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An Improvement on the Handling Time for Unsymmetrical Product during Visual Inspection - A Case Study

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Abstract

Quality inspection is a crucial activity in manufacturing by practicing a standard procedure for inspection before product delivery. The improvement of inspection time becomes a focal point of the visual inspection activities due to the handling time of product after inspection which received less attention by the practitioners. In practical, high handling time normally occur by virtue of operators who taking a long time in handling the products, especially unsymmetrical products after inspection; thus lead to delay of subsequent process. In this paper, a proper methodology of solving high handling time problem is proposed by adopting seven new quality tools such as affinity diagram and Process Decision Program Chart (PDPC). The analysis of the tools is to determine the factors that affect the handling time and subsequently develop a solution to minimize the handling time by making improvements on this quality work. A supporting jig is selected as the solution to countermeasure the problem, hence can achieve 34% of improvement in reducing handling time. The supporting jig is proven to be an effective method in minimizing the handling time and implemented to a case study conducted in a semiconductor company.

Keywords
Quality inspection, handling time, visual inspection, unsymmetrical product, affinity diagram, PDPC, supporting jig

1. Introduction

Nowadays, quality inspection has become the most basic and essential part in manufacturing industry in order to maintain customer satisfaction. It also is kept efficient to reduce the cost for the company. Inspection, is an activity to locate faulty items characterized by certain defects, in which plays vital elements in manufacturing to maintain process control and ensuring the customers will receive good products instead of faulty (Garrett et al. 2001). Most of this inspection tends to be visual, involving an examination for defects resulting in a decision to accept or reject a product on the basis of the basis of defect severity (Hou, 1992). Visual inspection normally performs by the operators in the traditional way of quality control, in which the inspection is done manually by using all human senses, such as vision, hearing, touch and smell.

There are two primary functions of visual inspection, which are visual search and decision making (Drury, 1975). Both functions are the main determinants in the performance of an inspection that greatly affect the success of the inspection task. The process of manual visual inspection is highly dependent on the operators. The natures of human that possess the ability to make decisions is what makes operators desirable for inspection tasks (George et al. 2003). Although automated inspections performing much faster with fewer errors, but it is still unable to surpass the superior decision making capabilities of humans. The inherent flexibility along with the superior decision making capabilities are the main factor that human remain an integral part of some inspection tasks (Micalizzi and Goldberg, 1989). Hence, a human inspector is still outperforming machines in most attribute in visual inspection tasks (Xiachun et al., 2003).

Completing the inspection task in the shortest time possible is a major concern in the inspection process. The time needed in completing an inspection task is known as the inspection time. The inspection time is vital to make sure that the products are shipped to customers within due date. The quality inspection process must have short cycle time so that more inspection process can be performed in a particular time. However, the time needed to handle the products after inspection task known as handling time is also important to maintain the speed of the inspection so that subsequent inspection task can be performed as soon as possible. Handling time is defined as the time taken for the operators to organize, arrange and to manage the parts before allocating the parts into boxes or packages for further process, after the inspection process. If the handling time for the product is too long, the time to start another inspection will be delayed. Too much time wasted in handling the part will lead to unfinished inspection of the products. Hence, handling time is an important factor for performing visual inspection process and to be controlled.

Therefore, the aim of this paper is to minimize the handling time on quality inspection work based on a proposed framework. The framework consists of process flow on the procedure of identifying the factors that affect the handling time and suggest solutions to overcome the problem of handling time. Each step in the framework is basically through the data collection and data analysis, prior to generate applicable and convenient solution.

The arrangement of this paper is structured into several sections. The next section will provide the methodology an improvement of this case study. The following sub-section including all phases of the methodology. The case study is detailed in section 3. Section 4 will discuss the result of the case study and section 5 is concluded.

2. Methodology

A systematic methodology for improvement on the handling time plays an important role in terms of the procedure towards obtaining better productivity. There are four phases in the methodology: data gathering and data analysis, root cause identification, feasible solution identification and solution selection, and solution execution. The methodology is based on the thorough analysis of inspection time, as depicted in Figure 1.

