QUALITY IMPROVEMENT OF FLEXIBLE PRINTED CIRCUIT (FPC) IN HARD DISK DRIVERS

by

Mr. Sonthiphorn Utchin

A Final Report of the Three - Credit Course
CE 6998 Project

Submitted in Partial Fulfillment
of the Requirements for the Degree of
Master of Science
in Computer and Engineering Management
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Project Title	Quality Improvement of Flexible Printed Circuit (FPC) in Hard Disk Drivers
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Academic Year	July 2001

The Graduate School of Assumption University has approved this final report of the three-credit course, CE 6998 PROJECT, submitted in partial fulfillment of the requirements for the degree of Master of Science in Computer and Engineering Management.

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ABSTRACT

This project concentrates on how to improve quality of Flexible Printed Circuit (FPC) by using principle of continuous improvement. For effectiveness and efficiency, continuous improvement and seven tools technique are fundamental to finding out the defect item, the root causes are cause of problem for reducing the percentage of final reject and optimizing on benefit.

Because of current economic crisis, Thai economy has encountered such crisis. There are many manufacturers in Thailand that have shut down because they can not stand for loss in manufacturing. So MKT-042S-0A which is one of many Flexible Printed Circuit is the heart of hard disk drivers to work completely of hard disk drivers. Nowadays, quality of FPC is not accepted by our customer. So quality improvement by using principle of continuous improvement help us to be accepted by our customer and to get more benefit also.

This project applies seven tools technique and principle of continuous improvement to solve the problem and increase quality. We reduce the percentage of final reject and improve quality of this product by finding out the root cause and implementing the possible solutions, monitoring quality continuously.

After improving quality of MKT-042S-0Acontinuously, the final reject decrease from 1.23% to 0.92% making the company gain more benefit.

ACKNOWLEDGEMENTS

I am indebted to the following people and organizations. Without them, this project would not have been possible.

I wish to express sincere gratitude to my advisor, Dr. Chamnong Jungthirapanich whose patient assistance, guidance, and constant encouragement led me from the project inception to the project completion. I would like to express appreciation to my project Advisory Committee members; Prof.Dr. Srisakdi Charmonman (Chairman), Asst.Prof.Dr. Boonmark Sirinaovakul (Senior Dean), Dr. Chamnong Jungthirapanich (Dean and my advisor), and Assoc.Prof. Somchai Thayarnyong (MUA Representative) for their comments and advice throughout the project.

My grateful thanks to Mr. Supat Patinavin, Production Manager at PCTT company, who recommended and supported about all knowledge of FPC, Mr. Sitthichai Thra-ampawan, Industrial Enagineer, who helped to shared and consulted the project and clarified my confusion in project methodology, and Miss Jantana Thongrompo who recommended in terms of Grammar and Format on this project.

The persons who stand beside me all the time and cheer me up are my parents and my colleagues at PCTT company.

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I. INTRODUCTION

1.1 General Background of the Project

At present, Thai economy is restoring from the economic crisis, which spread to the whole world. Hence quality improvement is one of many activities, which is useful for reducing investment cost and increasing profit.

Computer business is one of many businesses that are blooming. Hard disk driver is computer business that is interesting for quality improvement. To decrease and save investment cost and increases profit; there are many techniques to improve quality of FPC. Continuous improvement technique or seven tools, this technique is one of many techniques that help us to get profit.

Absolutely, quality improvement can help us to improve and to increase quality of product and reduce loss, which occur from defects. In addition, quality improvement still helps indirectly to increase productivity by changing defects to good products.

About technique improvement, there are two main tools that influence the quality improvement:

(1) Pareto Analysis

Pareto Analysis is the tool that is useful for identification of main defect. It is an excellent method that helps us to know what is the main defect? When we know it, we will solve it by using the Cause and Effect Analysis to improve quality.

(2) Cause and Effect Analysis

Cause and Effect Analysis is one of seven tools which emphasize on finding out the root cause of the main defect.

Both tools are main methods for improvement quality. In addition, there are many tools and methods that can help us to improve quality such as control chart, Histogram, scatter diagram or kaizen method etc. These methods will be chosen and are useful for improvement depending on measuring data and way of solution.

1.2 Significance of the Project

The aim of this project is to improve quality of MKT-042S-0A that is one of the elements in Hard disk driver because of defect occurred during production line. This project will use principle of improvement such as seven tools, kaizen and continuous improvement is necessary for monitoring quality and solving the remaining defects.

The importance of the project is to solve the problem, which affect to quality of product. In addition, this project wants to suggest about knowledge of improvement theory with manufacturing department who does not know the excellent method to get more quality improvement.

Thus if they study and bring various techniques of quality improvement to apply on their production line, they will help them to analyze and find out the problem, and know what is the main defect, cause of defect that should be solved firstly to improve quality of product. Then continuous improvement is one method that is necessary for monitoring and improving.

1.3 Statement of Problem

From economic crisis, it leads to many manufactures including our factory trying to improve our quality in order to get more output and gains profit.

This project would like to improve quality of MKT-042S-0A which has high order and high reject by means of providing use of seven tools, continuous improvement and apply them to production line. The main process of this product consists of four main processes as follows: circuit forming, cover coat, surface treatment and final process, only final process concerning with this project. At the final process, there are still many subprocesses in manufacturing of this product. As MKT-042S-0A is producing in production line, it probably occurs some defect that impact to quality of product and company's cost. In order to improve the quality of output and achieve customer satisfaction, it is necessary for finding out and analyzing the problem that influences with quality of product by using principle of quality improvement.

1.4 Methodology

The principle of quality improvement, seven tools, continuous improvement or kaizen method will use to find out the main defect and root cause then it will be solved by implementation of various solutions. So this project has the advantage for production section that has to be directly concerned on the output in order to get more profit on the production line. However, the methodology of this project is explained as follows:

(1) Use principle of Pareto Analysis and Cause and Effect Analysis to find out the main defect and the possible root causes.

(2) Create and implement the many solutions to solve the root causes.

(3) Combine the effective solutions together in order to reduce more reject and gain profit.

II. LITERATURE REVIEW

2.1 What Is Quality?

Quality can mean different things to different people and can be interpreted in a variety of ways by an individual. Quality may be thought to have two main divisions: the quality of a manufactured product and the quality of services received. From a manufacturing standpoint quality is simply conformance to specifications. The ultimate customer could describe Quality as fitness for use. When trying to edge out the competition, quality can be interpreted as producing the very best product or providing the very best service. In some industries a set of classifications have been established by design quality. For example. Several levels of design quality exist in the automotive industry, from top-of-the-line luxury models down to economy cars. At each level, however, the buyer would expect good conformance quality. In fact, auto manufactures encourage in-class comparisons to show that they have the best conformance quality in their class. Buyers who are not pleased with the overall quality of a specific model car are encouraged to "step up" a class or two (for more money, of course!). In the service sector, the hotel industry provides a good example of differences in design quality. All hotels and motels provide a place to sleep, but many features of design quality, such as services available, comfortable to luxurious surroundings, exercise rooms, pools, and hot tubs, separate the bargain hotel from a five-star hotel. Companies that produce products at the higher levels of design quality and companies that produce products for a market that has primarily a single level of design quality would be more inclined to use the combination of the two categories which stresses excellence in the quality definition.

Quality can also be linked to customer satisfaction. Some companies have used that definition for years, but there is now abroad move toward defining quality as total customer satisfaction. To use that definition, a company must know its customer, and in the multilevel markets, it must know the customers at each level for which it produces. The customer is becoming the driving force for quality.

Many companies that initially aimed at improving the quality of their products found that to satisfy the final customer, it was necessary to satisfy a whole sequence of internal customers. Each person involved in the manufacturing process received a partially completed product, performed the assigned operation(s), and passed it on to the next person. At each step in the process the internal customer had to receive a quality product and pass on a quality product. Away from the manufacturing area, those responsible for the order entry, shipping, and billing were also involved in achieving total customer satisfaction. Again, the final customer cannot receive a quality product unless the associated internal customers receive a quality product as well. This awareness led to the concept of total quality, that there are no exceptions to producing quality work. Everyone in a manufacturing environment or in the service sector has customers, internal or external, and must maintain total customer satisfaction:

One more recent development in the definition of quality is that of exceeding the customer's expectations. When the service is so good that the customer feels "special," when a product has an outstanding feature, or when the combination of product, service, and delivery leaves the customer truly amazed, the customer's expectations have been exceeded. Exceeding customer expectation has been extremely effective in building a loyal customer base. It is estimated to be five to seven times more costly to attain a new customer than it is to retain a current one, so it makes a lot of sense to go that extra step.

Quality is:

(1) Fitness for use

(2) Conformance to specifications

(3) Producing the very best products

(4) Excellence in products and services

(5) Total customer satisfaction

(6) Exceeding customer expectations

Total quality in an organization means simply that quality work is expected in every job. There are no exemptions. When something is done, it should be done right the first time. When a product is made, it should be defect-free. When a service is provided, the customer should be pleased with the result. Total quality has evolved as a necessary process for delivering a quality product or service as Figure 2.1 (Smith 1998).

Moreover, a number of authors have put forth definitions based on both customer benefits as well as customer burdens (primarily regarding products). Some definitions are pressed in many manners:

Quality should be aimed at the needs of the consumer, present and future; Deming.

Quality is the total composite product and service characteristics of marketing, engineering, manufacture, and maintenance through which the product and service in use will meet the expectations of the customer; Feigenbaum.

There are two common aspects of quality. One of these has to do with the consideration of the quality of a thing as an objective reality independent of the existence of humans. The other has to do with what we think, feel, or sense as a result of the objective reality; this subjective side of quality is closely linked to value; Shewhart

The extent of quality is determined by how well the true quality characteristics (customer needs, expressed in customer language) match substitute quality characteristics (product specifications, expressed by a producer in technical language); Ishikawa.

From many manner of quality, they lead us to view quality through the customer's eyes. True quality characteristics echo customer needs and set up subjective customer expectations. We translate these expectations into substitute quality characteristic that are defined in technical terms sufficient to design and produce products. Ultimately, customer satisfaction results from the degree of correspondence between the customer's true quality characteristics and our substitute characteristics.

