplate. By using an automatic machine that has specified setting parameters. To get good gluing results, we can place the material in the humidity that has been set on the material and ensure vacuum pressure (60 – 80 PSI), which can reduce bubbles significantly.

2.1.5 Frame Installation

Frame Installation is installing a frame on a baseplate that has been glued using a robotic machine. The way the frame is installed on the basplate is by the robot reading the barcode on the frame, then the robot will place the frame on the basplate in a visual position that has been set in the program.

2.1.6 Riveting

Riveting is a clamping process using a press machine powered by air pressure. Part of the riveting tool contains rivets which function as a means of connecting construction parts. Rivets are a type of nail that is cylindrical in shape and has a short rod on the stem.

2.1.7 Out Put

The Output Module is the result of the final process in the frame assembly which has gone through various processes and is suitable for going through the next process.

2.2 Combination Machine (gluing and riveting).

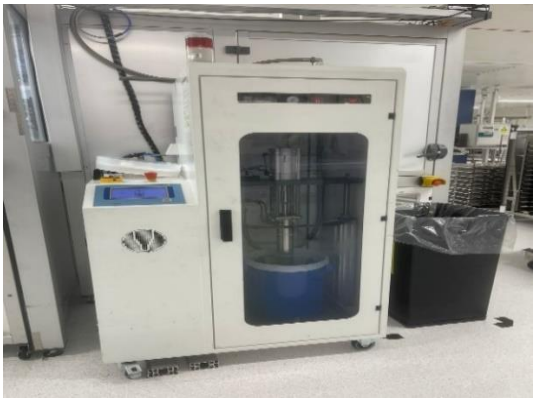
Combination machines are a combination of several gluing, frame package and riveting machine processes that are assembled to support the speed of producing modules and reduce problems caused by human error. The combination machine (gluing and riveting) is specially assembled by the Infeneon cegled company. On combination machines there are several parameters to regulate gluing and riveting pressure.

Figure 2. Combination Machine

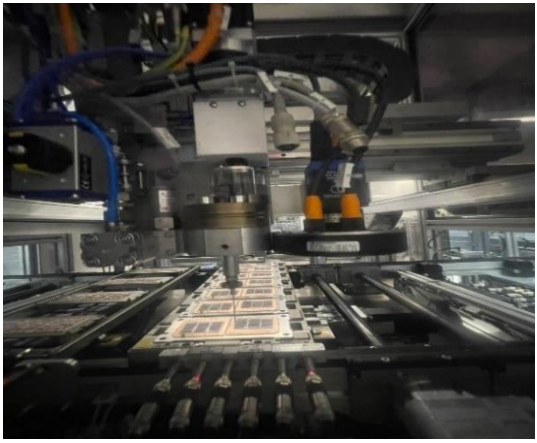
Figure 2 is a combination gluing and clamping machine specially designed to support the speed of the module frame assembly production process. To keep the machine process good, it is necessary to carry out routine checks on each process of the combination machine[2].

2.2.1 Gluing Process

The gluing process is to apply adhesive to the baseplate using glue. The gluing work process starts from installing the glue material on the combi machine with the specified material laying temperature, then a vacuum will be installed on the glue material. After the vacuum has been installed, the liquid glue will flow and will be heated to a temperature of 80-90 Psi to prevent bubbles from forming. Next, the liquid glue will be released through the needle and the camera will detect the area where the glue will be applied.



(a) Glue Material



(b) Glue installation process

Figure 3. Material and Gluing Process

Figure 3 is a display of the glue material used for the PCB base plate adhesion process with the assembly module frame. The feasibility of the glue results can be seen that there are no bubbles and the diameter of the thickness according to the design [2].

2.2.2 Package Frame

The process of installing the frame on the basplate using a frame picking technique using a robot. The robot used to pick up the frame has been programmed with a position between the x and y axes, as a fiducial for installing the frame.

