SMART MANUFACTURING: INTEGRATING FACTORY LOOK FOR EFFICIENCY AND INNOVATION

Melanie A. Marfa
Rhina Tibayan
Noel Maliksi

Slider Fab Manufacturing Engineering
Western Digital Philippines Corp. Special Export Processing Zone, Laguna Techno park, Binan, Laguna, Philippines
Melanie.Marfa@wdc.com,Rhina.Tibayan@wdc.com,Noel.Maliksi@wdc.com

ABSTRACT

In today's competitive technological environment, efficiency is crucial in reference to product Quality and competing to the rest of the manufacturing industry. This paper discusses how our application powered by Digitalization & Automation through Factory Look maintains competitiveness while it embodies a sophisticated paradigm shift, leveraging cutting-edge technologies to optimize production processes, enhance efficiency, and streamline operations within modern manufacturing setups.

Through analyzing its components, we've enhanced key areas to achieve our project goals. Traditional methods struggle with data inaccuracies and slow issue resolution, leading to quality problems and yield issues. To address this, we've implemented data analytics via Factory Look, empowering engineers with insights from big data for more efficient problem-solving. Our flexible tools enhance real-time equipment performance by embracing predictive maintenance and advanced analytics, prioritizing KPIs aligned with organizational goals, and automating processes. Timely intervention is vital to mitigate risks associated with slow data analysis.

1.0 INTRODUCTION

Historically, the challenge with traditional process control methods such as SPC and manual KPV monitoring stems from the manual collection of data and lack of protocols persist among older tools and managing numerous KPIs with limited resources necessitates strategic prioritization aligned with organizational goals, leading to delays in data analysis turnaround and Quality issues. This slow process poses a risk to large inventories, as manual searches for root causes of issues are time-consuming. Sample images which is shown in figure 1.

Figure 1: Sample manual monitoring of KPV, SPC and Quality feedback

In response, automated based tool that is capable to gather data automatically we call Factory Look that is designed to provide real-time visibility through intuitive dashboards and visualization tools, enabling informed decision-making. It offers browser-based access to key equipment and process metrics, with archived data easily acquire for trend analysis. Real-time data from processes, equipment, or sensors is captured and stored in a unified database, allowing for global production visualization.

The Smart factory technology feature is to digitizes manufacturing processes in terms of systematically detect deviations in failure rate trend real time, prompting appropriate actions to abnormalities, tool utilization, OEE, machine KPV online trend and SPC, optimizing efficiency, and enabling proactive decision-making. By leveraging data analytics, automation, smart manufacturing streamlines operations, reduces waste, and enhances responsiveness. This innovation drives, faster production, and increased profitability.
This paper will outline the development of these tools, covering data collection, advance analytic, and comprehensive reporting frameworks.

2.0 METHODOLOGY

The following concepts in data automation and analytics were explored in this study.

2.1 Tool Connectivity Concept

The fundamental idea involves using a HOST PC and Server with a factory-like appearance as the primary components for data transfer and automation. Data is gathered from diverse sources, then processed, and finally place into a data storage system. The stored data resides within the Factory look infrastructure.

Figure 2 as shown below, is the flow detailing the execution of Factory Look connectivity involves integrating a Host PC for data connection via the network.

1.Machine Signal Type (IO, Logfile, PLC)→Factory Host PC→Data transfer thru network→Factory look server

