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CONCEPTION OF TECHNICS FOR ELECTRONIC PRODUCTION OPTIMIZATION AND FLOW EFFICIENCY

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ABSTRACT

This paper describes new approaches to enhance the electronic industrial line performance. The technics presented in this article could thematically be deployed in diverse industrial environments as well as in multi-aspect productions, from semiconductors to complex aircrafts assembly for instance. Thus, a smarter system can be built and the feedback loop between the different quality testing systems and the production environment improved. Such a system is designed and implemented in order to increase the profit margins and decrease operating costs. Finally, motivated by the rich conclusions of this critical analysis, interesting open challenges are identified for future researches.

INTRODUCTION

The off-line quality control methods and strategies aims mainly to reduce the production costs and to optimize the resources. Their applications are affecting multiple production aspects such as the productivity and the product finishing speed, which is a key to optimizing the process for line and off-line production.

Assembly lines are deeply planned before any implementation or production start. However, multiple constraints may occur when products need a quick adaption or rework. We particularly face this in electronic and electric production contexts, where the customers' needs variate within time which increases the number of product features.

On another hand, such changes in assembly lines create difficulties on multiple levels. The logistic is impacted since the JIT and JIS should be updated. Assembly installations are most of the time reconFigured. The line operators as human beings are sensibilized with the help of lean processes. In addition, plenty of other parameters are changed in order to ensure a smooth production transition at each product update. These difficulties are also faced when a production process is optimized.

In this paper, a deep study and an experiment of an optimization in an assembly line of electronic devices was carried out using off-line production methods to fully understand and document the results and come up with conclusions.

1. PROBLEMATIC

It is important to maintain a fast quality control flow in a mass production context. In addition, in order to optimize the productivity, an efficient feedback-loop system is generally highlighted for transparency matters. Assembly lines are flow oriented production systems, and balancing problems are not easily defined in medium term production planning. In this paper we will analyze an assembly line that consists of similar testing stations k=1,...,m arranged along an industrial conveyor belt. (see Figure 1). Manufacturing a product on an assembly line requires partitioning the available work time related to the number of finished units required in a specific period of time, we call a partition unit a takt. In other work, the total amount of work is split into a set of elementary operations named tasks V= {1,...,n}. Performing a task j takes a task time tj and requires certain preconditions such as installations equipment and trained operators. It is estimated based on the absolute time an industrial production needs to achieve the goal of production initially planned

In order to analyze the correlation between quality and productivity and describe the production system, we suggest studying a sample prototype of it monitored by Statistical Process Control. We will schematize as a system the production prototype in Figure 1. This system contains multiple stations represented in the *square*, by products that we consider as a set of electronic components which may contain semiconductors, control units, sensors and actuators. The mentioned stations can represent computing stations, testing stations or End Of Lines (EOL) responsible for both inspection and product integration.

Machining stations are those realizing machining operations; inspection stations are those measuring some quality characteristics of the parts produced at one or more upstream machining stations. Integrated stations are those performing both manufacturing and inspection operations. (process example explaining a production flow based on the Figure 1)

In the Figure 1. we can for instance the production line is represented by the horizontal panel that contains the products in their sequence.

To sum-up the process, single product parts are considered as the industrial input that is being manufactured, processed and inspected to result with a conformity validation of the whole product at the end of the process flow. While the Data Treatment service is responsible of receiving the complete result of each product test, to make a data treatment and aggregation on it, then store the end result in the production Datawarehouse.

2. PROPOSED WORK

The main problematic behind this paper is to Figure out possible ways to perform and increase a production yield. Maximizing the profit remains a challenge at the heart of the manufacturing industry.

In a mass production context, a fast quality control flow is very important to maintain in order to optimize the productivity. Therefor the importance of a feedback-loop system using the test device's display as much as quick repairs are possible. Sophisticated testing equipments allow minimizing the production costs. These testing equipments are for instance used for Automatic testing in industrial production lines.

We can represent an Automatic Test Sets on different forms. The basic one is the mechatronic aspect that is quickly performed by the test devices in accordance with the production installations. Then comes the assisting routines, where different tasks are displayed to the production agent/worker and where he is supposed to follow step by step the test scenario in order to correctly mount the different parts and allow the tester to proceed to the necessary check.

Improvements have allowed to reduce the testing time. For example, replacing some visual and human checks and some manual operations with automatic routines. This allows to increase the operators' ergonomy by reducing their participation.