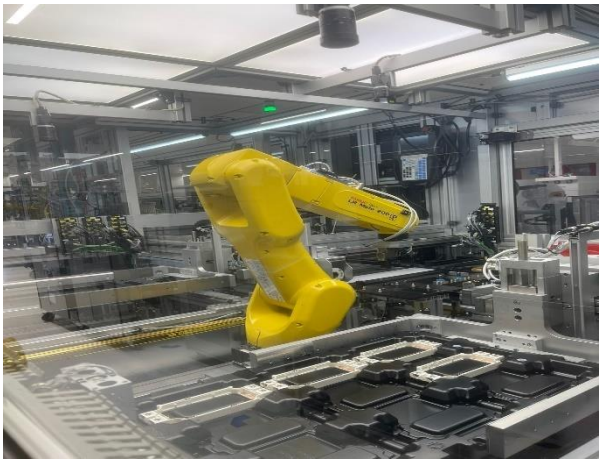


Figure 4. Pick Up Tool

Figure 4 is part of the process of installing the module assembly frame with the base plate, using robot technology that has been set up through programming by determining the X, Y, and Z axes [2].

2.2.3 Riveting Process

The riveting process is the binding of two materials together using a machine that works hydraulically, utilizing steam pressure or using a liquid as a medium to transmit power. Rivets are used as a means of fastening iron joints through the riveting process.

Tabel 1. Rivet Diameter Measurement Data Based on Hydraulic Pressure, Process Time, and Punch Diameter

Hydraulic Pressure	Long Process	Diameter Punch	Yield Diameter Rivet Specs: 4.7- 5.1
50	0.5	9.05	4.70
70	1.0	9.00	5.33
40	1.5	9.05	4.85
80	1.5	9.10	5.25
60	2.0	8.05	5.35
70	2.0	9.20	5.20

Table 1 is a description of the rivet diameter measurement data based on hydraulic pressure, process time, and punch diameter [2].

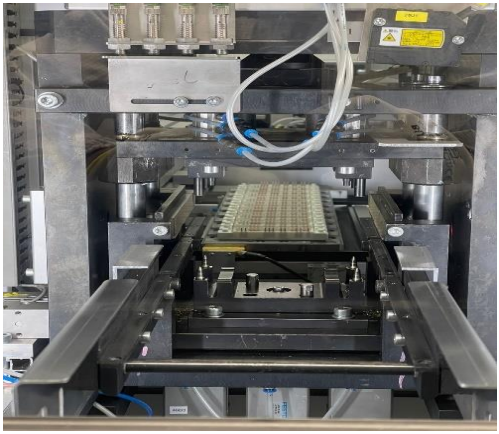


Figure 5. Riveting Process Figure

Figure 5 is the clamping process between the module assembly frame and the base plate, using a specially designed rivet tool [2].

2.3 Glue bubble error

Glue bubbles are a machine error condition caused by setting the temperature for placing the glue material not in accordance with the recommended material temperature, and glue bubble errors can occur when the heating device to remove the air is at an incorrect temperature or the temperature is less than 80 – 90 Psi.

2.4 Riveting Damage

Riveting damage is an error caused by several factors, one of the clamping machines experienced a lot of metal powder dirt from clamping. The clamp or rivet tool is damaged on the nail head so the clamping results are not good.

2.5 Preventive Maintenance

Preventive Maintenance is a process of maintenance activities and inspection of process parts on machines, which is carried out according to a specified time schedule. The important thing that must be paid attention to is the results of the riveting process, whether the riveting machine process is safe and not damaged. Rivets are prone to damage to the head and must be replaced periodically.

1. Maintenance or cleaning of the clamp.
2. Carry out rivet suitability checks.
3. Apply fluid to the hydraulic section.

2.6 Fishbone Diagram

Fishbone Diagram is a visual diagram that uses a method to analyze the root of the problem and find out the risks of something from the start. Fishbone diagram is one of the 7 basic quality analysis tools. Fishbone can be used by finding and determining the cause of a problem. Once the information is collected, the next thing is to arrange it into small bones in the fishbone diagram.

