Application of Big Data Analytics for Recommending V93K Tester Platform Focus Area with High Test Time and Index Time Deviation

Romero Sunshine Ander
Infineon Technologies Asia Pacific Pte. Ltd.
349253, Singapore
SunshineAnder.Romero@infineon.com

Koh Mei Hwei
Infineon Technologies Asia Pacific Pte. Ltd.
349253, Singapore
MeiHwei.Koh@infineon.com

Tang Ho Hwa @Howard
Infineon Technologies Asia Pacific Pte. Ltd.
349253, Singapore
HoHwa.Tang@infineon.com

Abstract

As the business grows, the customer volume, varieties and complexity also grows accordingly. In the testing area, the complexity is also higher with combinations of the tester, handler, test program, temperature and product. An effective solution is required to classify the accuracy of test time and index time and recommend the attention to the focus problem area. In this paper, the management of big data analytics was explored for recommending V93K tester platform focus area with high test time and index time deviation. The systematics will be able to summarize and help to decide quickly on the focus list for the factory engineers, manufacturing manager and operations to work on for productivity and gap closure.

Keywords:
Automatic Time Study, Time deviation, Equipment Monitoring, Recommended Focus Area, Productivity

Acknowledgements
The authors would like to thank Infineon Technologies management and fellow colleagues from various functional groups for providing the support and insights related to the paper.

Biographies

Sunshine Romero is an Industrial Engineering professional practitioner in Infineon Technologies in Singapore. She earned her Bachelor Degree in Industrial Engineering from De La Salle University, Philippines. She has 14 years of working experience in various companies such as Infineon Technologies, Stats ChipPAC, Global Foundries and Analog Devices in Singapore and in the Philippines. Her research interests include manufacturing standards, work method simplification, automations, systems integration, data analysis, productivity and lean.

Mei Hwei Koh is an Industrial Engineer in Infineon Technologies in Singapore. She earned her Bachelor Degree in Computer Aided Design and Manufacturing from University of Malaya, Malaysia. She has been working as an Industrial Engineer after her graduation in 2014 with 2.5 years of experience in capacity planning in Global Foundries. Her research interests include manufacturing, work method simplification, layout planning, productivity and lean.

Howard Tang is an Industrial Engineering professional practitioner in Infineon Technologies in Singapore. He earned Bachelor of Engineering in Mechanical and Production Engineering from Nanyang Technological University, Singapore and Masters of Science in Industrial and Systems Engineering from National University of Singapore. He has published conference papers. Howard is a professional with over 10 years of experience in working in various companies Infineon Technologies, Stats ChipPAC, Global Foundries and Defense Science and Technology Agency in Singapore. His research interests include manufacturing, management, automation, system integration, data analysis, optimization, productivity and lean.

Introduction

As our business grows, it has become increasingly important for the test time and index time accuracy, as any deviation may have an impact on the customer deliveries, result in capacity fulfillment issues and poor investment decisions.

The challenge for the project is not merely on identifying which products having the high test time and index time deviations but also to come up with a priority list of high runner devices so that the test engineering, planning and manufacturing related people can concentrate and quickly derive with the gap analysis and conclusion, and subsequently move forward to the next set of focus list of high runner devices until all deviations are eliminated or at the minimum impact on capacity.

System Development

This project is based mainly on the experience and benchmarking of industrial engineers, planners and management requirement to design the systematics.

System Requirement

A. Automatic Time Study

In order for the Unit per Hour (UPH) quality control to be meaningful, the following main parts are required:

<u>The Actuals</u>

1. The actual machine UPH can be captured
2. The actual machine UPH noises or outliers can be removed

<u>The Plan and Control Limits</u>

3. The definition of the planned UPH
4. The definition of the planned UPH Control Limits

<u>The Classification</u>

5. The actual machine UPH can be compared with the plan UPH
6. The actual machine UPH can be classified

This systematic is also based on the company's in-house Equipment Automatic Time Study tool which considers the same number of test sites that is planned for, with details of the test time, index time, test program, test program revision, temperature and time frame. Additional information such as tester identification (ID) and handler (ID) are also considered.

Mention combinations:

UPH (Test Time, Index Time)	= UPH (x,y)
Tester ID	= a
Hander ID	= b
Test Program	= c
Test Program Revision	= d
Temperature	= e
Time Frame	= f

B. Automatic Time Study Classification

Based on the above mentioned combinations of a, b, c, d, e, f, the machine UPH can be classified as shown in Table 1, where R and S are the upper and lower control limits, respectively.