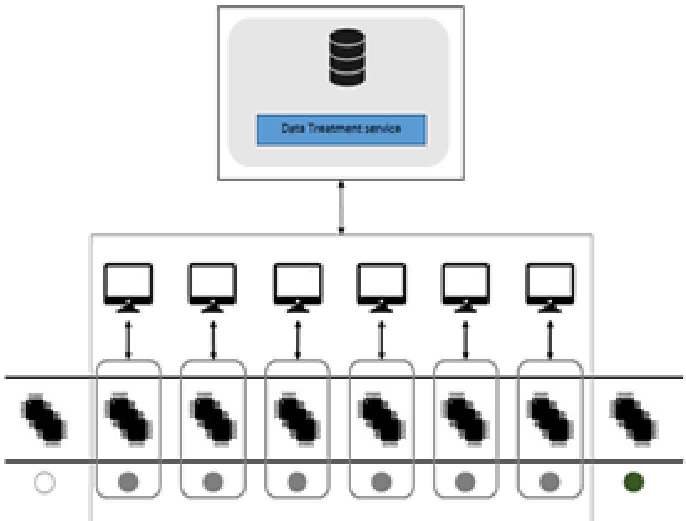

Figure 1 Production Line Sample

Also, this allows to reduce costs by reducing the test time. In addition to that, instead of a physical printed paper protocol for the test results, digital printout displayed on the test device itself is an even more sophisticated test Set.

This Automatic Test Set "new generation" permits a higher rate of testing per product element, an improvement in ergonomy for the production agents, thus a reduction in manpower quantity, and a reduced staff error.

Technic 1:

In order to enhance the behavior of the system described in the *Figure 1.* and to optimize the quality and productivity performance, we can propose to model the type of production system quality control as a system monitored by a Protocol Control Service, represented in *Figure 2*.

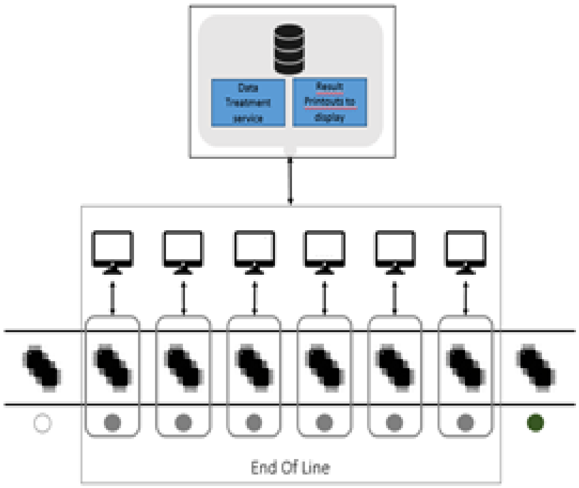

Figure 1 Quality control system

The considered system layout is serial, even if the proposed approach could be extended to include many different system architectures, such as assembly, disassembly, split and merge systems. This technic consists of automatically reporting the testing protocols to the responsible agents so that they take inline actions and probably solve the problem and save the rework time for that product. The idea is to implement an online monitoring and real time system allowing a fast feedback system to allow a maximal valid quality checks before sending the products to the next steps.

Technic 2:

Many research regarding the Takt time analysis, and lean production were previously performed. The most interesting part would be an analysis of the Takt time and a simulation in complex production systems at once.

The second technic consists of misplacing the defect products after being tested into an Off-Line such as a parallel line to the standard flow. The goal is to gain time allowing the repairing of thee defect products without disturbing or slowing the standard production flow down. Then afterwards (figure 3)

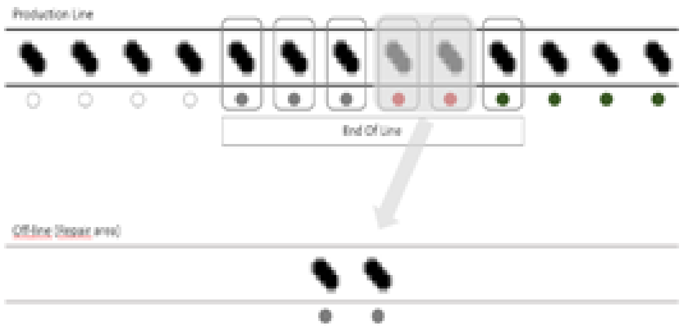

Figure 3 Implemeenting off-line repairs

Once the defaults are repaired or the missing electronic parts correctly assembled. The products may take place again in the main production flow in order to be retested and officially protocolled in order to continue within the flow. (figure 4)

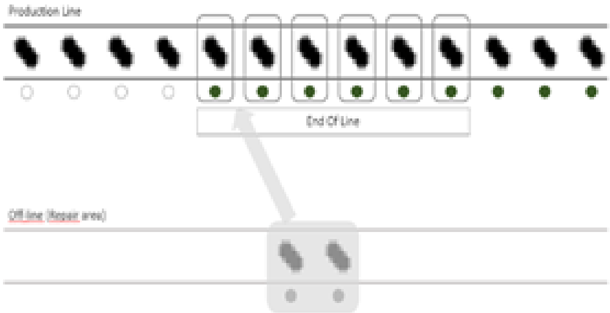

Figure 4 Reinject the product from the off-line to the in-line

3. RESULTS AND SIMULATIONS

Several improvements and optimizations have been implemented on a dummy test scenario on a simulations purpose. The results were conclusive as the test duration dropped drastically.