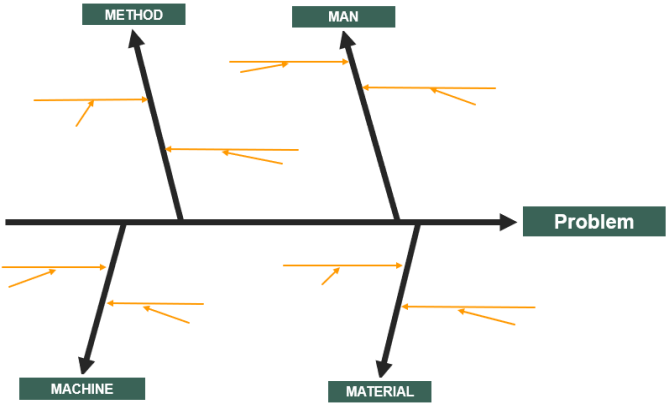


Figure 6. Template Fishbone Diagram

Figure 6 is a fishbone arrangement used to find solutions and root causes of problems [2].

2.6.1 Determine the main problem

The main part of the fishbone diagram is the main problem (consequence) that is happening. The main problem can be written in the head of the fish. This main problem will be the center of attention and main concern in making the diagram.

2.6.2 Identify key problem factors

Determine the factors causing the main problem. Each main bone in this fishbone diagram will be the main cause of the problem. These factors are humans, machines, materials and methods used.

2.6.3 Find potential causes for each category

For each underlying factor, we must find all possible causes. All possible causes of these factors will be located in the small bones or branches of the fishbone. The causes of problem factors can be found by identifying the problem object through observation.

2.6.4 Analysis of fishbone diagram conclusions

After determining each category, you can then determine the cause of the main problem. So that the results of the problem can be analyzed. The results of the problem analysis have been determined, we can determine a way or solution to solve the main problem by solving the root of the problem first.

Chapter 3. Method

3.1 Fishbone Diagram

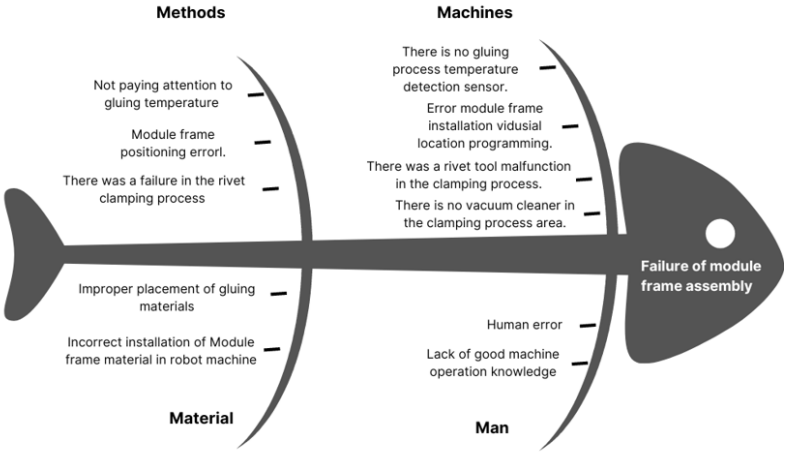


Figure 7. Fishbone Diagram Methode

Figure 7 is the description of the parts in the fishbone category arrangement to find solutions and root causes of problems [3].

3.1.1 Machine

Machinery is the most important part of production activities. The ability and completeness of the parts on the machine are important things that can make the machine operate efficiently, therefore the condition of the machine is very influential on the production process. Performing maintenance is one way to reduce errors on the machine.

3.1.2 Man

In the production process, human resources are essential to operate the machines. Therefore, knowledge and expertise in the use of production machinery is necessary to run the machine and respond quickly to resolve errors in the machine.

3.1.3 Methode

In solving a problem in the production process, a method or procedure is needed. The right method can help solve a problem quickly and precisely.

3.1.4 Materials

In the production process, material is important as input or input that is used to be processed into a product, if the material to be run in accordance with the specified procedure, of course, it will reduce several risks of damage, such as rejects in production, drops on the machine and can reduce the risk of downtime due to material.

