ELEVATING PROCESS CONTROL AND CERTIFICATION UTILIZING ALID

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ABSTRACT

Considering the continuous growth of technology and the integration of Industry 4.0 principles, a significant limitation faced by various companies is the shift from outdated to modern automation and control technologies. In this project, an innovative solution for connectivity, automation, and intelligence will be showcased, which will be align with the Smart Manufacturing Maturity Indexes.

Consequently, a dedicated team was formed to concentrate on implementing shopfloor solutions. This team's main objective is to tackle **Connectivity**, ensuring seamless integration of equipment and systems not only within the network but also with other MES and similar systems. Once connections are established, the team focuses on **Automation**, incorporating essential controls into the systems and processes. To fully harness the advantages of this improved connectivity and automation, they also delve into **Business Intelligence**, offering visualizations that allow the company to monitor process performance and handle business information effectively. This leads to faster decision-making and access to actionable insights, benefiting executives, managers, and employees alike.

Therefore, the fusion of connectivity, automation, and Business Intelligence becomes crucial for effectively monitoring process control in accordance with the given product specifications. Moreover, leveraging the capabilities of the Internet of Things (IoT) opens up numerous opportunities and innovations, transforming ordinary solutions into extraordinary ones.

1. 0 INTRODUCTION

One of the many obstacles in any industry is to eliminate their manual processes in their operations. In the case of semiconductor industry, with new products and various technologies coming in a flexible and adaptable system are also expected to support quality products coming out of the factory. To boost the manufacturing productivity, the manufacturing has used several Manufacturing Execution System (MES) to be more competitive in the market. The key benefits of an MES system include the emphasis on production quality and its cost improvement. This is also to improve the competitiveness by managing the resources such as machines, process, and facilities. One of the capabilities of this is to monitor, control and its quality management.

As the result, the team has come up with several solutions that can further streamline the procedure and implement the automations, which can mitigate manual procedures and human decision making, thus this will help the workers to devote more time to their actual duties. One of the principles on connecting the MES to automations is the Internet of Things (IoT). IoT has a wide range of technology that can connect different types of devices and machines. On the other hand, the automation will become more effective and smarter as an outcome of complicity of IoT. Among the list of continuous improvements, this paper will focus on the Alarm ID (ALID) which is the Critical Machine Alarms that will trigger an inspection in the process flow. This is to eliminate the possible potential defects, which can improve the quality control of the device.

1.1 Connectivity

Industry 4.0 originally designed to enhance the efficiency of the Manufacturing facilities. This is possible with the help of Internet of Thing (IoT) technology which helps the manufacturing to store and comprehend with the data information. Machine structures and design methodologies have evolved to make most out of Industry 4.0. This technology has been handed down from huge corporations to their suppliers across the world. This project highlights the design principles such as functional analysis which can be used to create better products. It also identifies how the connections supports the development of Smart Manufacturing facilities, with the implementation of Industry 4.0 concepts and resources.

1.1.1 Physical Connectivity (TCP/IP, LAN, Network, etc.)

LAN Network is one of the internet infrastructures that everyone uses. This can be found workplaces, residences and other public places, and it is being expanded in other applications. The IP Address is locally unique, the same address cannot be used twice, since per device is assign with a unique IP Address.

Figure 1. Show how the connectivity of automations and machine will interact.

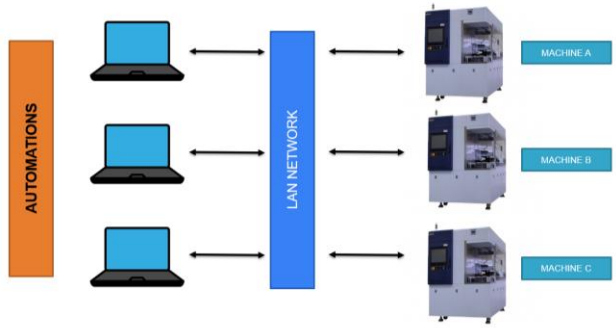

Figure 1. Automations to Machine Connectivity

1.1.2 Logical Connectivity (WLAN, SECSGEM)

WLAN or what we called Wireless Local Area Network, is a wireless computer network that connects two or more devices using a wireless communication. A WLAN can also offer access on the internet through a gateway. This is also called the WI-FI, to which consumers use portable wireless devices to access the internet. This will be applied to the Automations and MES. For the SECSGEM, this is one of the features in the machine which can be connected via LAN network (Figure 1)

Figure 2. Connectivity of MES and Automations can be via WIFI

Figure 2. MES to Automations Connectivity

1.2 Automations

To begin with, we will require the device information provided by the operations; thus, it is significant to ensure that the data given is accurately correct or this will cause a discrepancy in the device.