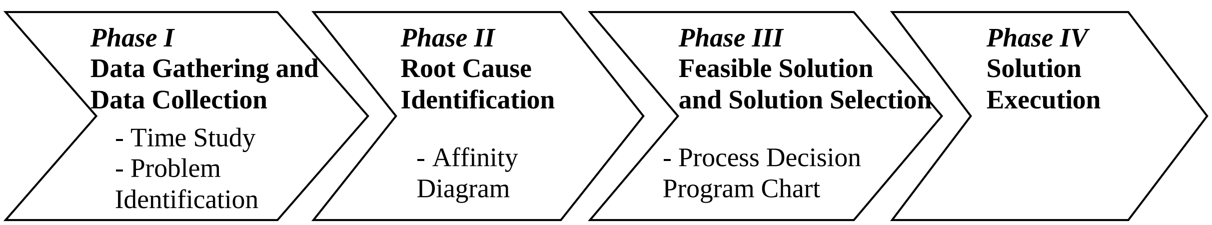

Figure 1: Methodology an improvement on the handling time

Referring to Figure 1, data gathering will be carried out in Phase I by using suitable approaches such as time study. Meanwhile, data analysis is done to examine and understands the current situation to identify the problem. The root cause identification in Phase II can be determined by using the suitable tools such as affinity diagram techniques. After the root causes are identified, the feasible solution to curb these root cause will then be proposed in Phase III. Solution selection will be conducted in Phase III by using Process Decision Program Chart (PDPC) to evaluate the practicality of each alternative feasible solution. The last phase is solution execution. The proposed methodology is implemented through a case study in a semiconductor company.

3. Case Study

Based on the of process improvement on the handling time in the visual inspection process as discussed earlier, a case study was conducted in a semiconductor company located in North, part of Malaysia. The company is equipped with highly automated state-of-the art facilities and leading technology in manufacturing printed circuit board (PCB). The company comprises a full range support and services from circuit design, prototype fabrication and mass production up to flex assembly. This case study mainly focuses on Quality Control (QC) Department which controls the product quality. The company is trying to grow as a highly competitive company, but high wastage is the main problem of which is due to high inspection time and handling time. Therefore, in order to show the applicability of process improvement methodology, it is adopted phases by phases as shown in Figure 1. A detail discussion of the each phase is given as in the following section.

3.1 Phase 1: Data Gathering and Data Analysis

Data gathering requires thorough understanding of the quality inspection process in the quality control department. The purpose of this phase is mainly to figure out the flaws that existed in the current visual inspection system. Then, data analysis is concerned with interpreting and verifying the results from data gathering to identifying the problem. This case study mainly focuses on the visual inspection section, by which observing the whole process that is done by the operators. During the observation, only one part of products were selected, which is unsymmetrical in the shape known as Part A. The operators started off the handling process of by taking the parts one by one from a heap of parts. This heap of parts was accumulated after inspection was done. The operators would count ten pieces of the parts and put aside the parts. This process is repeated for five times. The 10 piece stack were then collected and accumulated. However, the parts will get mix-up with each other due to the shape. Thus, the operators must adjust and arrange the parts before putting the parts into plastic bags. The total handling time for part A from five operators was tabulated in Table 1.

Table 1: Current practice handling time for part A

Handling Task (Person in charge)	Quantity (unit)	Counting Time	Adjusting Time	Total Handling Time
Operator 1	10	29.63s		
	10	28.28s		
	10	32.95s		
	10	34.71s		
	10	29.29s		
	50	**154.86s**	**31.35s**	**186.21s**
Operator 2	10	24.09s		
	10	27.53s		
	10	28.70s		
	10	26.21s		
	10	25.52s		
	50	**132.05s**	**30.63s**	**162.68s**
Operator 3	10	16.08s		
	10	23.18s		
	10	24.17s		
	10	16.56s		
	10	23.50s		
	50	**103.49s**	**33.52s**	**137.01s**
Operator 4	10	30.70s		
	10	31.25s		
	10	30.23s		
	10	31.99s		
	10	30.45s		
	50	**154.62s**	**32.42s**	**187.04s**
Operator 5	10	29.04s		
	10	25.28s		
	10	33.91s		
	10	28.31s		
	10	22.49s		
	50	**139.03s**	**30.83s**	**169.89s**
Average Total Handling Time				**168.56s**