3.2 Flow Chart

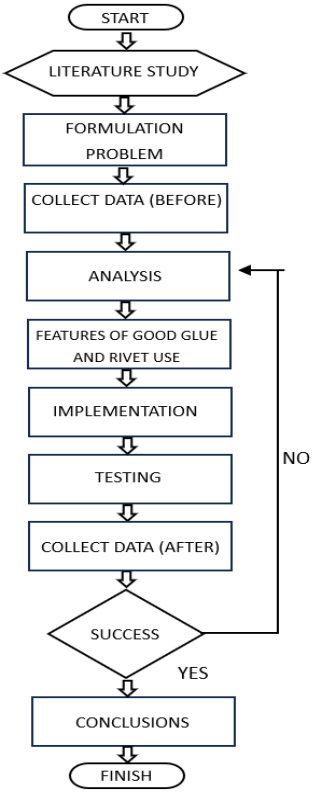


Figure 8. Example of a Flow Chart

Figure 8 is a flowchart to explain the steps in a process, from planning to process results.

3.3 Tools and Materials

3.3.1 Tools

1. Cut Pliers

One of the tools is cutting pliers, which can be used to open the lid of the sealed glue material. The pliers used must be good and sharp so that it is easy to open the lid of the material.

Figure 9. Cut Pliers

Figure 9 is a cutting pliers tool used in opening the glue material cover seal, on the module frame assembly combination machine [3].

2. L-lock

The L key is a key that has a specific function, and has a different diameter size. On the Combination machine the L key is used to open and install the clamping bolts in the rivet process.

Figure 10. L-lock

Figure 10 is the L-wrench tool, which is used at the opening of the clamping machine in fixing rivets [3].

3. Vacum Cleaner

One of the cleaning tools by sucking dust dirt and so on. In the vacuum combination machine used in the process of clamping rivets to clean powder dirt from the clamping results.

Figure 11. Vacum Cleaner

Figure 11 is a Vacuum Cleaning tool used to clean dust and powder dirt generated from the rivet clamping process [3].

4. Rubber Hammer

A rubber hammer is one of the tools used to give a blow, when the rivet clamping repair process has difficulty.

Figure 12. Rubber Hammer

Figure 12 is a rubber mallet tool, which is used to repair the rivet clamping machine that is experiencing jamming problems [3].

5. Rivets

Rivets are one type of nail that is cylindrical in shape and has a short rod in the middle. The use of rivets on a combination machine is as a means of connecting module construction parts in the clamping process.

Figure 13. Rivets

Figure 13 is a rivet tool, which has a special design and specific function for fastening two materials together using a clamping machine [3].

3.3.2 Material

1. Glue

Glue is a liquid that has the characteristics of attaching various components. The use of glue in module manufacturing is to glue the packaging on the Printed Circuit Board.

Figure 14. Glue

Figure 14 is the glue material, which is used to bond the base plate to the module assembly frame [3].

Tabel 2. Estimated Cost

No.	Tools/materials	Unit Price (Rp.)	Amount	Total (Rp.)	Information[1]
1	Cut Pliers	180.00	1	180.000	Company
2	L-lock	100.000	1	100.000	Company
3	Vacum Cleaner	800.000	1	800.000	Company
4	Rubber Hammer	300.000	1	300.000	Company
5	Rivets	300.000	1	300.000	Company
6	Glue	-	-	-	Company
	Total			1.680.000	Company

Table 2 is a description of the estimated price of the tools and materials used for the operational manufacture of module products [3].

3.3 . Test

The testing technique used is visual inspection of the process to verify the possibility of scrap. The goal is to find out the possible causes of scrap and based on the verification results also determine the potential causes of the possibility that are prioritized for verification. In terms of determining potential causes to be verified, a verification table is made as in the table below.