Figure 3 shows the connectivity of MES to Automations. MES will set the data controls which the automations will read and execute it.

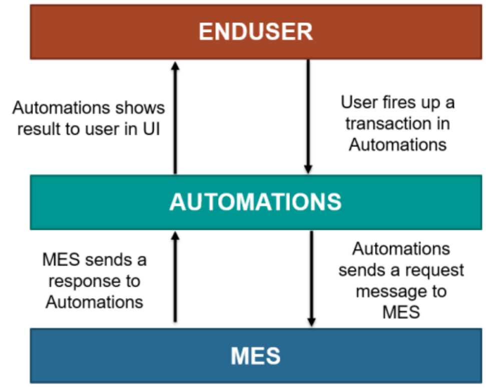

Figure 3. OSPI Tarlac MES to Automations Connectivity

With this connectivity, the team figured out a way to create controls that will be implemented in the MES for the automations to execute it. This will handle the fundamental controls of the Alarm ID (ALID) using Critical Machine Alarm in Saw Process.

Figure 4 Shows the before process in Wafer Saw when there is a Blade Breakage transaction then this will proceed to the next step.

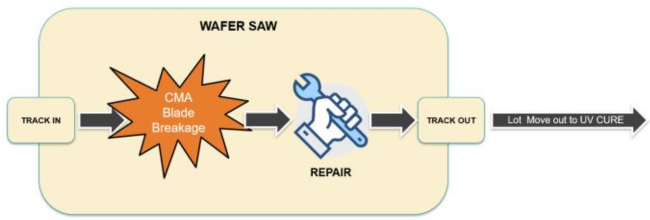

Figure 4. Wafer Saw transaction without CMA Control

On Figure 4, refers to the structure which the user will transact the lot, however there is a CMA Blade Breakage encountered, then this will be attended by the technician or engineer. Once this is resolved, the process will move on to the next step.

Figure 5 Shows the Inspection Compliance in Saw process.

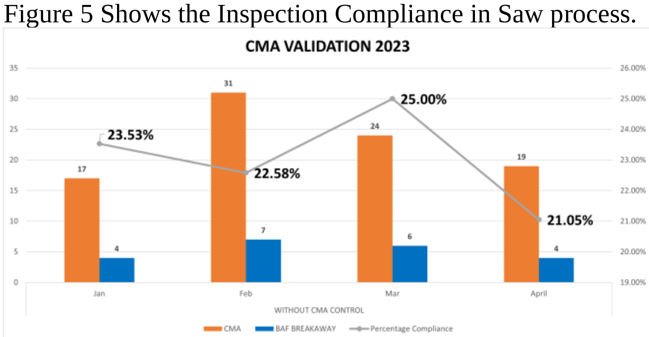

Figure 5. The inspection compliance for lots encountered CMA

On Figure 5, It pertains on the inspection compliance which is <25%, which will results to potential defects and also product escape. The team has developed a solution to mitigate product escape by utilizing CMA to initiate the inspection process.

Figure 6 MES Controls that automation will read.

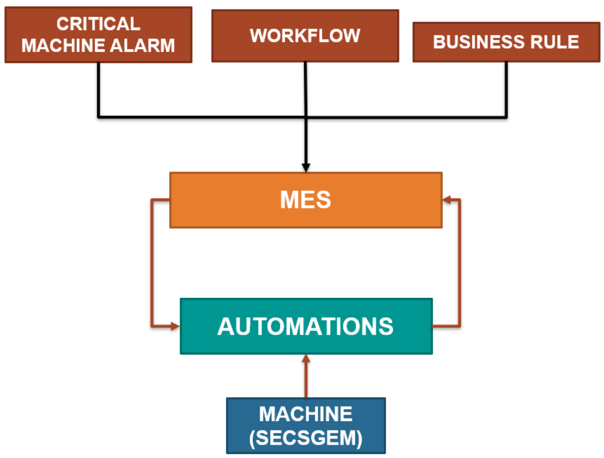

Figure 6. Set of controls for automations to execute.

For establishing the data controls, there are various measures to be implemented within the MES. These encompass the Critical Machine Alarm, Workflow, and the Creation of a new Business Rule. Furthermore, automation plays a role in overseeing the triggered Critical Machine Alarm, such that when the alarm is triggered during lot transactions, it initiates to go to the inspection process. However, before this will be proceeded to the next step which will lead to potential defects in the device.