As shown in Table 1, from company's practice, a total of 50 parts divides into 10 for each section due to the unsymmetrical shape of parts that required counting and adjusting after each inspection process. Then, time taken to counting and adjusting the part is recorded for handling time. This task is done by five operators and the average total handling time is 168.56 seconds. Through the analysis, time taken in arranging the parts after the inspection was considered as a waste. This is because the operators need to arrange the parts and position the parts in an organize manner before placing the parts in respective plastic bags. Thus, this extra time in handling the parts should be minimized to improve the productivity performance.

3.2 Phase II: Root Cause Identification

It is important to figure out the root cause of the problem prior to generate feasible solutions based on the problem identified. The main problem of high handling time is due to the time wasted by the operators in arranging the unsymmetrical parts for further processes. Thus, Affinity diagram technique is employed to identify the root cause of high handling time of the parts as shown in Figure 2.

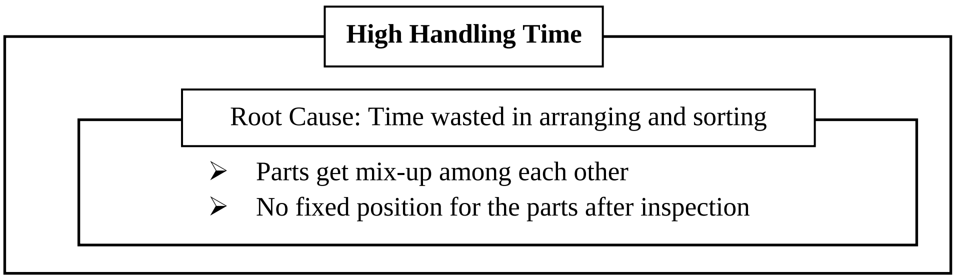

Figure 2: Root cause for high handling time

Referring to Figure 2, the main cause that affected the high handling time is the time taken in arranging and sorting out the parts. The unsymmetrical parts will get mix-up and overlapped among each other and the process of adjusting as well as arranging the parts were time consuming. Besides, no particular position is available to place the parts. The operators are randomly placed the parts and collected it back before arrange it properly which lead to the time wasted.

3.3 Phase III: Solution Generation and Solution Selection

This phase is to ameliorate the problem with effective solution after analyzing the current situation. The feasible solution of the root cause is proposed as in Table 2 below. Each solution is evaluated with respect to cost, ease of implementation and probability of an accomplishment upon implementation.

Table 2: Feasible solution for high handling time

Alternative	Feasible Solution
Alternative 1 Automated adjusting the machine to adjust the parts after each part is inspected	Various machines in the market have the capability to do different tasks according to customers’ requirements. These machines can be operated manually or automatically depending on the specifications of the machines. Automated machines have the advantage of time saving as the tasks can be done accurately in a short time.
Alternative 2 Extra operators to handle the parts after inspection	Parts handling is essential regardless of the parts geometry and sizes. Additional worker can be employed and be assigned specifically to perform part handling tasks after the inspection process.
Alternative 3 Supporting jigs or fixtures to fix the parts in position after inspection	Creating supporting jigs or fixtures can be used as alternatives in parts handling tasks. These jigs or fixtures will be specifically designed to accommodate the shapes and sizes of the parts that are inspected.

Therefore, Process Decision Program Chart (PDPC) is implemented to evaluate the practicality of each feasible solution as shown in Figure 3.