Tabel 3. Process Damage Catalog

No	Process Demage	Hypothesis	Verification	Potential
	Methods			Y/N
1	Glue Bubble	Determination of glue heating temperature is incorrect	Point 1	Y
2	Glue Thickness	Programming errors	Point 1	Y
3	Rivet Damage	less attention to the replacement life of riveting nails	Point 1	Y

Table 3 is a catalog of the good or bad assessment of a product that goes through the processing stage on the frame assembly combination machine [3].

3.3.1. Inspection Glue

Damage to the glue can be seen visually in the process, some of the damage to the glue are. There are bubbles in the glue liquid, and the thickness of the glue is not according to the programming standards.

3.3.2. Rivet Testing

Failure in the clamping process can be seen visually, the cause is that the rivets used have damage. The possibility of damage to the rivets is influenced by the long age of use of the rivets not being noticed.

Chapter 4. Results and Discussion

4.1 Modul production quality assessment results

To determine the good or bad quality of a module assembly process can be done by visually analyzing referring to the example of a catalog of good module process results.

Figure 15. EconoPACK 2&3 Module Assembly Result

Here is one of the results of a good Module assembly, or has passed the visual inspection test of each assembly process.

Tabel 4. Failure data sampling of module assembly.

Module assembly mounting failure					
BEFORE			**AFTER**		
MONTH	WEEK	UNIT	MONTH	WEEK	UNIT
DECEMBER	1	48	MARCH	1	38
	2	45		2	35
	3	50		3	41
	4	45		4	33
JANUARY	1	43	APRIL	1	37
	2	47		2	36
	3	44		3	39
	4	39		4	41
FEBRUARY	1	47	MAY	1	35
	2	49		2	37
	3	43		3	33
	4	50		4	35

TOTAL	**550**	**TOTAL**	**405**

Table 4. Presents the results of the number of defects in Module product manufacturing from the beginning of the assembly process to the end of assembly. The number of defects is grouped in weeks of each month.

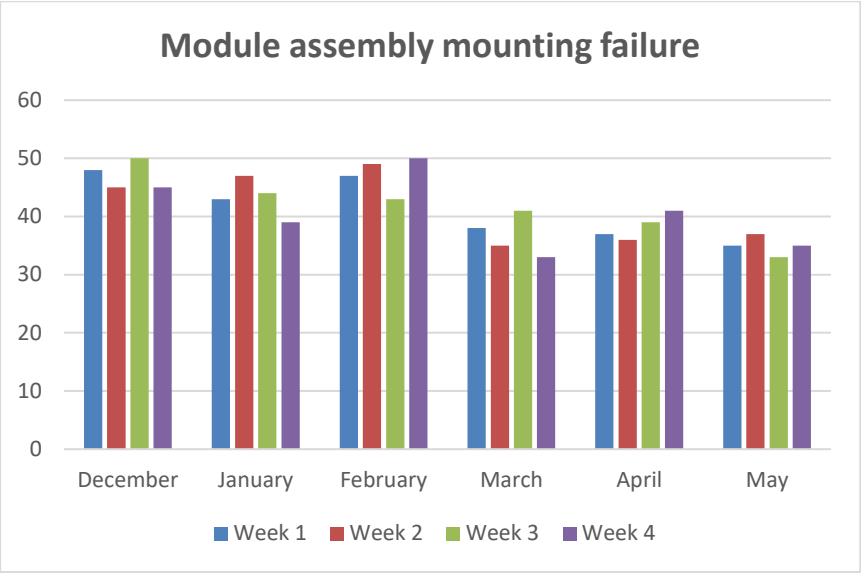


Figure 16.This is a bar chart of the Module assembly failure result data

In the Bar Diagram above which displays the data set, it shows that the number on the y-axis has increased failures in December, January, and February. Then in March, April, and May experienced a decrease in the number of failures. The thing that affects the Module production failure is the lack of routine control of the Module manufacturing machine process, such as the feasibility of tools on the machine, the machine work process area experiencing dirtiness as a result of the work process and giving an understanding of the use of the machine how to operate properly.