1.2.1 Automation Control 1 – Critical Machine Alarm

Now that all the data related to Critical Machine Alarms has been provided, the next step involves the implementation of CMAs onto the machine. The automations will automatically read the set of alarm coming from the MES and from the machine. This operation identifies the specific type of CMA that will be activated.

Figure 7. Critical Machine Alarm that has been applied in Saw Process

CriticalAlarmCode	Auto Job Limit	CriticalAlarmDescription
5416	1	Detected partial blade damage
5415	1	Detected whole blade damage

Figure 7. CMA Code

Figure 8. An example of product A to be transacted in the Saw Process with encountered CMA.

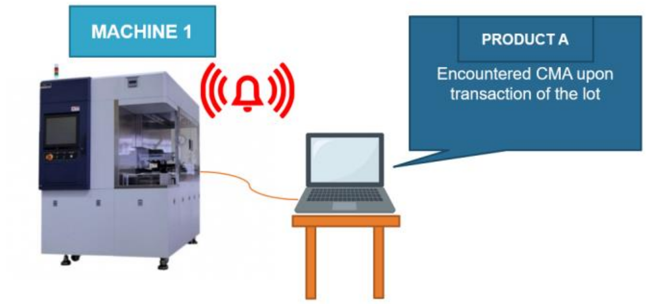

Figure 8. CMA was triggered.

For instance, when a lot goes through the saw process and encounters a CMA, it currently proceeds to the next process after track out. However, this is problematic as it could lead to potential defects in the subsequent steps. To address this, automation will be used to establish a closed-loop poka-yoke. This will require the lot to undergo inspection before proceeding to the next step, mitigating the risk of defects.

1.2.2 Automation Control 2 – Workflow

Now for the proposed workflow, wherein will apply a breakaway flow that once the CMA is triggered it will automatically undergo inspection process before proceeding to its next step. This closed loop aims to elevate product quality and eliminate product escape. This control will be applied in the MES per Wafer Prep Devices by ATS.

Figure 9. Shows the proposed flow upon Saw Process

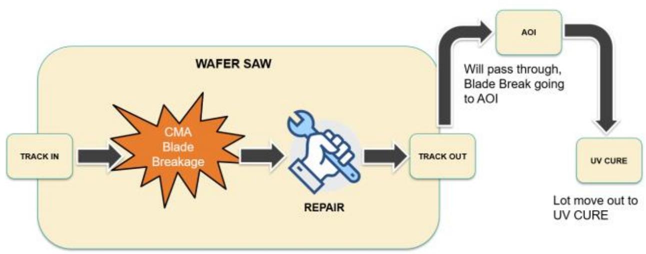

Figure 9. There will be a pokayoke once CMA is triggered.

The devices have been divided into 5 separate waves due to distinct workflows. This will be implemented per wave since this will also require testing per wave.

Figure 10. Shows the different waves per workflow device

WAVES	DEVICES
WAVE 1	PREMOUNTED WBC
WAVE 2	NON PREMOUNT WBC
WAVE 3	PREMOUNTED NON PLASMA WBC
WAVE 4	NON PREMOUNT PLASMA WBC
WAVE 5	NON PREMOUNT NON WBC

Figure 10. Devices that have different workflows

1.2.3 Automation Control 3 – Business Rule

The last configuration will be the Business rule, which is interesting since this is not readily available in the MES, that we will be needing the IT Team to create a new Business rule to activate the CMA Triggered Breakaway Flow.

Figure 11. Shows the workflow once business rule is implemented.

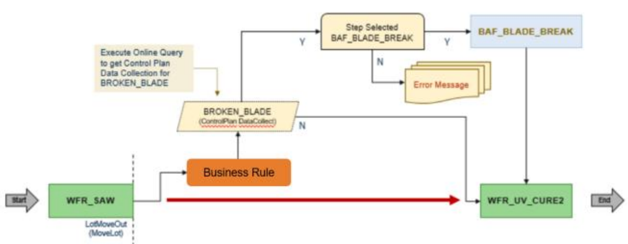

Figure 11. Business Rule will execute upon transaction.

The IT team is responsible for generating the Business Rule, which this will involves the configuration within both the MES and automation systems.

2. 0 REVIEW OF RELATED WORK

With the Industry 4.0 in mind, this is converting the semiconductor company to a smart factory that interconnects with other systems and devices. This also encourages some of the industrial companies to go on digital, the key requirements of it, is the communication and the connectivity. This project will describe the factors that needs to be achieve in order for the factory to be digitized, thru this we must implement the MES, Automations, and a SECSGEM capable machine. The MES will be setting all the controls for the Automations to execute it which this will be an economic efficiency for the Plant.