2. Vistrian utilizes the Factory Look server to construct the desired dashboard

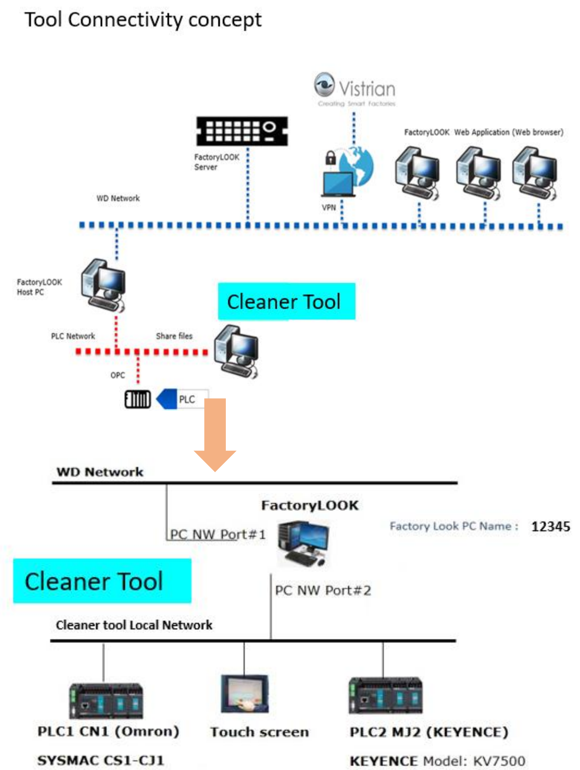


Figure 2: Tool connectivity concept

2.2 Data Collection and Dashboard Creation

In manufacturing, equipment with applicable FL application, Factory Look serves as the Equipment Execution System, efficiently tracking real time data on machinery and process time stored in its data server. To ensure smooth communication between systems, the Factory Look Host PC, equipped with an application programming interface (API), facilitates seamless data exchange. The diagram below offers a concise overview of the data collection sources and the entire Factory Look system.

The concept showed below Figure 3 illustrates how data is connected to the Factory Look server to generate the necessary metrics for monitoring within Factory Look.

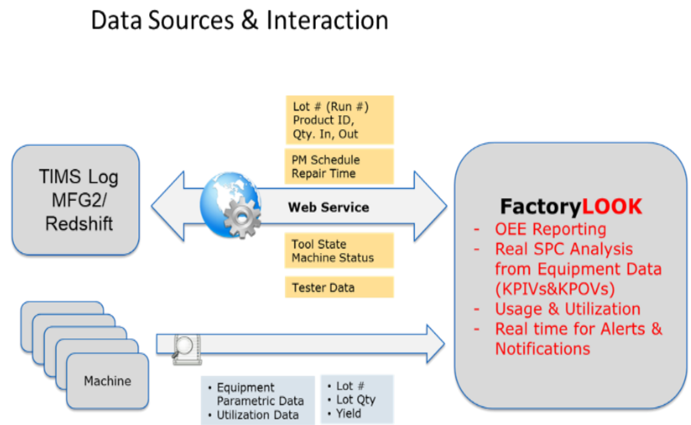


Figure 3: Data connection connectivity flow

2.3 Factory Look system creation for KPV's

Prior to implementation, the Equipment Factory Look undergoes a procedural preparatory phase, where the careful selection and monitoring of all critical Key Performance Variables (KPVs) are essential.

When choosing the KPVs (Key Performance Variables) for equipment on the Factory Host PC, it's essential to ensure they are connected via the specified "Signal Type." There's flexibility in the number of KPVs that can be added, as long as they are connected properly. Once connected, the system can monitor both the behavior of the KPVs and machine parameters. You can choose whether to include the KPVs and parameter list in the Visual System (VS) for monitoring purposes. Additionally, you have the option to designate certain parameters as either "Monitoring" or "Critical." Parameters marked for "Monitoring" won't trigger notifications there is events.

The details provided shown below Figure 4 outline the sequential process for creating and selecting Key Performance Variables (KPVs) along with the corresponding rules to be incorporated into Factory Look

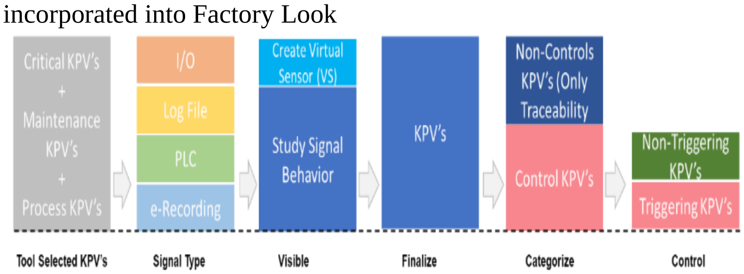


Figure 4: Step by step procedure for KPV creation and rules per KPV

2.4 Factory Look Equipment Advancement

2.4.1 Equipment Utilization and Dashboard

In the Smart Factory Look framework, it's also possible to monitor tool utilization and Equipment Dashboard. By leveraging this data, we can effectively optimize corrective actions to prevent unnecessary costs incurred from underutilized or unneeded resources sample chart as shown in figure 5.