Tabel 5. Failure result data from each Module assembly process

Month	Week	Bubble Gluing	Frame Mounting Demage	Clamping demage of rivets	Total unit eror
December	1	19	14	15	48
	2	17	15	13	45
	3	21	15	14	50
	4	18	11	16	45
January	1	15	11	17	43
	2	14	15	18	47
	3	17	12	15	44
	4	15	8	16	39
February	1	17	11	19	47
	2	17	12	20	49
	3	21	7	15	43
	4	23	8	19	50
March	1	13	9	16	38
	2	15	7	13	35
	3	18	8	15	41
	4	12	4	17	33
April	1	13	8	16	37
	2	15	7	14	36
	3	17	7	15	39
	4	19	7	15	41
May	1	11	8	16	35
	2	13	7	17	37
	3	14	4	15	33
	4	12	6	11	29

Table 5. Presents the results of Module production damage for each process performed. Total number of module production defects grouped in weeks each month.

4.1.2 Process of Gluing

The glue process on the Combination machine is the provision of gluing on the module base plate to glue the Module frame. In determining the quality of gluing, we can visually assess the results of the glue by looking at the reference catalog of the type of damage.

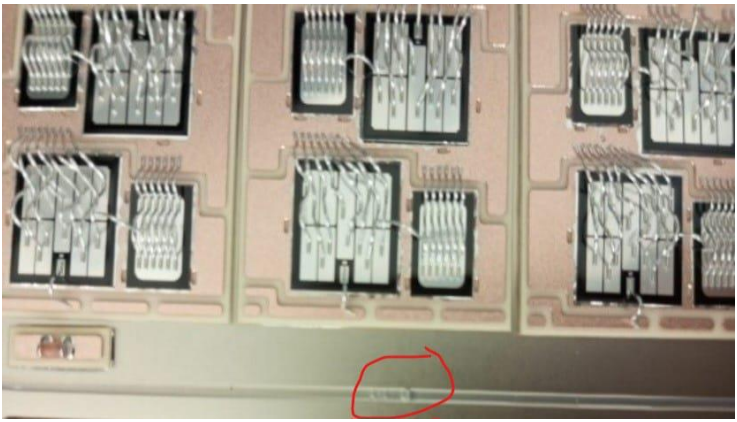


Figure 17. Is the result of gluing defects in the glue process.

The following picture shows the failure of bubbles in the glue, resulting in poor glue quality caused by the heating temperature of the glue nozzle not according to the procedure.

4.1.3 Module frame assembly process

In the process of assembling the module frame, the main thing is to determine the fiducial location of the module frame coordinates in making the robot pick up tool program.

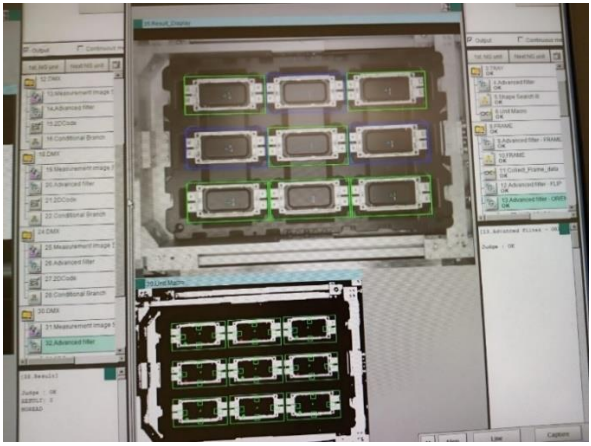


Figure 18. This is the programming design of the Pick up Tool robot.

The picture above is the programming application of the robotic module frame installation tool that records the placement of the module frame using the camera detection sensor.

4.1.4 Module rivet clamping process

The process of clamping rivets is to unite iron plates using the rivet method. The characteristic of these rivets is that they are permanent or cannot be removed once installed. Rivets have permanent properties that do not cause structural changes in the metal.

Figure 19. Shows the module before and after the rivet clamping process.

In the process of clamping rivets, the things that need to be considered are rivet tools that are in good condition, there is no damage to the lips of the rivets, and the place of the clamping process must be carried out routine maintenance or cleaning of powder from clamping rivets.