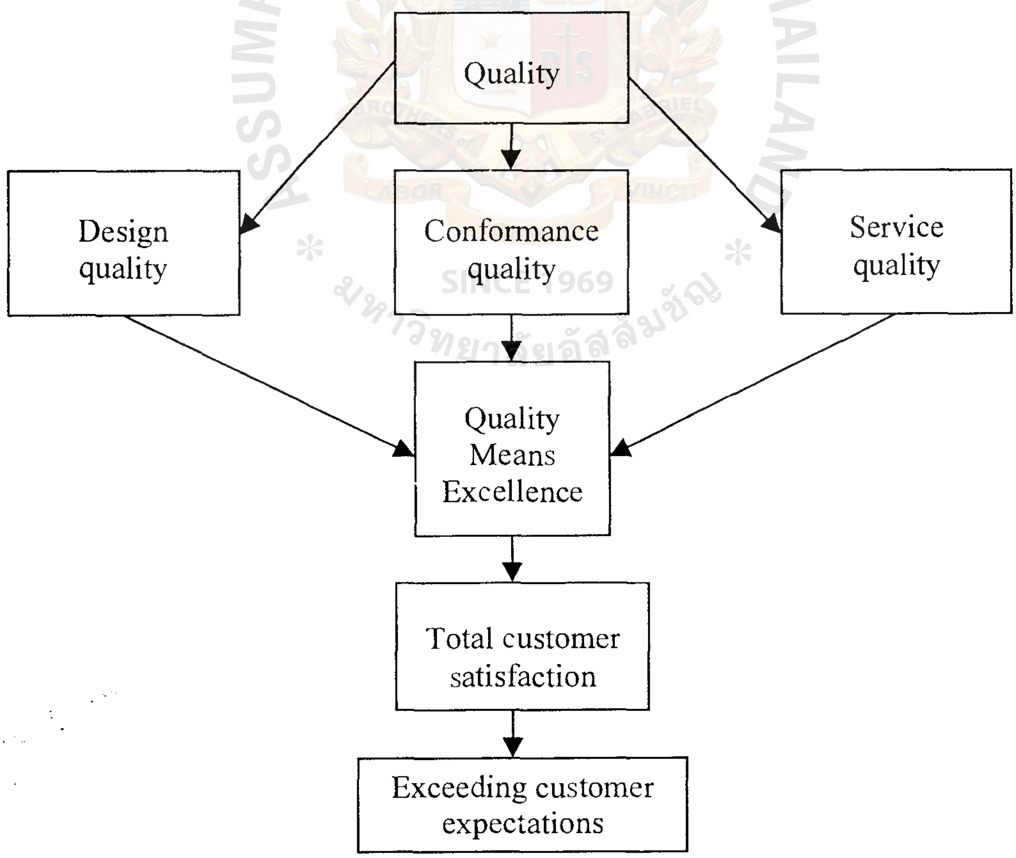


Figure 2.1. Quality Definitions (Kolarik 1999).

2.2 Quality Improvement

One reason that the competitive position of firms can falter is that the quality of goods and services produced does not meet the customer's expectations. When quality-the appropriateness of design specifications to function and use as well as the degree to which outputs conform to the design specifications-is poor, demand for products and services can dimish quickly (Adam and Ebert 1989).

Quality improvement shows that the productivity of a quality system can be measured by its contribution to the profits of a business. The proven key for obtaining the maximum profits available via product quality is the development of a quality system which can achieve and maintain the competent design of a product and the process by which it is manufactured (Broh 1982).

In addition, improving quality is one important way to maintain a competitive position in the global marketplace. Quality can be promoted to customers and employees. Consumers want quality products and services, and employees at all levels in the organization like to be associated with a winner.

From an economic perspective, when quality is emphasized and subsequently improved, waste is decreased or eliminated. Hours are not wasted reworking products. Material is not thrown away. Operations costs are reduced. At the same time, the customer receives products and services that are "fit" for use (Adam and Ebert 1989).

2.3 Continuous Improvement

One of the most fundamental elements of total quality is continuous improvement. The concept applies to process and the people who operate them. It also applies to products. However, a fundamental total-quality philosophy is that the best way to improve a product is to continually improve the processes by which it is made.

Improvement must be continuos: "Improve constantly and forever the system of production and service. Improvement is not a one-time effort. Management is obligated to continually look for ways to reduce waste and improve quality" (W. Edwards Damming).

2.3.1 Rationale for Continuous Improvement

Continuous improvement is fundamental to success in the global marketplace. Companies that are just maintaining the status quo in such key areas as quality, new product development, the adoption of new technologies, and process performance are like a runner who is standing still in a race. Competing in the global marketplace is like competing in the Olympics. Last year's records are sure to be broken this year. Athletes who don't improve continually are not likely to remain long in the winner's circle. The same is true of companies that must compete globally.

Customer needs are not static. They change continually. A special product feature that is considered innovative today will be considered just routine tomorrow. A product cast that is considered a bargain today will be too high to complete tomorrow. A good case in point in this regard is the ever-falling price for each new feature introduced in the personal computer. The only way a company can hope to compete in the modern marketplace is to continually improve.

2.3.2 Essential Improvement Activities

Continuous improvement is not about solving isolated problems as they occur. Advocates of total quality view such an approach as putting out fires. Solving a problem without correcting the fault that caused it-in other words, simply putting out the fire-just means the problem will occur again. Quality expert Peter R. Scholtes recommends the following five activities that he sees as crucial to continuous improvement which can be shown in Figure 2.2.

(a) Maintain communication. Communication is essential to continuous improvement. This cannot be overemphasized. Communication within improvement teams and between teams is a must. It is important to share information before, during, and after attempting to make improvements. All people involved as well as any person or unit that might be impacted by a planned improvement should know what is being done, why, and how it might affect them.

(b) Correct obvious problems. Often process problems are not obvious and a great deal of study is required to isolate them and find solutions. This is the typical case, and it is why the scientific approach is so important in a total-quality setting. However, there will be times when there is a problem with a process that is obvious. In such cases, the problem should be corrected immediately. Spending days studying a problem for which the solution is obvious just so that the scientific approach is used will result in ten-dollar solutions to ten-cent problems.

(c) Look upstream. Look for causes, not symptoms. This is a difficult point to make with people who are used to taking a cursory glance at a situation and putting out the fire as quickly as possible without taking the time to determine what caused it.

(d) Document problems and progress. Take the time to write it down. It is not uncommon for an organization to continue solving the same problem over and over because nobody took the time to document the problems that have been dealt with and how they were solved. A fundamental rule for any improvement project team is "document, document, document."

(e) Monitor changes. Regardless of how well studied a problem is, the solution eventually put in place may not solve it or may only partially solve it. For this reason, it is important to monitor the performance of a process after changes have been implemented. It is also important to ensure that pride of ownership on the part of those who recommended the changes does not interfere with objective monitoring of the changes. These activities are essential regardless of how the improvement effort is structured.

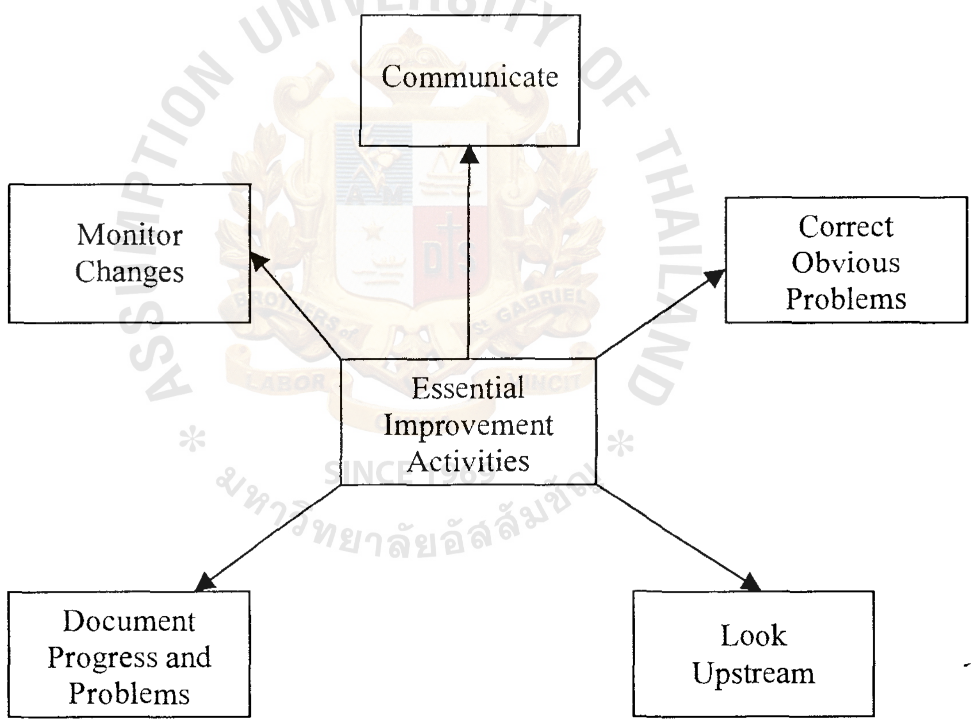


Figure 2.2. Essential Improvement Activities (Goetsch and Davis 1997).

2.3.3 Structure for Quality Improvement

Quality improvement doesn't just happen. It must be undertaken in a systematic, step-by-step manner. In order for an organization to make continuous improvements, it must be structured appropriately. Quality pioneer Joseph Juran calls this "mobilizing for quality improvement." It involves the following steps:

(a) Establish a quality council. The quality council has overall responsibility for continuous improvement. According to Juran, "The basic responsibility of this council is to launch, coordinate, and institutionalize annual quality improvement." It is essential that the membership include executive-level decision makers.

(b) Develop a statement if responsibilities. It is essential that all members of the quality council, as well as employees who are not currently members, understand the council's responsibilities. One of the first priorities of the council is to develop and distribute a statement of responsibilities bearing the signature of the organization's CEO. Responsibilities that should be stated include the following: (1) policy formulation as it relates to quality; (2) setting the benchmarks and dimensions (cost of poor quality, etc.) (3) establishing the team and project selection processes; (4) providing the necessary resources (training, time away from job duties to serve on a project team, and so on); (5) project implementation; (6) establishing quality measures for monitoring progress and undertaking monitoring efforts; and (7) implementing an appropriate reward and recognition program.

(c) Establishing the necessary infrastructure. The quality council constitutes the foundation of an organization's quality effort. However, there is more to the quality infrastructure than just the council. The remainder if the quality infrastructure consists of subcommittees of the council that are assigned responsibility for specific duties, project improvement teams, quality-improvement managers, a quality training program, and a structured improvement process.

2.3.4 The Kaizen Approach

Kaizen is the name given by the Japanese to the concept of continuous incremental improvement. Ka*i* means change and *zen* means good. Kaizen, therefore, means making changes for the better on a continual, never-ending basis. The improvement aspect of Kaizen refers to both people and processes.

If the Kaizen philosophy is in place, all aspects of an organization should be improving all the time. People processes and management practices should improve continually; good enough is never good enough. In his landmark book, KAIZEN: The Key to Japan's Competitive Success, Masaaki Imai gives an overview of the concept that is summarized in the following paragraphs:

(a) Kaizen value system. The underlying value system of Kaizen can be summarized as continual improvement of all things, at all levels, all the time, forever. All of the strategies for achieving this fall under the Kaizen umbrella. See Figure 2.3. Executive managers, middle managers, supervisors, and line employees all play key roles in implementing Kaizen.

(b) Role of executive management. Executive managers are responsible for establishing Kaizen as the overriding corporate strategy and communicating this commitment to all levels of the organization, allocating the resources necessary for Kaizen to work, establishing appropriate policies, ensuring full deployment of Kaizen policies, and establishing systems, procedures, and structures that promote Kaizen.