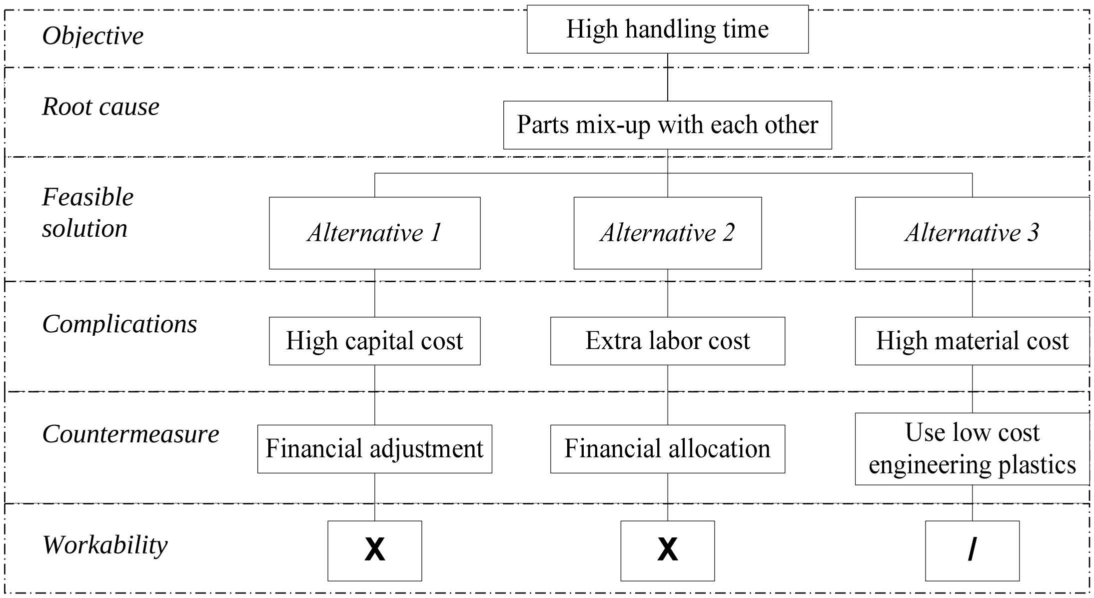

Figure 3: Process Decision Program Chart (PDPC)

As refer to Figure 3, *Alternative 3* is selected as the solution to the problem identified in Phase I. High handling time is mainly caused by the unsymmetrical shape of the parts that lead to the mixing up problem among the parts itself. Therefore, the solution generated must be able to overcome the mixing up problem. Hence, a supporting jig is suggested as the solution in order to place the parts neatly on the jig after inspection tasks. The supporting jig is designed based on the dimension of the part A.

3.4 Phase IV: Solution Execution

The final phase involves the implementation of the selected solution in the previous phase by which the supporting jig is designed and the prototype of the jig is fabricates. The new supporting jig must be verified to test on the practicality of the suggested solution to ensure that the handling time for part A can be reduced as in Figure 4. The design of supporting jig is then illustrated as Figure 5.