4.2 Discussion

4.2.1 Gluing result inspection test

The glue process is the process of gluing the base plate to the module assembly frame. To produce a good glue product we need to pay attention to the quality of the glue according to the standard. The following graphic diagram explains the number of damage results grouped every month.

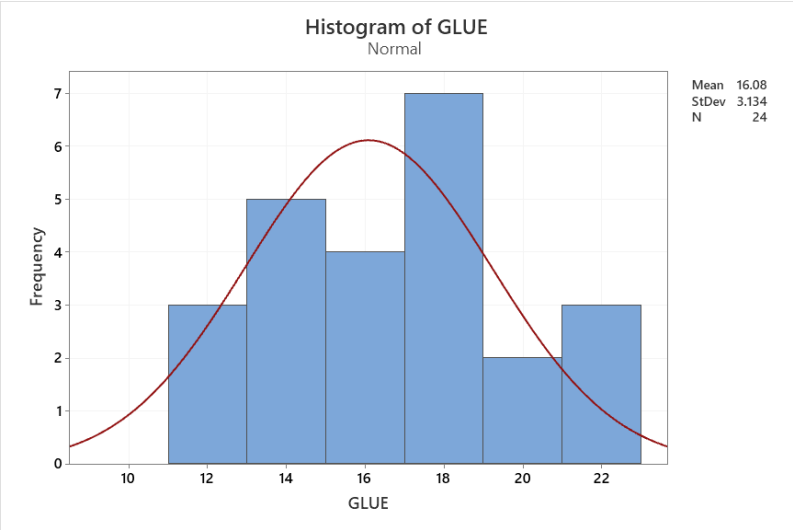


Figure 20. It displays the results of the data on the gluing process

From the analysis of the graphical values on the curve line, it shows that the distribution of values does not include the conditions that apply to the Normal Distribution. Some things that we can note are that the average or mean value of the data distribution is not at the peak of the curve or is not bell-shaped. Then the number of areas located under the normal curve has a value of 1. Among them are half (1/2) on the right side and also half (1/2) on the left side. Some factors that affect the non-normality of the data are the number of failures in the uncontrolled gluing process. The cause of failure in the gluing process is the heating of the gluing material which is not good, causing bubbles and the size of the gluing diameter which is not appropriate.

4.2.2 Module frame assembly analysis result

In the process of assembling the module frame using a robot pick up tool controlled by a camera sensor detector that has been determined by the vidusial location in the software.

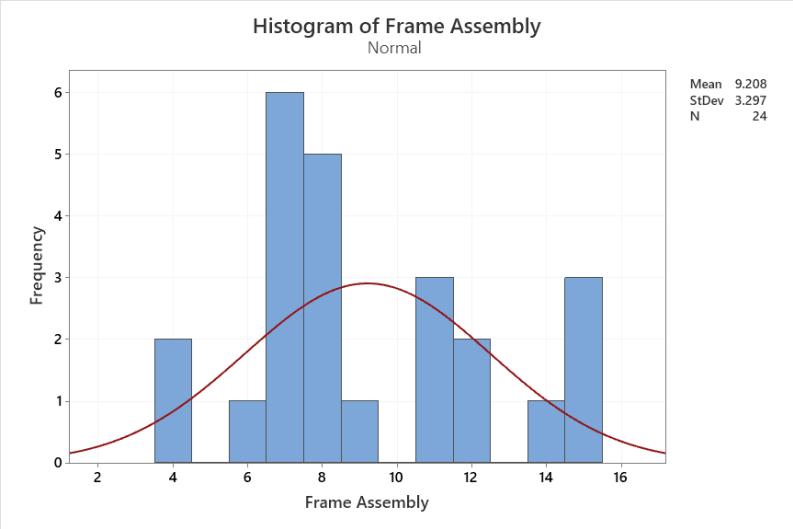


Figure 21. Is a bar chart, Module frame assembly failure result data.