2.1 Connectivity (MES)

The concept of connectivity on the Shop floor is completely new especially in a semiconductor industry. And then here comes Industry 4.0, The connectivity of it will now be easy to build by applying also the IoT, with this, it will be a big impact to the factory to implement Industry 4.0.

Figure 12. Machine connection with Automation

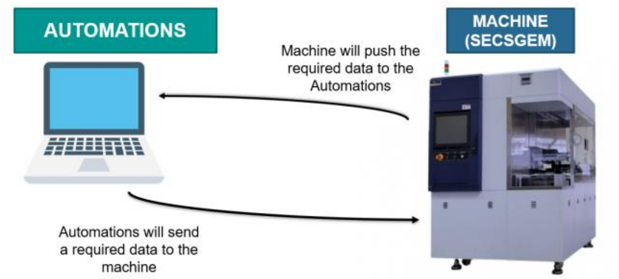

Figure 12. Connection between the machine and automations

One of the requirements to acquire Industry 4.0 is to implement the MES (Manufacturing Execution System). This system will be the central information control of the automations. It has a function to control all matrixes that will be read by the Automations. MES also operates in real time, and typically will act more efficiently than its actual processing time. The controls will be managed by our team (ATS - Assembly and Test Support). The team will first gather all the data device given by the operations then convert it to Matrixes, this is called Modelling.

Figure 13. Below are the data that will be modelled by ATS

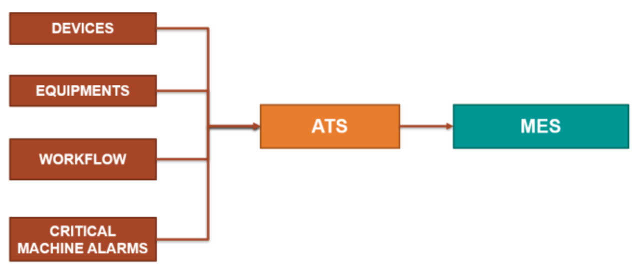

Figure 13. ATS to push data in MES

2.2 Automations

The main goal of Automations is to provide solutions, restrictions, and communication. For the automation to be deploy, the device use will be a laptop. There are also additional adapters to be included in the Automations for communications, this is the SECGEMS capability of the machine in order for the Automations to connect. The SECGEMS is one of the features of the machine, that allows the machine to be configure and access via network. Usually, wafer prep machines in the plant have this feature equipped. Once the MES is all set, this will now be executed by the Automations.

Figure 14. Shows the set of controls that will be push to the Automations.

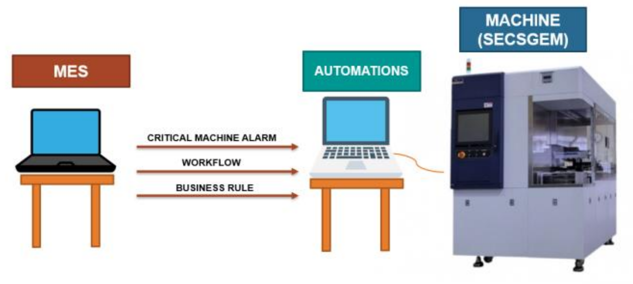

Figure 14. Data Information to be push in Automations.

2.3 Business Intelligence

Business Intelligence Solutions may assist both strategic and decision making by using the data from source system that can obtain the historical and real time data. Before the used of BI Software, such as Tableau, extracting raw data from different applications typically must be integrated and consolidated for the users to have an accurate and consistent data. By using the software Tableau, this enables the users to view the graphs and data in real time.

Figure 15. CMA count per equipment

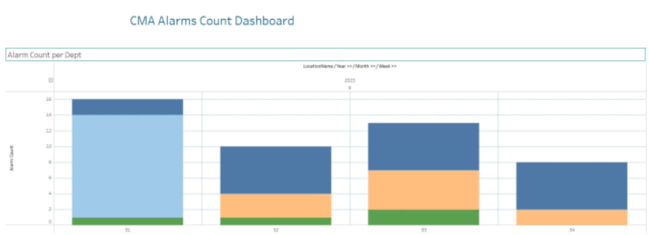

Figure 15. Tableau Report For CMA

3.0 METHODOLOGY

For the continuous improvement, the team have come up with a solution to Figure 4 workflow this is to eliminate the product escape and improve the quality control, which the inspection will be triggered via CMA.

Figure 16 Using the SIPOC analysis, we define the key elements of the process, to enhance efficiency and ensure that the right inputs are transformed into the desired outputs.