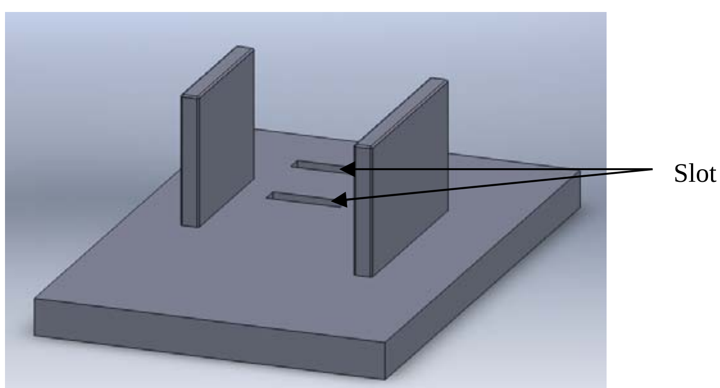

Figure 4: Supporting jig

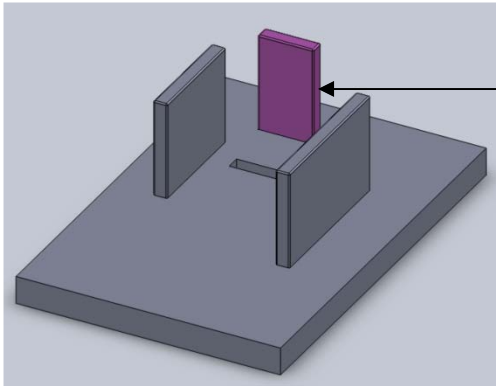

Figure 5: Supporting jigs for part A

As shown in Figure 5, the slabs for part A are removable where the slabs can be placed in their respective slots according to the requirement. The function of the removable slabs is to provide flexibility to the supporting jig. The required slab will be placed in the respective slots when needed. The function of the jig is illustrated as in Figure 6.

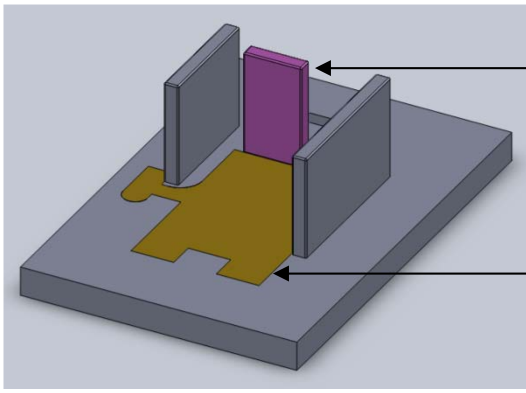

Figure 6: Position of part A using the supporting jig

As each part is inspected, the inspected part will be immediately placed onto the jig as shown in Figure 6, thus eliminating the need for adjusting and arranging the parts after the all the parts are inspected. In the latter, the test run is carried out in the quality inspection section in the company. During the test run, five operators are assigned to perform the handling tasks by using the supporting jig. The operators are required to count and place the parts onto the new supporting jig.

In this case study, part A is choosing to be tested and the number of parts to be collected in each cycle was 50 units. Each unit was counted and put onto the supporting jig. After the total quantity of units required had been reached, the units were placed into a plastic bag. The handling time to handle the parts were recorded and presented in Table 3.

Table 3: After improvement handling time for part A using supporting jig

Handling Task (person in charge)	**Quantity (unit)**	**Handling Time (seconds)**		
		Counting Time	**Adjusting Time**	**Total Handling Time**
Operator 1	50	119.5s	1.41s	**120.91s**
Operator 2	50	106.32s	1.32s	**107.64s**
Operator 3	50	105.32s	1.81s	**107.13s**
Operator 4	50	109.12s	1.13s	**110.25s**
Operator 5	50	104.17s	1.56s	**105.73s**
Average Total Handling Time				**110.33s**

Referring to Table 3, 50 units per section were counted all at once for the performing handling task instead of 10 units per section which increase the task of the operator. Therefore, the supporting jig suggested easing the tasks of the operator by eliminating the need to count the units per section thus reduce the waste of handling time. The operator was able to continuously count the number of units required in one cycle without the need to separate the units into sections because the jig was able to hold the more units in place compared to using the hand to hold the units based on the current method. Hence, the supporting jig suggested is proven to be applicable in performing inspection task especially to reduce handling time, indirectly speed up delivery finish goods to the customer.

4. Discussion

Through the case study, the high handling time leads to low productivity of the good product. Thus, a supporting jig is designed to help the operator handle a part during inspection tasks. The effect of the use of the supporting jig for handling tasks can be seen by illustrating the results of the test run in a bar graph, as shown in Figure 7.