The results of the Histogram display of the assembly process failure on the module, show that the graph diagram does not include the requirements of Normal Distribution. Following the analysis of abnormal distribution, the average or mean value of the data distribution is not at the peak of the curve or is not bell-shaped. In the distribution of graphic data values there is an imbalance or assessment that leans on one category only. The factor that affects the distribution of uncontrolled data is the number of uncontrolled failures. The thing that causes process failure is the wrong placement of material at the software programming location, which has been set vidusial location. Thus causing the module frame barcode to not be detected on the camera sensor part of the robot retrieval tool.

4.2.3 Rivet clamping Result Analysis

In the clamping process using rivets to unite the iron plate using the rivet method. There is a failure of the clamping results that are not good, namely damage to the lips of the rivets so that the iron plate with the frame is not strong.

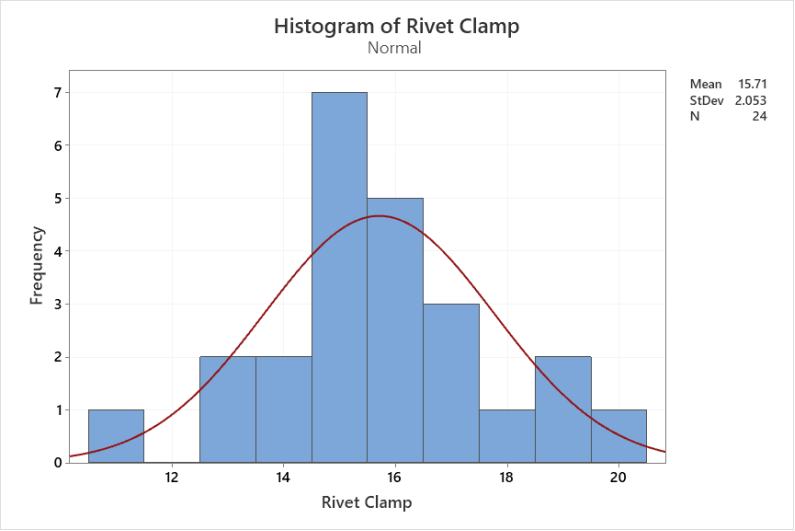


Figure 22. Displays the results of the rivet clamping process defect data.

From the analysis of the value of the graph on the curve line, it shows that the histogram includes the criteria for Normal Distribution. What shows that the graph includes a normal distribution is that the average or mean value is centered to form a bell or is at the top point of the curve. The distribution of graphic values on the curve does not occur gaps or leaning to the left and right. In the rivet clamping work process, the thing that must be considered is the condition of the rivet tool on the machine in good condition without any defects, and the work process area remains clean without any dirt from the clamping. This is done to maintain the quality of the process results.

Chapter 5. Conclusions and Recommendations

5.1. Conclusions

From the module assembly process using the glue combination machine, frame installation, and rivet clamping. It can be seen that each assembly process has a standard quality of production results, to achieve good quality standard products. By doing routine maintenance of the machine and analyzing the type of damage to the Module product. Then we can consider the results of the product failure analysis to find out the steps taken to repair and prevent damage from occurring again. Steps taken to prevent module production failure are.

1. Understand machine process work procedure.
2. pay attention to the data of material sheat and machine tools.
3. Perform routine maintenance on machine tools.

5.2. Recommendations

According to the author, the explanation of the process of making the module is good, but it needs to be developed further and maybe there are some things that should be improved. Such as the appearance of limited data sources and the explanation is more emphasized again. But overall it is good.

Bibliography

[1] Personal Documents and infineon technologies, module assembly machine. Cegled, in Hungary. In the year 1996.

[2] Infineon Technology, Module Assembly Process. Cegled, Hungary. In 1996.

[3] Infineon Technology, Module assembly process tools and materials. Cegled, Hungary. In 1996.

[4] Statistics and Process Control (SPC), Budiana, EM-302 Material First Meeting, 2022.

[5] Infineon Technology, Module Assembly Process. Cegled, Hungary. In 1996.

[6] Statistics and Process Control (SPC), Budiana, EM-302 Material First Meeting, 2022

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