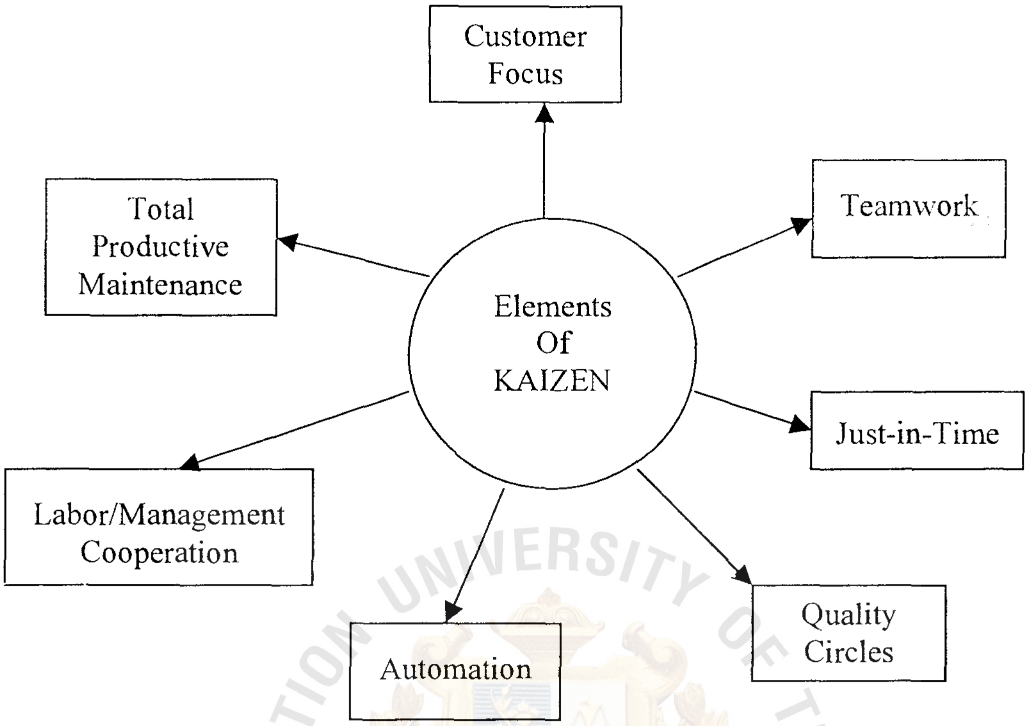


Figure 2.3. Element of Kaizen (Goetsch and Davis 1997).

(c) Role of middle managers. Middle managers are responsible for implementing the Kaizen policies established by executive management; establishing, maintaining, and improving work standards; ensuring that employees receive the training necessary to understand and implement Kaizen; and ensuring that employees learn how to use all applicable problem-solving tools.

(d) Role of supervisors. Supervisors are responsible for applying the Kaizen approach in their functional roles, developing plans for carrying out the Kaizen approach at the functional level, improving communication in the workplace, maintaining morale, providing coaching for teamwork activities, soliciting Kaizen suggestions from employees, and making Kaizen suggestions.

(e) Role of employees. Employees are responsible for participating in Kaizen through teamwork activities, making Kaizen suggestions, engaging in continuous self-improvement activities, continually enhancing job skills through education and training, and continually broadening job skills through cross-functional training.

(f) Kaizen and quality. In a total-quality setting, quality is defined by customers. Regardless of how customers define quality, it can always be improved and it should be, continually. Kaizen is a broad concept that promotes quality from the all- encompassing Big Q perspective (Goetsch and Davis 1997).

2.4 Seven Tools

Tools for quality improvement also enable today's employees, whether engineers, technologists, production workers, managers, or office staff, to do their jobs. Virtually no one can function in an organization that has embraced total quality without some or all of these tools. They are tools for collecting and displaying information in ways to help the human brain grasp thoughts and ideas that, when applied to physical processes, cause the processes to yield better results.

The seven tools exist to help do a job which involves with quality improvement. Each of these tools is some form of chart for the collection and display of specific kinds of data. Through the collection and display facility, the data becomes useful information-information that can be used to solve problems, keep track of work being done, even predict future performance and problems.

2.4.1 Cause-Effect Diagram

The purpose of a cause-effect diagram is to aid in discovering cause and effect by providing a systematic picture of effects and causes. A cause is a fundamental condition or stimulus that ultimately creates an effect or result of some type. Cause-effect analyses are essentially systematic inquiries into potential causes, given an effect of interest, or consequently a systematic inquiry as to potential effects resulting from given causes. Ishikawa developed the concept of the cause-effect (C-E) diagram-also known as a fishbone diagram-as one of the seven indispensable tools for quality improvement.

Cause-effect diagrams consist of an effect located on the right-hand side of the diagram and a series of causes stratified and structured along branches and twigs on the left-hand side. Figure 2.4. Provides a basic structural layout for a C-E diagram. Development of a C-E diagram typically involves brainstorming potential causes relative to a given effect, and then stratifying or clustering them into categories. Major categories are represented by branches, while subcategories are represented by twigs.

Three basic C-E diagram formats exist: (1) cause enumeration, (2) dispersion analysis, and (3) process analysis. The cause enumeration C-E diagram is the most common. The objective is to identify as many potential causes for a given effect as possible, without regard to the strength of any particular cause. The dispersion analysis C-E diagram looks like the enumeration C-E diagram; however, the process of development is more systematic in that we pursue lines of questioning associated with identified branches, in order to develop cause details. The process analysis C-E diagram tends to follow process and sub-process lines in its branch structure.

2.4.2 Check Sheet

The purpose of a check sheet is to classify, stratify, and tally observed data in the form of occurrences of events or outcomes, so that we can obtain a feel for relative frequency and dispersion of the events or outcomes.

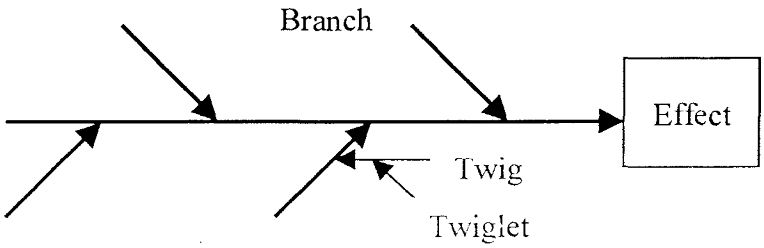


Figure 2.4. Cause-Effect Diagram.

The check sheet is one of Ishikawa's seven indispensable quality improvement tools. Two basic types of check sheets exist, a tabular check sheet and a pictorial check sheet. A tabular check sheet contains several categories or strata associated with some classification of interest, e.g., time of day, category of defect, equipment unit, A pictorial check sheet provides a graphic cue as to a product/process profile that serves as the basis for tallying our observations. For example, we could use a process flow diagram and mark/tally subprocesses or processing units where defects were generated, allowing stacks of marks to develop over time. For products, a product pictorial might include an outline or profile of the product, with defects marked or tallied at the point of occurrence.

Although the check sheet is a simple tool, it is an indispensable aid in helping to collect data regarding both products and processes. It is extremely useful in initial data collection and monitoring for process improvement efforts.

2.4.3 Control Chart

The purpose of a control chart is to monitor a process metric in order to expose the presence of special cause influences operating the process.

Process control charts make up a significant portion of what is termed statistical quality control/statistical process control (SQC/SPC). The process control chart is one of the seven fundamental or indispensable tools. In evaluating problem and finding solutions for them, it is important to distinguish between special causes and common causes. Figure 2.5 shows a typical control chart. Data is plotted over time, just as with a run chart; the difference is that the data stay between the upper control limit (UCL) and the lower control limit (LCL) while varying about the center line or average. Whenever a special cause (nonstatistical cause) impacts the process, one of two things will happen: either a plot point will penetrate UCL or LCL, or there will be a "run" of several points in a row above or below the average line. When a penetration or a lengthy run appear, this is the control chart's signal that something is wrong that requires immediate attention.

As long as the plots stay between the limits and don't congregate on one side or the other of the process average line, the process is in statistical control. If either of these conditions is not met, then we can say that the process is not in statistical control, or simply, is "out of control."

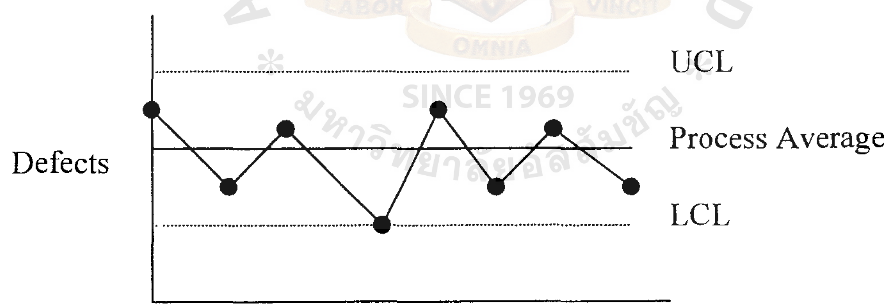
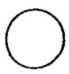


Figure 2.5. Basic Control Chart.

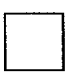
2.4.4 Flow Chart

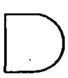
The purpose of a flowchart is to provide an annotated graphical depiction of a process flow in terms of input, transformation, and output. A flowchart depicts process flow by using a sequence of symbols and words to represent process flow components, all connected with directional lines to indicate flow paths. A wide variety of processes rectangular symbols are used that are self-descriptive or annotated near the symbol. In other cases, the symbols are iconic in the sense that the symbol shape is indicative of the process element (Kolarik 1999).

The process chart symbols used in the illustrations in this volume are those shown and described as follows:

 **Operation.** An operation is performed when an object is intentionally changed in any of its physical or chemical characteristic, assembled, or disassembled from another object. An operation is also performed when information is changed (e.g., mathematical calculations) or when planning or control decision are made.

 **Transportation.** Transportation occurs when an object is moved from one place to another, except when such movement is a part of an operation or is caused by the operator at the workstation during and operation or inspection. Transportation occurs between, not within, operational stages of the process.

 **Inspection.** An inspection is made when an object is compared against a standard for quality or quantity in any of its characteristics.

 **Delay.** A delay occurs when conditions (except those that intentionally change the physical or chemical characteristics of the object) do not permit or require immediate performance the next planned action. Objects may be delayed a queue or waiting line before the next stage of the process.

▽ **Storage.** Storage is effected when an object is retained and protected against unauthorized removal.

◻ **Combined activity.** To show activities performed either concurrently or by the same operator at the same workstation, the symbols for those activities are combined.

These symbols are arrayed on various forms of flow charts designed to highlight work flow processing stages with respect to their sequential relationships with references to time, distances, space, or the organizational units responsible (Chen and McGarrah 1982).

2.4.5 Histogram

The purpose of a histogram is to provide a graphical depiction of both location and dispersion in a univariate data set. A histogram essentially depicts a data set by assigning each observation in the data set to one of several cells or predefined categories and then depicting associated cell counts and relative frequencies. Typically a minimum of 20 to 30 observations is necessary to produce a meaningful histogram. Histograms are constructed in several steps:

(a) Determine the range of the data. Here we calculate the difference between the largest and smallest values.

(b) Determine the number of cells or categories. Usually we develop from 5 to 15 cells.

(c) Determine cell midpoints and boundaries. Cells of equal width are usually defined; however, cells can vary in width.

(d) Place each observation in a cell. Each observation must fall in only one cell. A check sheet format is useful to classify each observation.

(e) Display the cells. The frequency and/or relative frequency if each cell determine the cell's relative height in vertical histograms.

Computer aids are available to develop histograms. Modern spreadsheets as well as dedicated statistical analysis packages can be used to produce and display histograms. Other descriptive statistical analysis tools used to assess location and dispersion include stem and leaf plots and box plots. Finally, histograms are fundamental to data exploration. They are universally useful in quantitative data analysis to assess location and dispersion. They are not capable of capturing the time sequence associated with data collection. For example of Histogram, it is shown in Figure 2.6.