The following Graph (figure 7) represents a sample of 25 test set. And almost one hour was spared for this particular sample. This leads to a reduction of more than 75% of the total time needed before the optimizations.

So as a sum-up, the results of the proposed system structure is mainly a cost reducing represented by a 75% time sparing following the simulation tests. Important to notice as well that the time sparing in a production environment usually means a staff reducing. This also influences the production agents, since the analyze time is reduced which automatically the ergonomy.

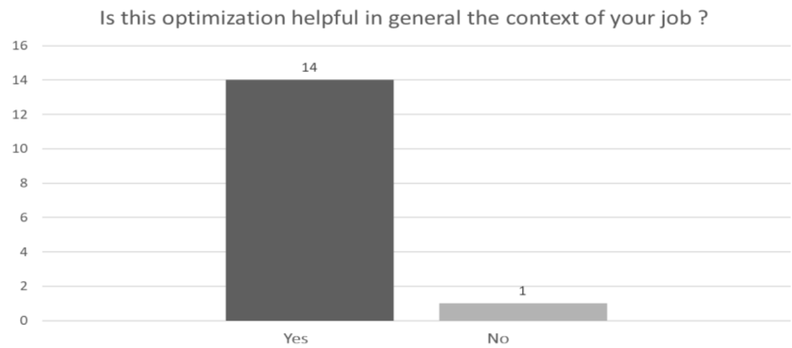

Figure 5 Optimisations' results

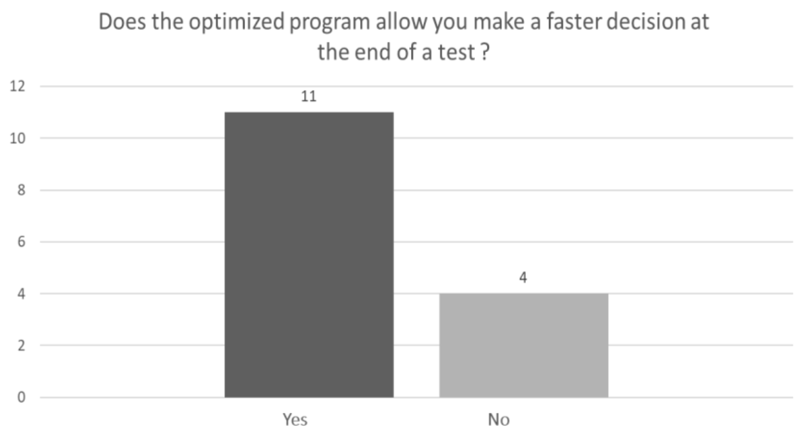

Figure 6 Optimisations' results

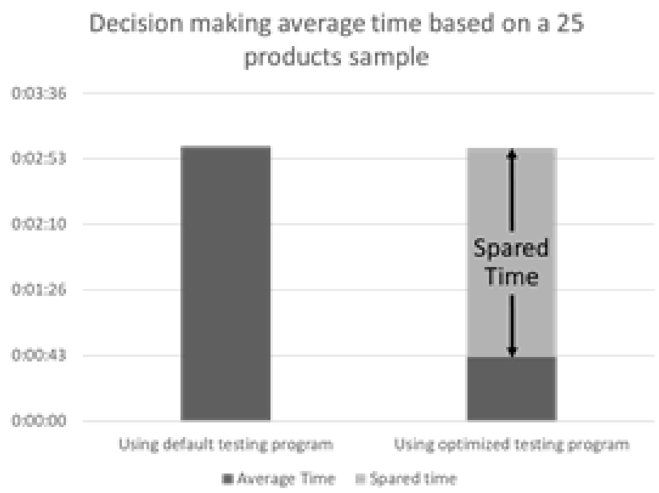

Figure 1 Optimisations' results

4. CONCLUSION AND FUTURE WORK

As maximizing the production yield being the main focus of the manufacturing industry, the described technics allow a certain profit margin.

The resulted data is recorded through the progression of products in the assembly line. Data science methods can be applied to specific testing and measurement records in order to detect problems and anomalies in one hand and predict failures and upcoming errors. And regarding the global electronic and semiconductor shortage situation around the world, a machine learning model can be trained in order to predict missing parts in addition to system of product failures.

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