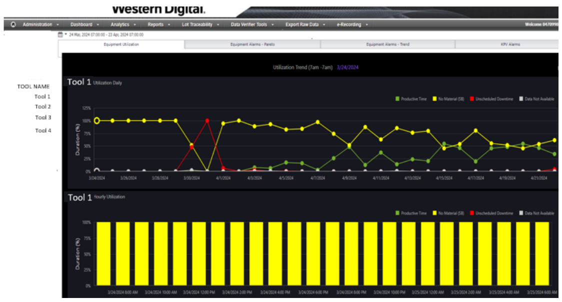


Figure 5: Sample trend tool utilization

2.4.2 KPV's trend Chart

In process control, it's crucial to regularly monitor Key Process Variables (KPVs) or machine parameters to ensure optimal tool performance in a factory setting. In Factory Look application, time-based charts are utilized to visualize these process parameters over time. The KPV trend chart generates essential details such as parameter names, timestamps, and data values, enriching user interaction. When a value surpasses the predefined limits, it alerts users to exceedances, signaling the need for immediate attention. Additionally, users have the capability to export chart data, facilitating further analysis or sharing for collaborative efforts, sample chart of KPV as shown in figure 6.

Figure 6: Sample trend chart of KPV

2.4.3 Overall Equipment Effectiveness

OEE's power is evident in its structured method for uncovering improvement opportunities. By breaking down the various components of OEE—downtime, speed loss, and defects—it allows for the identification of bottlenecks, inefficiencies, and areas primed for enhancement. Factory Look OEE is capable to include specific metrics that measure manufacturing productivity, further aiding in understanding, and optimizing production processes. Figure 7 illustrates a sample computation of Overall Equipment Effectiveness (OEE) and showcases the monitoring samples that will be displayed within the Factory Look application.

- **OEE** is the Overall Equipment Efficiency and is
  - Availability Efficiency x Performance Efficiency x Quality Efficiency, which is
  - (Equipment uptime/Total time) x (Productive time/Equipment uptime x Actual Rate/Theoretical Rate) x (Theoretical Productive time for Effective units/Theoretical time for Actual units),
  - Where Equipment uptime = Productive time + Engineering + Stand by time
  - and Effective Units = Actual Units – (Scrap units + Rework units)

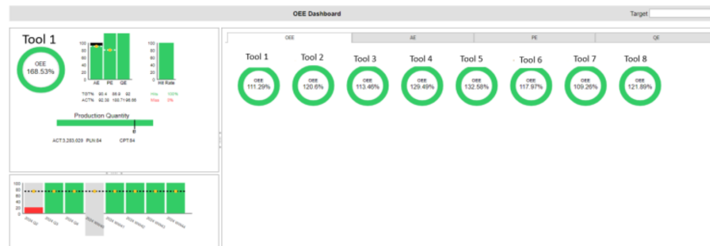


Figure 7: Sample data monitoring of OEE

2.4.4 SPC Trend

In addition to Equipment Utilization, KPV, and OEE, Factory Look can also incorporate Statistical Process Control (SPC) to mitigate unforeseen variables and enhance processes. Employing SPC toward this end not only aids in process improvement but also supports the attainment of broader business goals, such as elevating customer satisfaction and lowering customer complaints.
This proactive approach helps prevent potential yield and quality issues, particularly with continuous tool usage. The trigger alarm item was validated using set rules and was confirmed valid. Figure 8 demonstrates a sample trend that automatically updates and is showcased within the Factory Look application.