2.4.6 Pareto Analysis

The purpose of a Pareto analysis is to systematically stratify and rank causes or results associated with past performance so as to help us visualize the maldistribution thereof. With reference to Figure 2.7, it is an example of Pareto Diagram.

The number of occurrences of the cost of occurrences for specific problems are charted on a bar graph. All occurrences data will be ordered by type, category, or other classification. The largest bars indicate the major problems and are used to determine the priorities for problem solving. This tool will use the bar graph that ranks problems in decreasing order of frequency, was adapted to quality control by Joseph M. Juran.

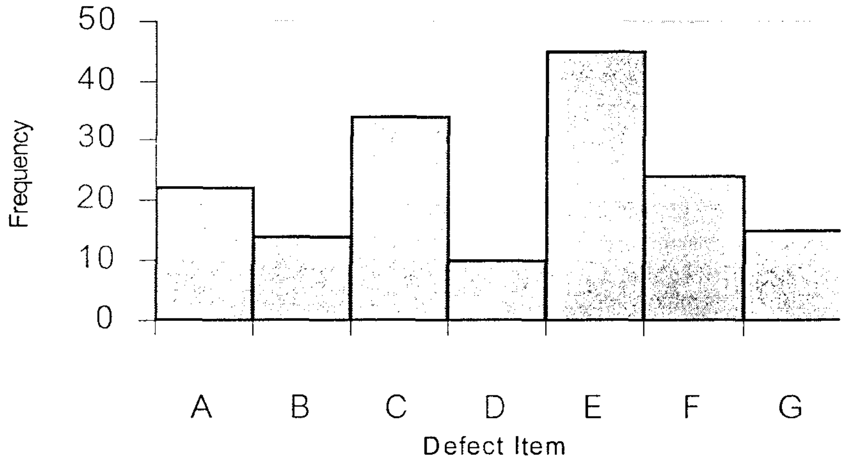


Figure 2.6. Histogram.

The Pareto principle, credited to Italian economist Vilfredo Pareto, involves the concept that the comparative distribution of certain economic factors, such as wealth, follow an inverse relationship. Pareto discovered that 80% of the wealth in this country in the early 1900s was concentrated in 20% of the population. Dr. Juran popularized the term "the Pareto principal" who discovered that the 80%-20% split also occurs in quality control. Eight percent of the scrap is caused by 20% of the quality problems, and 80% of the dollars loss caused by poor quality concentrated in 20% of quality problems. The important outcome of a Pareto chart is its assessment of process problem priorities. It is the vital few problems from the trivial many. Another plus for the Pareto chart is its eliminate of receptivity, the tendency to overestimate the importance of the most recent problem. When problem analysis is done for a Pareto chart, data are gathered that give number of occurrences for each problem and the dollars loss associate with it. When all the data have been gathered, percentages can be tabulated for both the number data and the dollar loss data.

Using the Pareto analysis, we stratify and rank process characteristics. Such characteristics fall into one of two categories: (1) results or (2) causes. Regardless of the category, our analysis procedure is the same:

(1) Determine the general result or cause to be analyzed, an appropriate unit of measure, and a meaningful analysis period, e.g., a week, month, year.

(2) Collect and stratify the associated data. A check sheet may serve as an appropriate tool to help categorize the data. Usually 5 to 10 categories, including an "all others" category, are sufficient.

(3) Quantify the Pareto analysis data. Tally the total observations in each category and determine relative percentages.

(4) Develop the Pareto diagram. Plot each category along the horizontal axis and its associated relative frequency on the vertical axis, along with a cumulative probability across the bars on the plot.

(5) Interpret the Pareto diagram. Because of the 80-20 rule, we typically interpret the few categories that produce roughly 80 percent of the cumulative result or cause total.

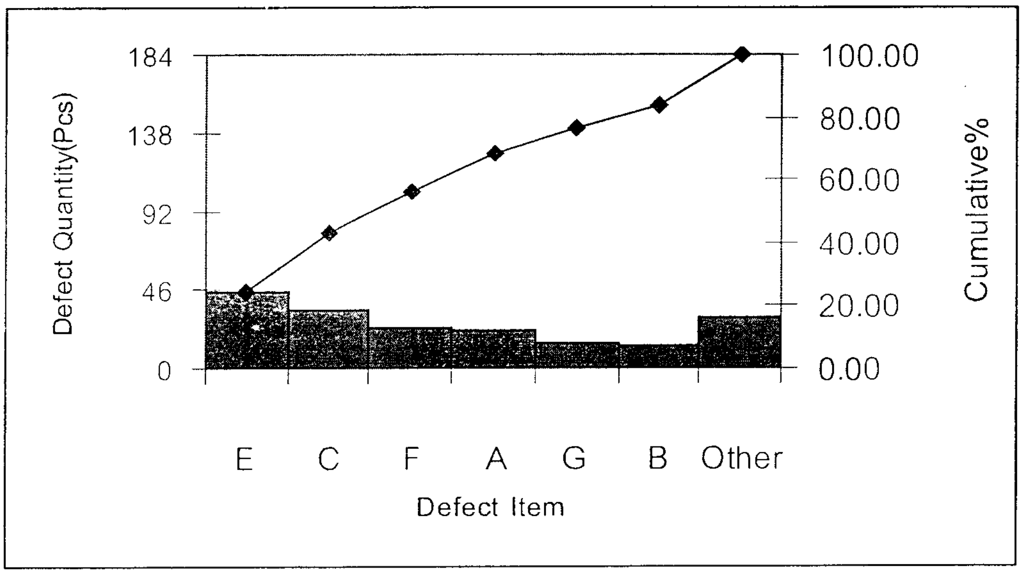


Figure 2.7. Pareto Diagram.

2.4.7 Scatter Diagram

The purpose of a scatter diagram or plot is to provide a graphical display of the numerical relationship between two or more variables. A scatter diagram or plot graphically depicts numerical relationships between variables. The development of a scatter diagram or plot involves several steps:

(1) Identify the variables of interest. Identify the metric, sensor, and data collection means.

(2) Collect the data in multivariate sets. Each set represents one observation and contains one data point for each variable. For example. For a bivariate set, say X1 and X2, we collect data pairs.

(3) Develop a set of axes. Each variable occupies one axis. Two variables require two axes; three variables require three axes.

(4) Plot the data observations on the axes. Typically, the time order or sequence is not important or noted on the plot.

(5) Interpret the plot. We assess relationships in terms of correlation, looking for increasing or decreasing patterns in the plots. For example, as in Figure 2.8, a position correlation is seen when large values of one variable correspond to large values of another variable. Or, negative correlation occurs when large values of one variable correspond to small values of another variable. No correlation implies a scattered arrangement of points without any noticeable shape or direction.

Scatter diagrams provide a graphic picture of quantitative relationships. The correlation tool described previously provides a counterpart quantitative measure of numerical (linear) association. Patterns that are not of a linear nature, e.g., an arc of some type, are readily apparent on a scatter diagram or plot, whereas they are not picked up with a linear correlation metric (Kolarik 1999).

2.5 Flexible Printed Circuit (FPC)

Flexible printed circuits are a unique type of interconnection system. Although many of the manufacturing processes for flexible circuits are similar to rigid boards, it is necessary to modify these processes to take into consideration such special factors as handling of thin films and foils. Specifications relating to adhesive systems are also important, since each type has different processing and electromechanical characteristics which must be tailored to the application. By relying on this body of detailed information on the general techniques, it is fairly straightforward to relate to the differences in materials and processes presented here for an understanding of flexible printed circuits as a separate technology.

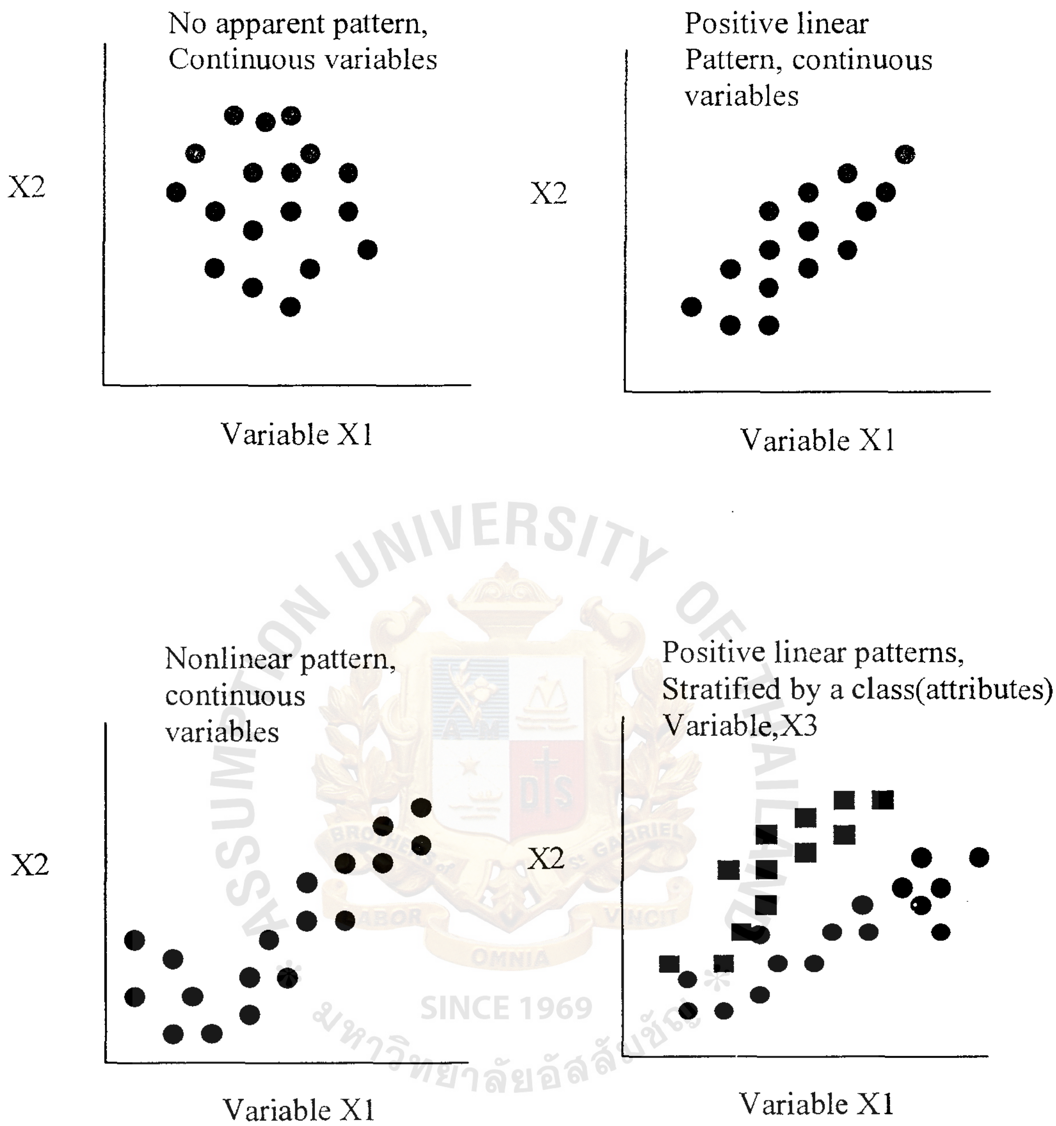


Figure 2.8. Selected Scatter Diagram Patterns.