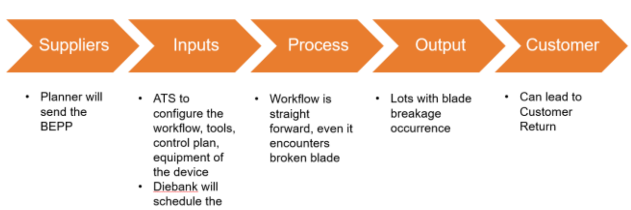

Figure 16. Tableau Report For CMA

By using the 7-step QC Story approach, we have determine that most of the lots that has not been inspected have cause potential defects. As we gathered the data and analyze it was confirmed that a considerable number of lots experiencing Critical Machine Alarms (CMA) do not undergo the required inspection, as illustrated in Figure 5. We have identify that the workflow often advances to the subsequent step without the necessary inspection. In response, the team devised a solution—the implementation of the CMA Triggered Breakaway Flow—leading to a remarkable enhancement in inspection compliance, reaching 100%.

4.0 RESULTS AND DISCUSSION

The prerequisites for project implementation consist of several key elements. Initially, data requirements the gathering of Critical Machine Alarms (CMA), Workflow, and the devices. Subsequently, the IT Team to configure process within the Manufacturing Execution System (MES) and Automation. Thirdly, is the modelling of ATS pushing the data through MES. Finally, VPC testing is conducted on a per-wave basis.

The Wafer Prep devices has been separated by different waves upon implementation in Figure 10. We need to test this per wave in order to check its functionality based on the inspections.

Figure 17. Wave 1 Test cases which are already Passed

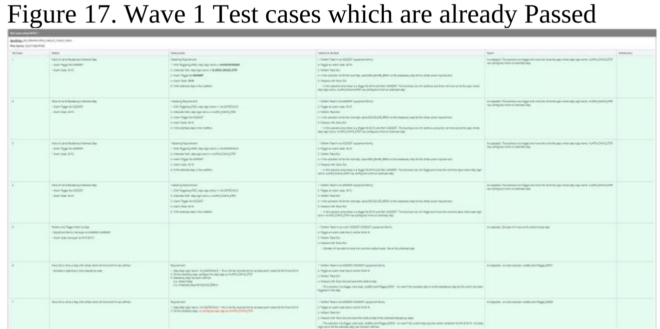

Figure 17. List of Test Cases.

Figure 18 The comparison between the without CMA Breakaway flow and with CMA Breakaway Flow

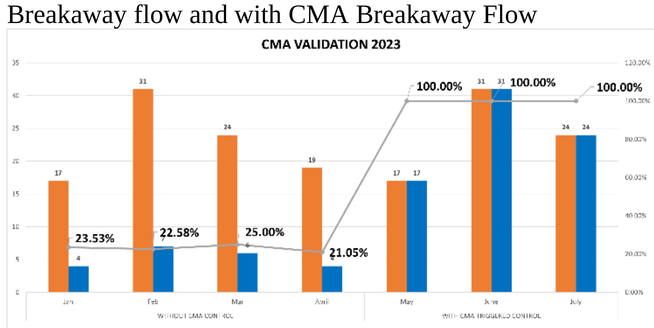

Figure 18. CMA Inspection Compliance Validation

As a result, upon observing Figure 18 the inspection compliance percentage falls below <25% which this is for the manual inspection. However, upon successful project implementation of CMA Triggered Breakaway Flow, the inspection compliance percentage improves to 100%, indicating that all lots triggered by CMA undergo through inspection. We can ensure you that upon the implementation of this project there will be no product escape since all the lots will go through inspection.

5.0 CONCLUSION

Based on the collected and analyzed data, it was observed that the manually triggered breakaway flow some of the lots did not proceed to inspection. However, after conducting thorough experimentation and implementing a closed-loop approach involving CMA triggering, a reliable Poka-Yoke solution has been successfully implemented.

6.0 RECOMMENDATIONS

It is recommended that implementation of the identified solution be sustained to all other possible areas. Also, the Team needs to continue evaluating other possible workflow that will further eliminate the remaining potential defects. Lastly, it's important to extend this approach to all relevant machines across various Assembly Locations and share it with other sites as well.

7.0 ACKNOWLEDGMENT

The authors would like to thank and acknowledge everyone who contributed their time, effort, support, and commitment to the implementation of this project and technical paper.

In the complete success of this project, we would like to thank Mr. Roy Rico, Manufacturing Director, Mr. Joshua Buenaventura, NPI and Project Management Department Head who contributed their knowledge, ideas, and skills.

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