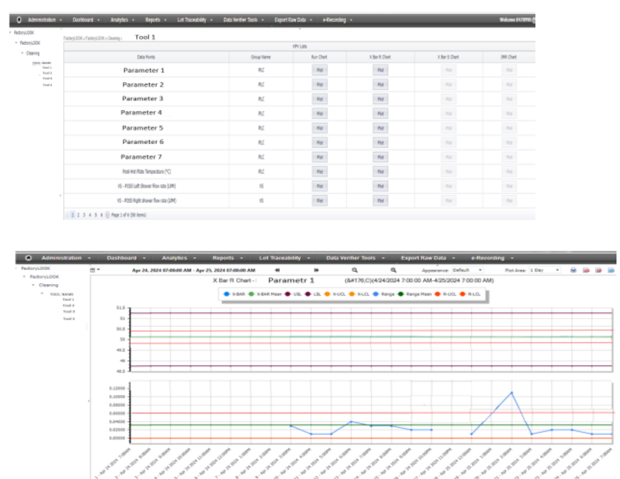
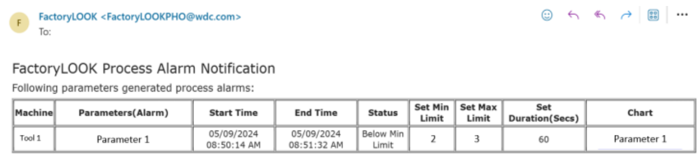


Figure 8: Sample trend chart of SPC chart and parameter list

2.4.5 Alarm Notification for OOC

Factory Look provides a comprehensive overview of equipment operations, incorporating an intelligent alarm system to alert about anomalies such as exceeding specifications or loss of control. It sends customized email alerts to selected recipients, timed to address action requirements. Figure 9 depicts an example notification that designated recipients will receive upon the detection of an Out-of-Control (OOC) event.


FactoryLOOK <FactoryLOOKPHO@wdc.com>
To:

FactoryLOOK Process Alarm Notification

Following parameters generated process alarms:

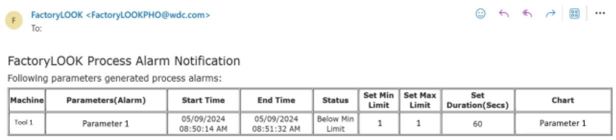
Machine	Parameters(Alarm)	Start Time	End Time	Status	Set Min Limit	Set Max Limit	Set Duration(Secs)	Chart
Tool 1	Parameter 1	05/09/2024 08:50:14 AM	05/09/2024 08:51:32 AM	Below Min Limit	2	3	60	Parameter 1

Figure 9: Sample email notification

3.0 RESULT AND DISCUSSION

The Factory Look feature is designed to logically detect deviations in failure rate trends, triggering appropriate responses to anomalies. This paper will portray the development of these tools, encompassing data collection, preprocessing, analytical methodologies, and reporting frameworks.

Utilizing the Factory Look application has enabled us to proactively prevent quality issues and minimize their impact on affected parts. Here are some success stories following its implementation:


FactoryLOOK <FactoryLOOKPHO@wdc.com>
To:

FactoryLOOK Process Alarm Notification

Following parameters generated process alarms:

Machine	Parameters(Alarm)	Start Time	End Time	Status	Set Min Limit	Set Max Limit	Set Duration(Secs)	Chart
Tool 1	Parameter 1	05/09/2024 08:50:14 AM	05/09/2024 08:51:32 AM	Below Min Limit	1	1	60	Parameter 1

Figure 10: Sample notification of Out-of-control KPV

Figure 10 provides examples of notifications for actual issues detected in the cleaning tool. Utilizing the Factory Look system, email alerts promptly identify instances of incorrect recipe usage, preventing further processing of parts. This proactive approach helps mitigate cleanliness concerns and the potential for customer complaints, ultimately averting additional expenses.

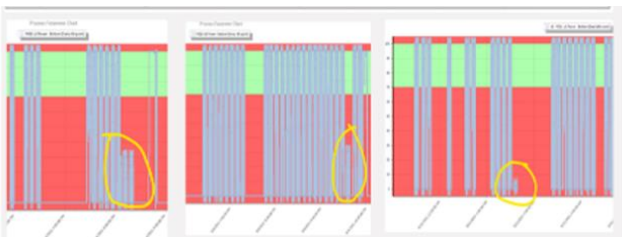


Figure 11: Sample trend of unforeseen KPV limitation of machine interlock

In Figure 11, some abnormalities in Tool Key Performance Variables (KPVs) may go undetected by tool interlocks due to their limitations. However, the Factory Look system has the capability to identify these unnoticed instances of out-of-control (OOC) conditions.