Flexible printed circuits are defined as "a patterned arrangement of printed circuits and components utilizing flexible base materials with or without flexible cover layers." This definition may be accurate, but it leaves a lot to be desired relative to the actual use of flexible circuits and the proper choices of materials necessary for each and every application.

To understand flexible circuits, one must be familiar with metal foils, plastic films, and adhesive systems and must understand how all three are selected and used.

2.5.1 Films

One of the primary considerations in designing a flexible circuit is the selection of the proper base and cover film. (The cover film insulates the etched pattern of the circuit much as solder mask or resist does in rigid boards.) Although there are many substrates which could conceivably be used, there are only two kinds of films in general use for flexible circuits. These films are polyimide and polyester.

(a) Polyimide (Kapton)

The first choice of film in most circuit applications is polyimide film. Polyimide film can withstand the temperatures required in soldering operations. It has no known organic solvent, and it cannot be fused. This film is also used in wire insulation and transformer insulation, and as insulation in motors.

Polyimide films are offered in standard thicknesses of 0.0005, 0.001 0.002, 0.003, and 0.005 in. There are some very specialized versions of Kapton film,but these are available for use in applications requiring very special properties. Examples of these materials are designated as follows:

(1) Kapton XT: Improved thermal conductivity for better heat dissipation as a dielectric insulator, or for higher speeds in thermal-transfer printers.

(2) Kapton XC: Film with conductive fillers providing a range of electrical conductivities for specific uses.

While Kapton XT film is readily available, the Kapton XC products were still in experimental use only at the time of this writing, and the manufacturer of the film should be contacted for availability.

(b) Polyester (Mylar)

Polyester film represents a good value for use in many flexible circuit applications. Technically, it is known as "polyethelyne terephthalate," which is a polymer formed by the condensation reaction of ethylene glycol and terephthalic acid.

Polyester film is low in cost: about1/20 the cost of polyimide film. It contains no plasticizers and therefore does not become brittle under normal conditions. It is very resistant to solvents and other chemicals and has a high tensile strength and a good dielectric strength. The service temperature for this film ranges from 70 to 150 C. The low temperature resistance of the film is a drawback when the finished circuit must be exposed to soldering temperatures over 230C, but with careful engineering of the product, even this problem can be circumvented by designing a circuit with a heavy 0.005-in base. It should have large solder pads and wide traces, and 2-oz copper foil should be specified. This will result in a circuit which can be carefully hand-soldered or even wave-soldered using an appropriate mask or jig to keep the heat away from all parts of the circuit except the portions being soldered. Polyester is widely used in automotive and communications circuitry and is most cost-effective in very large applications.

(c) Aramid Material (Nomex)

Although the two films previously discussed are the most common ones in use, there is other base insulation materials which have attractive properties. Some of these include Nomex and Dacron-epoxy. Nomex is Du Pont's random-fiber aramid material. Nomex is a high-temperature paper which withstands soldering temperatures very well. Its main drawback in flexible circuit applications is that it is very hygroscopic and absorbs processing chemicals, which must be carefully removed from one wet process point to the next. Nomex has fairly low initiation and propagation tear strengths. The material has a fairly low dielectric constant about half that of Kapton.

(d) Polyester-Epoxy (BEND/flex)

Dacron-epoxy base insulation material is available in 0.005-, 0.0085-, 0.015-, 0.020-, and 0.030-in thicknesses. The material is manufactured using a nonwoven mat of Dacron polyester and glass fibers which is saturated with a B-stage epoxy. This saturated mat is then combined with copper foil and laminated into single and double-clad material without using a separate, adhesive system. One of the more interesting forms of this material is in a product called BEND/flex, which looks similar to rigid printed circuit materials but which can be bent into three-dimensional shapes without heating. The material will hold a set. This unique bendability is due to a low and broad glass transition temperature of the fully cured material.

2.5.2 Foils

Metal foils used to create the circuit patterns are usually made of copper. Copper foil is measured in ounces per square foot. Copper foil is usually desired for most flexible circuit applications. It is also available in heavier weights if desired for high current applications in which a large cross section of material in the conductors is necessary.

There are two fundamental differences in the kinds of copper foils used in flexible printed circuitry. One product is produced by electrolytic deposition, and the other is produced by cold rolling.

(a) Electrodeposited Copper

Electrodeposited (ED) copper is made by electroplating copper onto a stainless steel drum. The longer this plating action continues, the thicker the copper foil becomes. After the material is coated onto the drum, it is removed in coil form. The "drum side" of the material has a very smooth, shiny finish, whereas the outside, or dull side, of the material has a tooth which provides as very good surface for adhesive to take place with the adhesive. The grain structure of ED foil is very vertical in nature, and although this gives excellent bonds to various film bases, it is less ductile than the rolled, annealed product that is used primarily in dynamic, or moving applications.

(b) Rolled Annealed Copper

Rolled annealed copper is manufactured by melting cathode copper, which is produced electrolytically, and then forming this copper into large ingots. This direct chill casting method allows for controlled solidification, which provides continuous purity monitoring and grain size selection and also eliminates existing defects, such as voids which would influence the quality of the foil when it is rolled into its final form.

The copper ingots are large and weigh several tons. They are hot-rolled to an intermediate gauge and then milled on all surfaces to ensure that there are no defects, After this milling operation, the copper is cold-rolled and anneaked to specifications before being processed in a specially designed rolling mill called a Sendzimir mill.

Rolled copper is very flexible and should be used in dynamic applications requiring constant flexing. There are almost as many kinds of copper alloys as there are birds in the air.

Flexible circuits, however, use only a few types. Some of the types are designated in hardness values. The temper of rolled copper can vary from 1/8 hard to 3/4 hard, most commonly specified. These are also available as rolled and annealed copper. There is also a trademarked type available from the Thin Strip Brass Group, Sommers Division of Olin Corporation, called LTA copper. It is an alloy called "110" and is fairly hard when received by the flexible circuit materials laminator. It anneals at low temperatures which are the same as processing temperatures for laminations. This gives the laminator a copper which is easily handled without stretching or wrinkling and yet anneals into a very soft foil after it is combined with the film.

One other important feature to specify when using rolled annealed copper is a treatment which enhances the bond. The horizontal grain structure in the rolled copper is fairly smooth. An additional process which is similar to an electrolytic flash of copper on the surface enhances the bond without deterioration the superior flexing characteristics of the rolled annealed copper.

2.5.3 Adhesives

The third component of most flexible circuit materials is the adhesive system. There are many brand names available, but in the final analysis there are three major types of systems: polyesters, epoxies, and acrylics. Each system and the dozens of modifications which exist offer properties suitable for a variety of applications.

(a) Epoxy Adhesives

Epoxy systems include modified epoxies known as phenolic butyrals and nitrile phenolics. These systems are widely used and are generally lower in cost than acrylics but higher in cost than polyesters. Epoxy has good high-temperature resistance and remains in good condition in all approved soldering system. It also has very long- term stability at elevated temperatures in environmental conditions up to 250 °F.

(b) Polyester Adhesives

Polyesters are the lowest-cost adhesives used and the only adhesives which can be used properly with polyester films for base laminate and polyester cover film. The major drawback of the system is low heat resistance, which may not be a drawback at all if the application for the circuit does not require soldering, as in many automotive instrument cluster applications.

(c) Acrylic Adhesives

Acrylic systems are most often used when the completed circuits are used in high-temperature soldering applications. They have the best resistance to short-term, high-temperature exposure.

2.5.4 Flexible Circuit Design

Flexible circuits are much different from their rigid board cousins in material composition, handling requirements, processing requirements, design rules, and interconnection technology.

There are several rules about design of flexible circuit almost universally true.

(a) The material is less dimensionally stable than rigid material, so usually artwork must be developed to allow for material shrinkage during processing.

(b) Retrofits almost never work. The design must be started from scratch.

(c) All designs must be thought of in terms of a three-dimensional form, since the purpose of flexible circuits is to interconnect on multiplanar fields.

About applications, the two primary applications are static and dynamic. In static applications, the circuits are usually flexed once or bent into position, and they remain in that position for the life of the product. Dynamic applications must be specified differently to provide for maximum flex life, while using a combination of materials (Coombs 1988).

2.6 Hard Disk Drive

No personal computer user will get very far these days without a hard disk drive. For all but the most basic forms of computing, a hard drive is as essential as a monitor is, a keyboard is, and random access memory (RAM). Therefore, it is no accident that hard disks are standard equipment on most of the personal computers sold today.

A hard disk is a metal platter coated with magnetic oxide that can be magnetized to represent data. Hard disks come in a variety of sizes. Hard disks for mainframes and minicomputers may be as large as 14 inches in diameter. Several disks can be assembled into a disk pack. There are different types of disk pack, with the number of platters varying by model. Each disk in the pack has top and bottom surfaces on which to record data. Many disk devices, however, do not record data on the top of the top platter or on the bottom of the bottom platter.

A disk drive is a machine that allows data to be read a disk or written on a disk. A disk pack is mounted on a disk drive that is a separate unit connected to the computer. Large computers have dozens or even hundreds of disk drives. In a disk pack all disks rotate at the same time, although only one disk is being read or written on at any one time.

Nowadays, hard disks for personal computers are 5.25-inch or 3.25-inch disks in sealed modules and even gigabytes are not usual. Hard disk capacity for personal computers has soared in recent years; capacities of hundreds of megabytes are common and gigabytes are not unusual. Although an individual probably cannot imagine generating enough output-letters, budgets, reports, and so forth-to fill a hard disk, software packages take up a lot of space and can make a dent rather quickly. Furthermore, graphics images and audio and video files require large file capacities. Perhaps more important than capacity, however, is the convenience of speed. Personal computer users find accessing files on a hard disk is significantly faster and thus more convenient than accessing files on a diskette.

From above detail, hard disk is the very heart of computer. After all, data processing equipment is worthless if it doesn't have data to process. The hard disk thus holds both raw materials and finished inventory. The keyboard, monitor, and system unit are just the machines on the shop floor.

So a hard disk is far more than just another system component and is not something users can merely plug in, turn on, and forget about. Hard disk drive is a system in and of itself-a powerful, sophisticated infinitely customizable piece of equipment that is the very heart of personal computer (Glossbrenner and Anis 1990).

III. PROJECT METHODOLOGY

3.1 Current Situation Review

Before the researcher explains to more detail about the project, the researcher would like to describe the overall production process including the all basic knowledge of flexible printed circuit or be called briefly "FPC".

3.1.1 What Is MKT-042S-0A?

From all FPC produced, researcher selects MKT-042S-0A which is one of many FPC to improve quality because it has high orders and high rejects that affect to company profit. About MKT-042S-0A, there are so many products and customer so it is necessary for setting code to remember and call easily. Moreover it is one of many products of MATSUSHITA. The application of MKT-042S-0A is to use in Hard Disk Drive of the computer.

3.1.2 Material for Manufacturing MKT-042S-0A

There are many kinds of material to produce MKT-042S-0A as follows:

(1) COPPER CLAD LAMINATES (CCL)

Copper Clad Laminates is primary and important material of MKT-042S-0A to make circuit pattern. As CCL consists of copper which can crease readily, we must be careful in holding it. In Figure 3.1, it shows the structure of copper clad laminates (CCL).