UPH Classification	Formulations
Out-Of-Control-Faster	$UPH(x,y)_{abcdef} > R$
Out-Of-Control-Slower	$UPH(x,y)_{abcdef} < S$
OK (or Within Control Limits)	$S \leq UPH(x,y)_{abcdef} \leq R$

Table 1: UPH Classification and Formulations

Figure 1: Example of UPH Classification Bar Graph Report based on 13 weeks (3 Months) data

Execution

In the initial phase of the UPH improvement project for the Backend Testing bottleneck, V93K, the top 20 focus products with high UPH deviation are identified, so that the machines and products UPH are under control.

In the measurement stage, a simple but yet effective system is setup to allow clear classification of the actual UPH that are out-of-control or within the tolerance limit of deviation.

The top 20 focus product considerations (applicable to each focus product) are as follows:

1. Occurs more than one (1) machine or tester ID
2. Occurs equals to or more than five (5) weeks of data
3. High runner devices based on number of units processed
4. With minimum ten (10) records or data points
5. If 100% of records or data points UPH classification are Out-Of-Control-Faster, amend the actual test time and/or index time to reflect the UPH improvement
6. If 100% of records or data points UPH classification are Out-Of-Control-Slower, understand the gap between plan versus actual test time and/or index time, derive productivity measures to meet the plan, review and monitor the improvement
7. If there is a UPH classification mixture of Out-Of-Control-Faster, Out-Of-Control-Slower and OK, understand the gap between plan versus actual test time and/or index time, derive productivity measures to consistently meet the plan, review and monitor the improvement

Upon closer analysis of the top 20 focus key products, after considering more than one (1) machine, five (5) weeks data of the high runner devices with minimum ten (10) records, the following are applied:

<u>100% of records or data points UPH classification are Out-Of-Control-Faster</u>

1. Reflect the UPH improvement by updating the actual test time and/or index time numbers

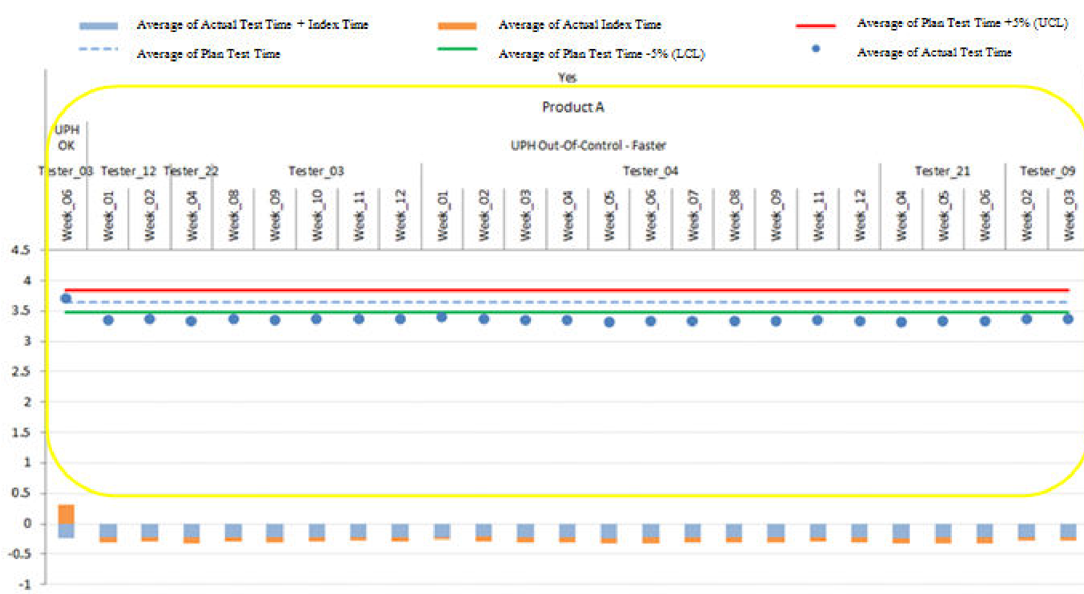

Figure 2: Example of UPH Classification with 100% Out-Of-Control-Faster, wherein the data points of all the actual sum of test time and index time is consistently lower than the plan