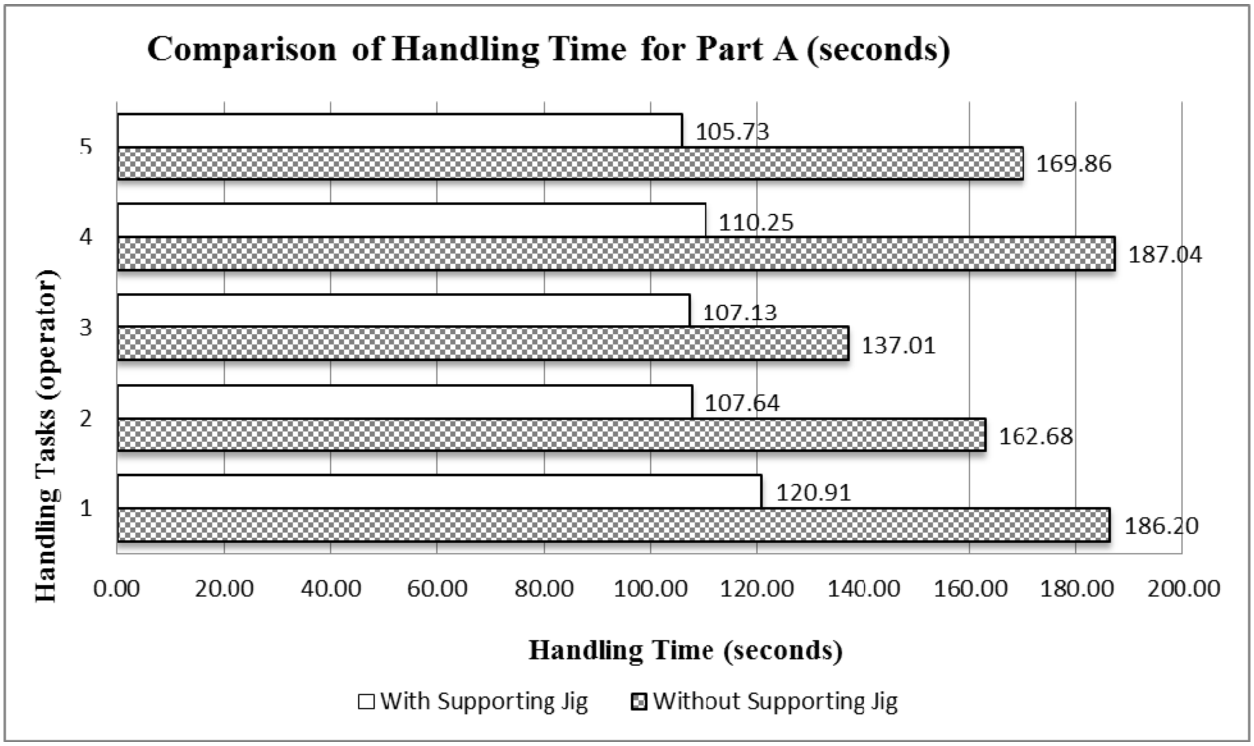

Figure 7: Bar graph of handling time comparison

Referring to Figure 7, the effect of using supporting jig in reducing handling time is presented in the form of graphs where the handling time taken is reduced significantly for each handling task. Based on the graph, the maximum handling time using supporting jig is 120.91 seconds compared to the handling time of the current method is 186.20 seconds. Thus, the supporting jig suggested can assist in saving handling time during handling tasks, in which achieved 34% of improvement. From a company perspective, the effect of saving one minute handling time per cycle will be significant as there are a large number of units on one lot. Consequently, the time saved will be increased as the operator is more familiar with the jig; hence ease the process of arranging and adjusting the parts after inspection. The result is a good start for companies to practice continuous improvement culture within the organization. This paper proves the practicality of using supporting jig in reducing handling time for the post-inspection process.

5. Conclusion

A proper step is vital with the aid of seven new quality tools such as affinity diagram and Process Decision Program Chart (PDPC). Adopting the seven new seven quality tools can abridge and form a better analysis procedure in a structured point of view. By using the affinity diagram can facilitates breakthrough thinking and stimulate fresh ideas in determining the root cause of problems, whereas PDPC is important to find feasible counter measure to overcome problems. Hence, it will lead to new perspective for both organization and academic involving quality control environment.

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Biography

Nur Syazwani Abd Suki received her Beng (Hons) degree in Manufacturing Engineering with Management from Universiti Sains Malaysia in 2013. Currently, she is an MSc (Research) candidate in School of Mechanical Engineering at the University Sains Malaysia. Her research interest is on manufacturing system and quality control.

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