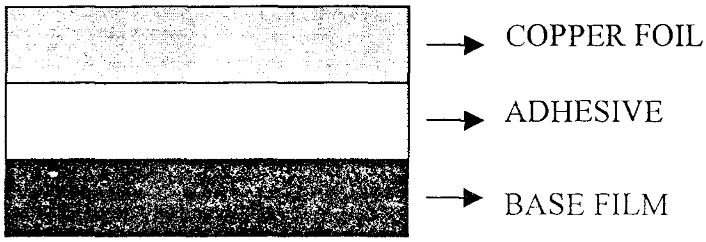


Figure 3.1. The Structure of Copper Clad Laminates (CCL).

(2) COVER LAY (CL)

Cover Lay is to use for covering surface of circuit and to prevent rust problem, in addition, it has high durability and high elastic. In Figure 3.2, it displays the structure of cover lay (CL).

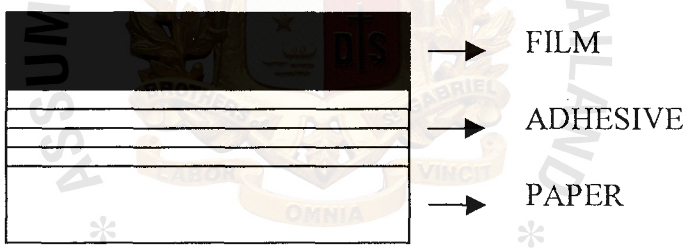


Figure 3.2. The Structure of Cover Lay (CL).

(3) SYMBOL INK

Symbol Ink uses for painting some words to identify or display code or produced date.

(4) ADHESIVE (ADH)

Adhesive is used for attachment between components and FPC or between stiffener and FPC. The are two kinds of adhesive as follows:

(a) Pressure sensitive adhesive

It can attach by using press force or pressure.

(b) Thermo setting adhesive

It can attach by using heat from Curing process.

In case of MKT-042S-0A, thermo setting adhesive is defined to use in this product and LF-100 is version of adhesive.

(5) STIFFENER (STF)

Stiffener is used to increase strongness of FPC by attachment. There are four kinds of stiffener as follows:

(a) POLYIMIDE FILM

(b) PET FILM

(c) PAPER PHENOLIX

(d) GLASS EPOXY

Each kind of STF consists of many versions. For MKT-042S-0A, version of Polyimide Film is PI 125, which has thickness as 125 micron.

(6) DRY FILM (DF)

Dry Film is used to help for making circuit pattern, which will not appear on FPC. As Figure 3.3, you can see the structure of Dry Film (DF).

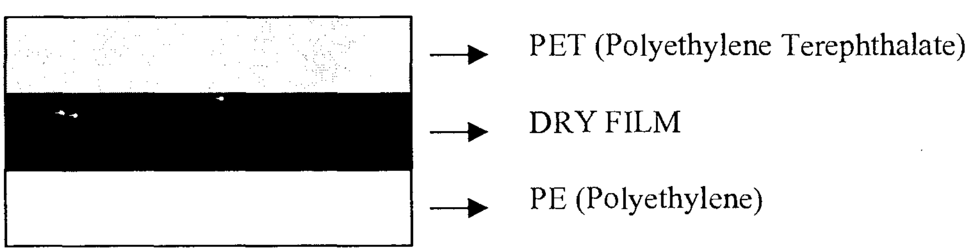


Figure 3.3. The Structure of Dry Film (DF).

(7) CUSHION

Cushion consists of many kinds of PVC to support high pressure in CURING process in order to press strongly between CL and CCL. In Figure 3.4, it can show the structure of Cushion.

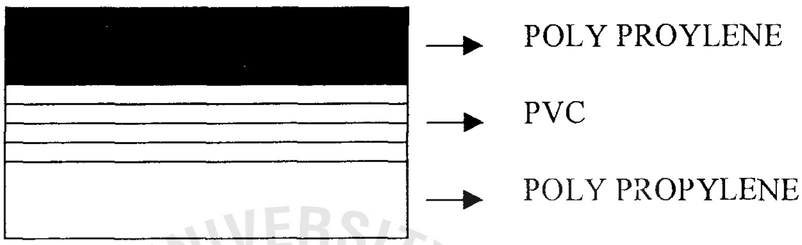


Figure 3.4. The Structure of Cushion.

3.1.3 Type of MKT-042S-0A

There are three types of FPC which can classify from layer of copper or circuit as follows:

(1) Single Side that has only one side of circuit.

(2) Double Side that has two sides of circuit.

(3) Multilayer that has more than two sides of circuit.

In case of MKT-042S-0A, it is single side because it has only one side of circuit.

3.1.4 Structure of MKT-042S-0A

Refer to previous part, the structure of MKT-042S-0A which consists of all of material will be shown in Figure 3.5.

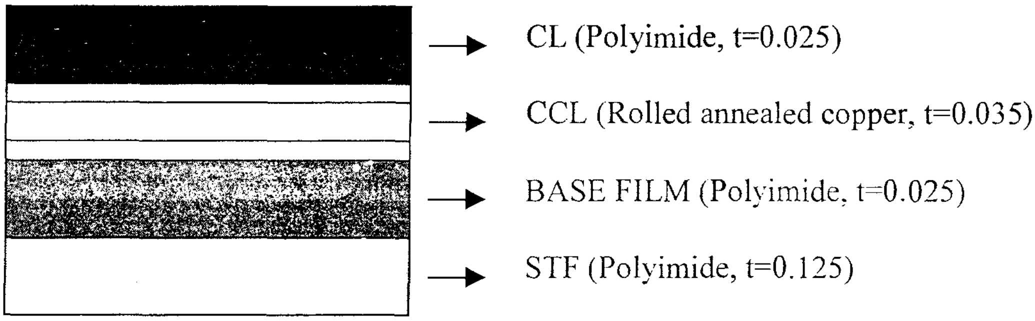


Figure 3.5. Cross Section of MKT-042S-0A.

3.1.5 More Detail of the Structure of MKT-042S-0A

In each area of MKT-042S-0A, there are many words to use for calling and different definition. To be more clear, researcher would like to explain some area and definition of MKT-042S-0A as follows:

(1) SOLDER SIDE

Solder Side is side that legs of component will be wired at this side. Normally, we will call "F-Side" that is stand for Front Side.

(2) COMPONENT SIDE

Component side will put down components on this side. We can call "B-Side" that is stand for Back Side.

(3) LAND

Area that has no hole for insertion legs of component but it can put down components and wire their legs on this area.

(4) LAND HOLE

Area that has hole in the middle area to insert the legs of component.

Most of diameter will concern with legs of component which can insert easily into this hole.

(6) OUT LINE MISMATCH

Most of this character are concerned with PIC and BLK process because out line of the product is different level that is caused from PIC and BLK process that are proceeded in different time and different die.

(7) WARNING MARKER

The advantage of warning marker is to check and confirm the position of piercing or blanking. About marker for checking, there are many types of warning marker, which concern with each product such as warning marker at connector fingers, copper ring or copper around hole.

In case of MKT-042S-0A, it uses some defined hole to check and confirm the position of piercing or blanking. Figure 3.6, it display warning marker of MKT-042S-0A.

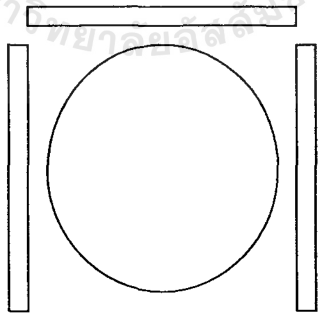


Figure 3.6. Warning Marker on MKT-042S-0A.

(8) CONNECTOR FINGERS

This area is similar to finger in order to insert into connector for transferring of electric from FPC to component.

3.1.6 Production Process of MKT-042S-0A

About production process of MKT-042S-0A, there are many processes of manufacturing. Each process must follow to sequence of process which depends on design of each product also. In manufacturing of MKT-042S-0A, it consists of four main processes as follows:

(1) Circuit Forming

(2) Cover Coating

(3) Surface Treatment

(4) Final Process

Each main process of manufacturing consists of many sub-processes but the project concerns only with the final process. Thus the researcher would like to describe only the final process also. There are many sub-processes which are in the final process and concerned with the project as follows:

(a) Pilot Hole Punching (PHP)

This process will use pilot hole machine to drill holes at defined marks such as mark "N" or "VN". These drilled holes will be used to insert pin of next processes such as OST, PIC and BLK.

(b) Cutting by Vic Die (VIC)

This process will use vic die to cut and separate the product sheet from big sheet to small sheet in order to work easily in the next process.

(c) Piercing (PIC)

Die is a necessary thing in this process which will be assembled in machine. This process will drill or cut at some areas of the product and be easy for BLK process.

In this project, it consists of three processes of PIC as PIC1, PIC2 and PIC3 which each PIC will use the different die and will cut or drill at the different area also.

(d) Pre-Pack (PPA)

This process will use the pet film to attach with the product sheet before blanking process. When the products pass the blanking process, the products that are in piece shape will be attached with such pet film.

(e) Blanking (BLK)

Die is essential to drill at some area of the product. This product does not need to cut the product sheet being the product in piece shape.

(f) Remove Base Plate

This process concerns with removal base plate after BLK process.

(g) Open-Short Test (OST)

Fixture is a tool that is necessary for testing the abnormality of circuit such as open or short circuit. About fixture, it is designed and made of each product.

(h) Final Inspection (FIN)

This process is responsible for inspection by referring with specification that will emphasize on inspection the product may incur any defective during manufacturing.

About specification and all defects, the researcher will explain in more detail again in next part.

(a) Quality Assurance (QA)

To ensure that all products sent to our customer are good products which do not mix of some rejects, the sampling method will be used to guarantee about quality.

(b) Baking (BAK)

Bake is a process that is needed for MKT-042S-0A. Bake will use heat at 120 °C and 1 hour.

(c) Packing (PAK)

The method and container for packing are important because all products must be sent to our customers which are so far from the factory. So transportation is the important factor to keep in good condition until our customer receives them. MKT-042S-0A will be contained in plastic bag and use separate paper inserted between each product sheet.

3.1.3 Specification and Defectives

With reference to FIN process, production needs specification for inspection. There are four kinds of document for inspection or reference as follows:

(1) DRAWING (DWG)

DWG will be plotted in each product. Drawing consists of many details such as size, shape, material, position of material including identify more detail between customer and manufacturer.

(2) FUJIKURA STANDARD (FS)

FS is standard for general inspection of all products. This document will be employed to refer in case drawing has no detail.

(3) PCTT E-FPC SPECIFICATION (PES)

PES is standard for inspection of individual product. PES is compiled and issued only important point for inspection by referring both DWG and FS.

(4) LIMIT SAMPLE

This document will be made in case it is difficult to judge and other documents are not clear for inspection. Limit Sample will attach both reject sample and accept sample to show level of reject and accept respectively.

In addition, there are many defect items for inspection to identify occurred reject. The item number, defect item and definition of each main process (Circuit Forming, Cover Coat, Surface Treatment and Final Process) will be explained and shown in Table 3.1. However the project concerns and emphasizes on only the Final Process that is the cause of the various defects, so both production processes and defects of MKT-042S-0A will refer only to the Final Process.