<u>100% of records or data points UPH classification are Out-Of-Control-Slower</u>

1. Understand the UPH deviation between plan versus actual (e.g. find the root cause of the gap on test time and/or index time)
2. The focus team will discuss and provide productivity projects to close the gap between plan versus actual
3. After productivity plan implementation and satisfying all the focus product considerations, if 100% of the data points still shows UPH classification Out-Of-Control-Slower, the team will discuss and make an agreement whether to continue to monitor for the next five (5) weeks or update the slower actual test time and/or index time

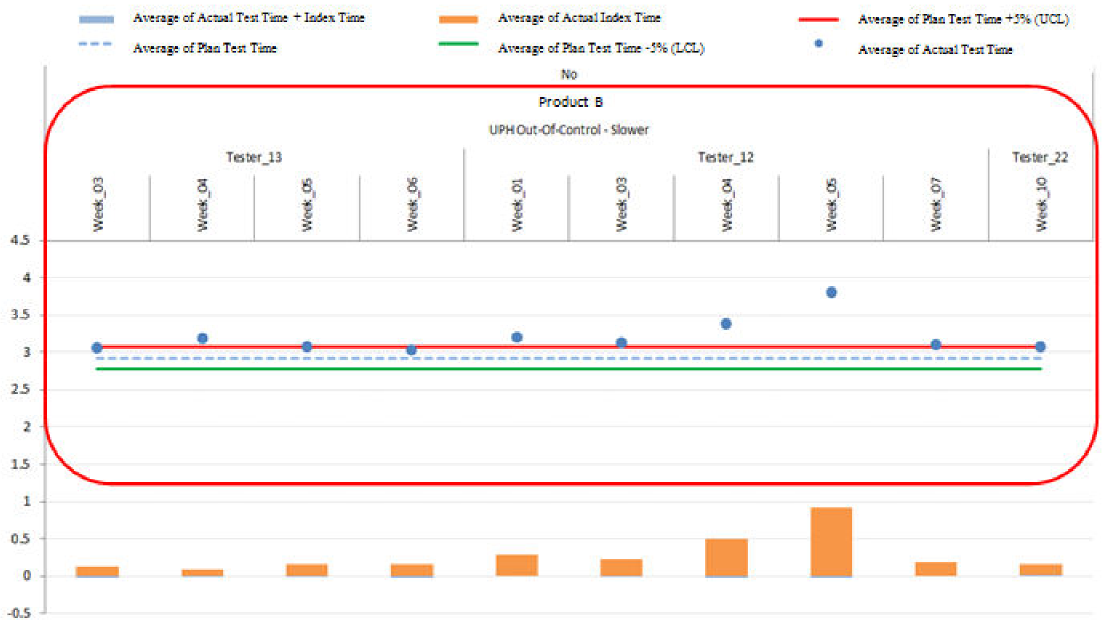

Figure 3: Example of UPH Classification with 100% Out-Of-Control-Slower data points, wherein the data points of all the actual sum of test time and index time is consistently higher than the plan

<u>Mixture of UPH Classification that are Out-of-Control-Faster, Out-of-Control-Slower and OK</u>

1. Understand the UPH deviation between plan versus actual (e.g. find the root cause of the gap on test time and/or index time)
2. The focus team will discuss and provide productivity projects to close the gap between plan versus actual
3. After productivity plan implementation and satisfying all the focus product considerations, if the data points still shows mixture of UPH classification that are Out-Of-Control-Faster and Out-Of-Control-Slower, the team will discuss and make an agreement whether to continue to monitor for the next five (5) weeks or hold onto the plan and move to the next set of focus products

Figure 4: Example of Mixture Out-Of-Control Faster/ Slower/ OK, wherein some of the data points of the actual sum of test time and index time are higher, lower and within the plan

Result

After simulating the actual improvement of 100% Out-Of-Control-Faster, the average "UPH OK" increased from 62% to 63% (gap closure of 1%). It is also observed that the machine can consistently outperform the initial plan UPH. (See Figure 5 for the UPH Classification for the Month 1 to 3 w.r.t. initial plan UPH).