Tool to Tool KIV performance

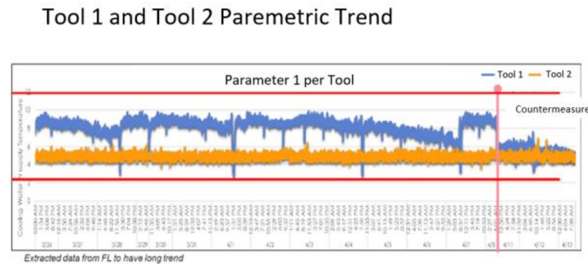


Figure 12: Tool to tool performance trend chart

Figure 12 demonstrates that by leveraging the Factory Look application, there is an opportunity to eliminate variations between tools.

In factory settings, leveraging variations in performance among tools or machines can enhance the efficiency of weaker ones. This involves analyzing key process variables or machine parameters and making necessary adjustments. By identifying root causes and implementing measures like quality control, consistency can be improved. Automated adjustments using feedback loops can optimize performance. The goal is to enhance overall process efficiency and product quality by addressing factors contributing to variability between tools or machines.

After completing the Factory Look application utilization, the team has successfully managed tool KPV control and machine performance. The benefits of this implementation are summarized in Table 1.

Table 1: Summary of Benefits

Category	Details	% Gain
Manhours	Tech activity allocation	Reduced by 33%
Cost	-US Sonic calibration	100% cost reduction (eliminate calibration)
	-Rewashing of parts	97% reduction of IDM usage
Quality	Protect customer feedback	100% improved (no customer feedback from 2020 up to date)
Productivity	Predictive Maintenance	50% downtime reduction

4.0 CONCLUSION

The implementation of Factory Look has demonstrated its effectiveness as a data analytical tool in manufacturing areas. The direct connection of Factory Look to the tools has enabled powerful and efficient analysis of complex manufacturing data. This allows engineers and line owners to quickly identify significant issues, facilitating early detection of process variations. Such proactive measures empower the manufacturing community to achieve faster issue resolution and minimize production costs.

5.0 RECOMMENDATION

Using a smart factory look can greatly enhance efficiency, productivity, and safety within manufacturing environments. Here are some recommendations for implementing a smart factory look.

Data Visualization: Utilize dashboards and data visualization tools to display key performance indicators (KPIs), production metrics, and other relevant data in a clear and easily understandable manner. This helps manufacturing engineering make informed decisions in real-time.

IoT Integration: Incorporate Internet of Things (IoT) devices such as sensors and actuators to gather real-time data from machines, equipment, and processes. This data can be used for monitoring, predictive maintenance, and optimizing workflows.

Automation: Implement automated real time monitoring to streamline manufacturing processes and eliminate manual data gathering

Continuously Improvement Culture: Foster a culture of continuous improvement where employees are encouraged to suggest and implement process enhancement, innovations, and efficiency gains.

By incorporating these recommendations, you can create a smart factory environment that is agile, efficient, and resilient, enabling you to stay competitive in today's rapidly evolving manufacturing landscape.

6.0 ACKNOWLEDGMENT

We extend our sincere thanks to all who have contributed to the successful completion of this project, with special appreciation to the System Engineering, Manufacturing Engineering, and IT teams.

7.0 REFERENCES

1.https://www.automation.com/en-us/suppliers/aps21/vistrian-inc

8.0 ABOUT THE AUTHORS

Melanie Marfa has 26 years of working experience at Western Digital Corporation and currently holds the position as Manufacturing Engineer, with experience in slider fabrication in key process of Cleaning in the field of Process Engineering.

Rhina Tibayan has a 17 years' work experience at Western Digital and currently holds a position as Manufacturing Senior Manager, with experience in slider fabrication in key process of Cleaning, Inspection and Sorting in the field of Process and Equipment Engineering.

Noel Maliksi has a 20 years work experience at Western Digital Corp and is engaged at Engineering System, with experience in Equipment Maintenance, Process Engineering and Currently handling tool automation under System Engineering.