3.1.8 Final Process Flow Chart

Production final process of this product will show in Figure 3.7.

Table 3.1. Item Number, Defect Item and Definition of Any Defect.

Circuit Forming

Item No.	Defect	Definition
1	Open circuit	Some part of circuit is separated.
2	Short circuit	Some part of circuit is connected.
3	Nick	Some part of circuit is concaved.
4	Pin hole	Some part of circuit is hole.
5	Protrusion	Some part of circuit is protruded.
6	Residue	Have remaining copper between circuit.
7	Rust under CL	Have dirty of rust under CL.
8	Through hole plating	Abnormality occurring from through hole plating process.
9	Others	Any abnormality that are not defined in defect item.
9.1	Surface etching	Some part of circuit is eroded by chemical solution.
9.2	Scratch	Have a scratch on circuit but under CL.
9.3	Circuit delamination	Circuit move off base film.

Table 3.1. Item Number, Defect Item and Definition of Any Defect. (Continued)

Cover Coat

Item No.	Defect	Definition
10	CL Misposition	The lamination of CL do not fit to mark.
	SR Misposition	The printing of ink do not fit to mark.
11	Contamination (CL&CCL)	Have any particle between CL and CCL.
12	CL Bubble	Have a bubble between CL and CCL.
13	Adhesive Flow	Have a adhesive flow out CL.
14	Ink (SR) Pin Hole	Some area of ink covered is hole.
15	CL Burr	The edge of CL is burr.
16	Other	Any abnormality that are not defined in defect item.
16.1	No Stiffener	Have no Stiffener on required position of FPC.
16.2	Stiffener Misposition	The lamination of Stiffener do not fit to mark.
16.3	Dent	Some part of FPC is dent.
16.4	Creasing	Have a creasing on FPC occurring from CURING sub-process.
	Wrinkle	Have a wrinkle on FPC occurring from CURING sub-process.

Table 3.1. Item Number, Defect Item and Definition of Any Defect. (Continued)

Surface Treatment

Item No.	Defect	Definition
17	Unplating	Have no lead on required area.
18	Plate Pin Hole	Some area of lead is hole.
19	Solder Wick	Chemical solution flow under CL.
20	Plate Thickness Out-Spec	The thickness of plate is out of spec.
21	Other	Any abnormality not defined in defect item.
21.1	Rust on Surface	Have dirty of rust on plate.
21.2	Plate Defect	Abnormality occurring from solder plating sub-process.

Final Process

Item No.	Defect	Definition
22	Adhesive Misposition	The lamination of adhesive do not fit to required position.
23	Stiffener Misposition	The lamination of stiffener do not fit to required position.
24	Stiffener Bubble	Have a bubble between Stiffener and FPC.
25	Dent	Some part of FPC is dent.
26	Scratch on FPC	Some part of FPC is scratch.

Table 3.1. Item Number, Defect Item and Definition of Any Defect. (Continued)

Final Process

Item No.	Defect	Definition
27	FPC Burr	The edge of FPC is burr.
28	Creasing	Some part of FPC is creasing.
29	Blanking Misposition	The cutting of blanking process miss to required position.
30	Tear	Some part of FPC is tear.
31	Other	Any abnormality are not defined in defect item.
31.1	Material Peel off	Some area of Stiffener or adhesive attached to FPC open out.
31.2	Contamination	Have any particle between stiffener/adhesive and FPC.
31.3	Stiffener Crack	Stiffener is broken.
31.4	No Material	Have no stiffener or adhesive on required area.
31.5	No Pierce, No Blanking	The cutting or drilling is on FPC incompletely.
31.6	Emboss Defect	Have any defect on emboss area.
31.7	Metal Dome Defect	Have any defect on metal dome area.
31.8	Dirt	Has dirty on any area of FPC.
31.9	Lost	Some pieces of FPC lost.
31.10	Adhesive Flow	Adhesive over flow from release paper.
31.11	Defect Mix Level	Rejected pieces are mixed with good products.

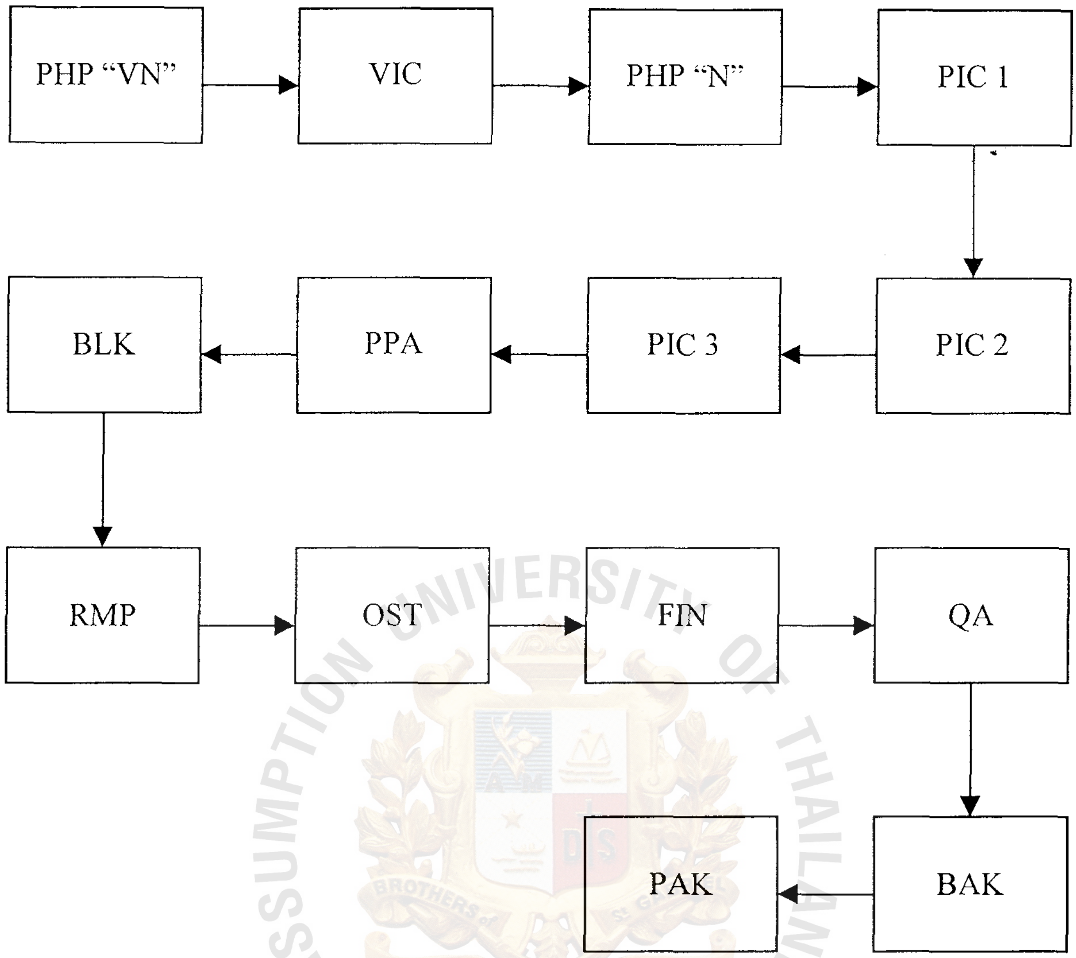


Figure 3.7. An MKT-042S-0A Flow Chart.

3.2 Problem Solution Requirements

As the final process of MKT-042S-0A is main process which affects to percentage of reject, this project will use the proper technique to stress and solve the main defect to reduce the percentage of reject and gain more profit.

However this project steps are classified into several steps which are as follows:

(1) Data Collection

This project has emphasized on one FPC model which is MKT-042S-0A because it has such high order and high reject that it impacts to company profit. The data has been collected for 1 month and focused on two significant inputs these are defect quantity and defect types of FPC.

(2) Pareto Analysis

The pareto chart will be used to recognize the problem and establish the problem priority. The tools can only define which the problem exist and which one should have the highest priority in order to solve them as first priority.

(3) Cause&Effect Analysis

After pareto diagram show which defect is the highest priority, the fishbone diagram will implement. The tools will determine what factors incur defect. It is illustrated in the chain of symptoms leading to identify the root cause of defect.

(4) Solving the Problem

After cause&effect diagram point to what factors are root cause, the involved production process will be measured. All information has been gathered to made trial and error and analyzed the result of experimental. Thus all information from experimental will be used to generate possible solutions.

(5) Developing Solution Alternatives

When the concerned process are defined including what factors occur defective known, the possible solutions will be generated. This project will focus on the preventive action to keep quality to be customer satisfaction.

3.3 Data Collection

Data collection is the beginning step to identify the main defect. There are only two elements which collected the item and number of defective occurring from final process. The researcher collected and compiled data about one month. We stress on only one model, which is MKT-042S-0A at final process.

The data will be recorded and collected in form of output reject as Figure 3.8. Then we will bring data about one month to summarize the defect types, summation quantity of each defect as shown in Table 3.2.

From Table 3.2, a number of rejects occurred in one month will be recorded in total column. Then each item will be calculated in percentage by comparing with total input respectively. Calculate the percentage of each reject as shown below:

$$\text{Reject of dent item (\%)} = \frac{\text{Total of dent (Pcs)} \times 100}{\text{Total input (Pcs)}}$$

$$= \frac{5{,}371 \times 100}{585{,}216}$$

$$= 0.92$$

In addition, all of rejects will be compiled and calculated in the percentage of total final reject (%). Next we will calculate the total final reject as shown below:

$$\text{Total Final Reject (\%)} = \frac{\text{Total Final Reject (Pcs)} \times 100}{\text{Total Input (Pcs)}}$$

$$= \frac{7{,}184 \times 100}{585{,}216}$$

$$= 1.23$$

Lot no.												Total (Pcs)
Date												
No.	Item											
22	Adhesive Misposition											
23	Stiffener Misposition											
24	Stiffener Bubble											
25	Dent											
26	Scratch on FPC											
27	Burr											
28	Creasing											
29	Blanking Misposition											
30	Tear											
31	Others											
31.1	Material Peel Off											
31.2	Contamination											
31.3	Stiffener Crack											
31.4	No Material											
31.5	No Piercing/Blanking											
31.6	Emboss Defect											
31.7	Metal Dome Defect											
31.8	Dirt											
31.9	Lost											
31.10	Adhesive Flow											
31.11	Defect Mix Level											
Total Input (Pcs)												
Total Final Reject (Pcs)												
Total Final Reject (%)												

Figure 3.8. Output Reject Form.

Table 3.2. Final Process Summary of MKT-042S-0A.