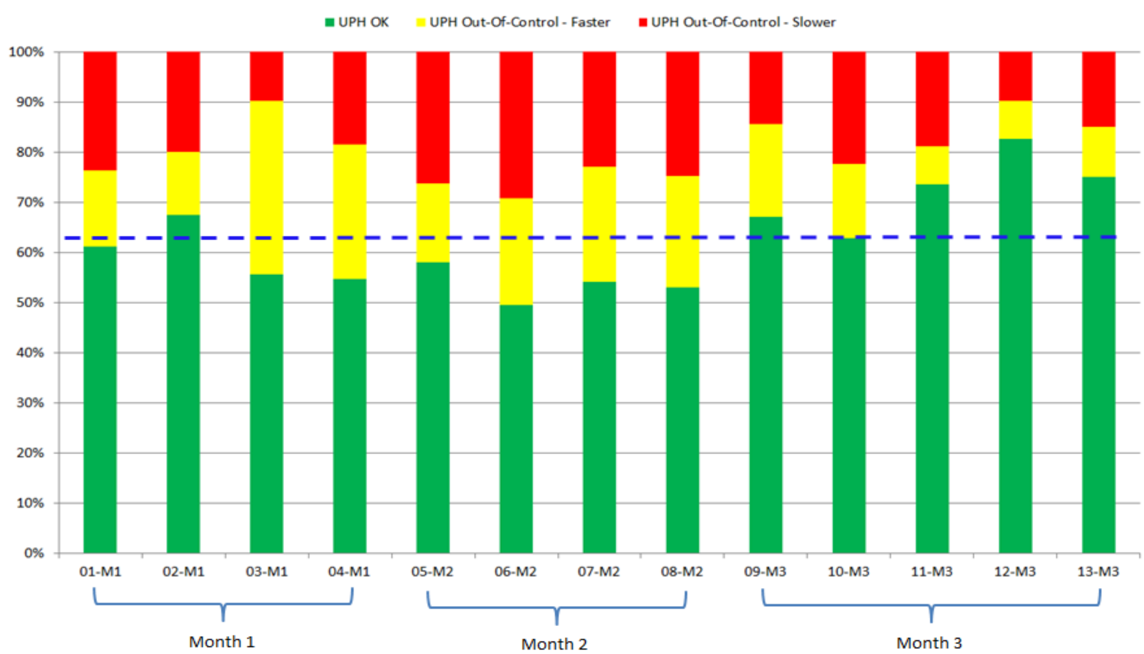

Figure 5: UPH Classification for Month 1 to Month 3 w.r.t. initial plan UPH

With this project, the team is able to achieve 3 important outcomes:

1) Increase the plan UPH from the initial plan UPH –Out-Of-Control-Faster (Yellow zone) to UPH OK (Green zone)

This gives the factory and operation the confidence that the machine UPH is stable and predictable on the output. The engineers can now focus on those machines or products that are truly the real problem.

2) The amount of time to generate Top 20 focus list was reduced from 1 month to 15-30 minutes. The engineers can now work efficiently with this automated time study.

3) The engineers able to detect quickly the Out-Of-Control-Faster / Out-Of-Control-Slower for improvement either caused by the test time and/or index time deviation.

Conclusion

This UPH Improvement Systematic allows various functional departments of Industrial Engineers, Equipment Engineers, Planners and Operations people to align better. This in turn leads to better machine stability, better capacity commitment and fulfillment of demand.

Includes this improvement project in the weekly productivity meeting and reflect any changes required.

References

[1] H. Tang, Nyoman, Imsar and Rois (2017), Application of Equipment Automatic Time Study for UPH Improvement of Orthodyne 7200 and 7200+ Aluminum Wire Bonder, Asia Pacific Industrial Engineering & Management Systems Conference 2017

[2] H. Tang, D. Yeo and A. Ding (2016), Equipment Automatic Time Study in Semiconductor Manufacturing, 2016 Industrial and Systems Engineering Research Conference.

[3] George, Michael L. (2005), The Lean Six Sigma Pocket Toolbook: A Quick Reference Guide to Nearly 100 Tools for Improving Process Quality, Speed, and Complexity, New York: McGraw-Hill

[4] Niebel, Benjamin W. (1993). Motion and Time Study. 9th ed. Homewood, IL: Irwin.

[5] Nelson, Daniel (1980). Frederick W. Taylor and the Rise of Scientific Management. Madison: University of Wisconsin Press. ISBN 0-299-08160-5.

[6] Taylor, Frederick Winslow. [1911] (1998). The Principles of Scientific Management. Cosimo Classics. ISBN-10: 1-59605-889-7

[7] George Kanawaty (1992) Introduction to Work Study Bernan Assoc