No.	Item	Total (Pcs)	Reject (%)
22	Adhesive Misposition	0	0.00
23	Stiffener Misposition	0	0.00
24	Stiffener Bubble	1	0.00
25	Dent	5,371	0.92
26	Scratch on FPC	43	0.01
27	Burr	174	0.03
28	Creasing	22	0.00
29	Blanking/Piercing Misposition	1,017	0.174
30	Tear	39	0.01
31	Others	221	0.04
31.1	Material Peel Off	0	0.00
31.2	Contamination	0	0.00
31.3	Stiffener Crack	0	0.00
31.4	No Material	0	0.00
31.5	No Piercing/Banking	0	0.00
31.6	Emboss Defect	0	0.00
31.7	Metal Dome Defect	0	0.00
31.8	Dirt	0	0.00
31.9	Lost	296	0.05
31.10	Adhesive Flow	0	0.00
31.11	Defect Mix Level	0	0.00
Total Input (Pcs.)		585,216	
Total Final Reject (Pcs.)		7,184	
Total Final Reject (%)		1.23	

3.4 Pareto Analysis

From data collection, we will have data both defect quantities and defect types of MKT-042S-0A for one month period. Therefore these data will be employed to create pareto diagram. Firstly, I make the table by collecting data and tallying the number in each category. Then the percentages and accumulative percentage will be tabulated. The main defects which have the highest number of occurrences from the table. The categories are listed by the number of occurrences as shown in Table 3.3.

Refer to Table 3.3, dent item that occurred the highest frequency will be first priority. Next blanking/piercing misposition is second item. The remaining item are prioritized by descending order. In column of percent, it is brought from column of reject in Table 3.2. In last column of Table, accumulative, it can calculate the percentage of accumulative which follows formula as shown below:

$$\text{Accumulative of first defect (\%)} = \frac{\text{First defect (Pcs)} \times 100}{\text{Total Final Reject (Pcs)}}$$

Accumulative of next defect (%)

$$= \text{ACC. of previous defect (\%)} + \frac{\text{next defect (Pcs)} \times 100}{\text{Total Final Reject (Pcs)}}$$

For example;

$$\text{Accumulative of dent (\%)} = \frac{\text{Reject of dent item (Pcs)} \times 100}{\text{Total Final Reject (Pcs)}}$$

$$= \frac{5{,}371 \times 100}{7{,}184}$$

$$= 74.76$$

$$\text{Acc. of BLK/PIC Misp.(\%)} = \text{Acc. of dent(\%)} + \frac{\text{BLK/PIC Misp. Item (Pcs)} \times 100}{\text{Total Final Reject (Pcs)}}$$

$$= 74.76 + \frac{1{,}017 \times 100}{7{,}184}$$

$$= 74.76 + 14.16$$

$$= 88.92$$

$$\text{Acc. of lost (\%)} = \text{Acc. of BLK/PIC Misp.(\%)} + \frac{\text{Lost item (Pcs)} \times 100}{\text{Total Final Reject (Pcs)}}$$

$$= 88.92 + \frac{296 \times 100}{7{,}184}$$

$$= 88.92 + 4.12$$

$$= 93.04$$

$$\text{Acc. of Burr (\%)} = \text{Acc. of Lost (\%)} + \frac{\text{Burr item (Pcs)} \times 100}{\text{Total Final Reject (Pcs)}}$$

$$= 93.04 + \frac{174 \times 100}{7{,}184}$$

$$= 93.04 + 2.42$$

$$= 95.46$$

In the remaining items, they can be calculated as above using the same formula including other item which are compiled from items having a few quantity.

Table 3.3. Defect Category and Percentage Accumulation of MKT-042S-0A.

Item	Total (Pcs.)	Percent (%)	Acc (%)
Dent	5,371	0.92	74.76
Blanking/Poercing Misposition	1,017	0.17	88.92
Lost	296	0.05	93.04
Burr	174	0.03	95.46
Scratch on FPC	43	0.01	96.06
Tear	39	0.01	96.60
Creasing	22	0.00	96.91
Stiffener Bubble	1	0.00	96.92
Others	221	0.04	100

From Table 3.3, these are prioritized by descending order, which are explained as follows:

(a) Dent, which are explained as the surface of FPC has a small pit that affect to circuit. The defects concern with pierce process.

(b) Blanking/Piercing misposition is the defect which some outline of product cut excessively.

(c) Lost which are lost during the process.

(d) Burr, which are described as incomplete outline.

(e) Scratch on FPC can explain that scratch occurs on the surface of FPC.

(f) Tear is the defect, which FPC tears.

(g) Creasing which are described as creasing of FPC.

(h) Stiffener Bubble which there are small bubble between FPC and Stiffener.

(i) Others are the defects, which can not identify in any item.

Refer to Table 3.3, the percentage column shows Dent 0.92%, Blanking misposition 0.17%, Lost 0.05%, Burr 0.03%, Scratch on FPC 0.01%, Tear 0.01%, Creasing 0.00%, Stiffener bubble 0.00% and Others 0.04% respectively. It can be concluded that the main defect is dent because the number of occurrences has the highest frequency. From the collected data and tabulated in Table 3.3, they can be made in tool, which is called as Pareto diagram and shown of the Figure 3.9. The categories have been ordered from largest to smallest occurrences. The left scale tracks the number of defects per category with the bar graph, which are the above defects. The right scale tracks the accumulated percentage of all defects with a line graph.

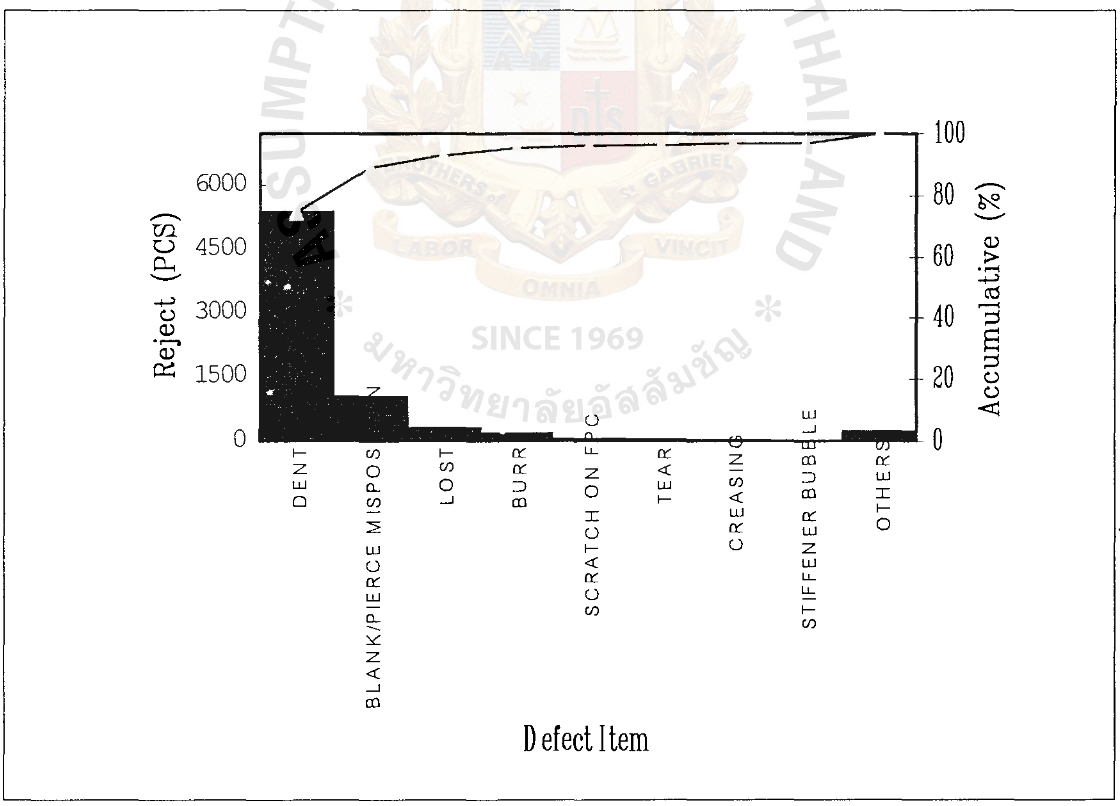


Figure 3.9. Pareto Diagram of Defect Priority.

3.5 Cause and Effect Analysis

From the main defect investigation by Pareto diagram, it can identify the involved process, then define the possible problems. In the case of this project, the main defect is dent. Thus the researcher will solve dent defect and improve quality of MKT-042S-0A.

The reject samples of dent are investigated and found that most character of dent is at around hole areas. From analyzing at such hole areas, the researcher found that it is dent that occurs from die of PIC1 process because such hole areas are drilled by die of PIC1 process. Absolutely, this main defect has caused which comes from PIC1 process. Then PIC1 process will be analyzed to find out the root cause by Cause and Effect Analysis. The application of Cause and Effect Analysis will show and identify the problem, which may concern and be the root cause of dent as shown on Figure 3.10.

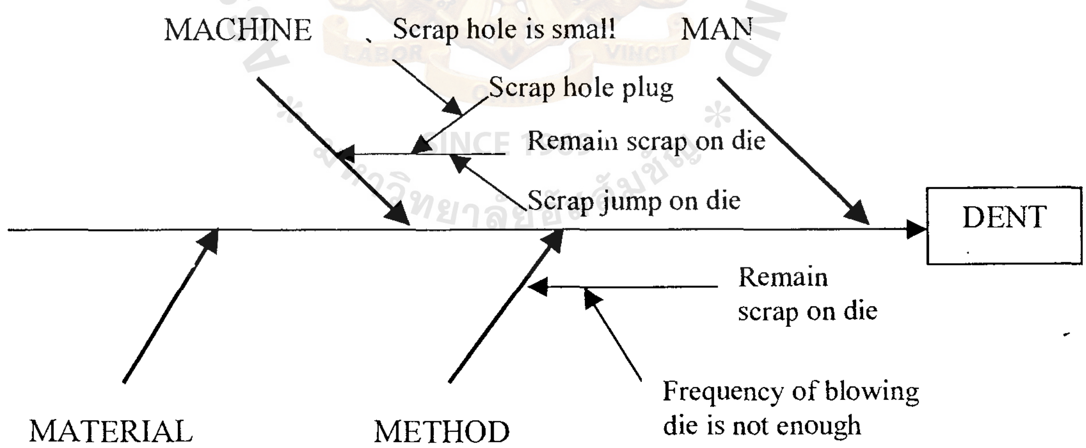


Figure 3.10. Cause and Effect Analysis for Dent.

Due to the previous part, we can define the problem and find out the root cause from symptom of dent by expression in tool of Cause and Effect Analysis. The problem expression will lead to the root cause and the process concerns.

About Cause and Effect Analysis, it can be called "Fishbone Diagram" that will separate the root cause into four parts concerning. These parts are man, machine, method and material as shown Figure 3.10.

3.6 Analyzing Problem and Process Concerned

With reference to the preceding part, the problems are defined and the related symptom are expressed in Cause and Effect Analysis or Fishbone Diagram in Figure 3.10, the problem of dent will lead to the root cause and the process concerns. There are two parts of Fishbone Diagram which concern with dent as machine and method.

(1) Method

About dent problem, we mean technique or method of operation during working. Refer to Figure 3.10 again, it displays the probable root cause, which influences dent.

Firstly, Frequency of blowing die is not enough. We observed the symptom of dent and met that there are remaining scraps, which occur from cutting of previous shot. Normally, the operation of PIC1 process is to blow the surface of die every 10 sheets by air gun. The operation must pierce four shot a sheet. It means every forty shots will be blown one time.

From original operation about blowing, it can assume that is not enough for blowing every 10 sheets. Because there may have remained scraps before next time to blow will arrive. Researcher means from second shot in first sheet until last shot in tenth sheet. It can remain scrap for cutting and affect to dent problem.

(2) Machine

Researcher means tool or equipment, which is used to produce the product. In this project, tool that is the cause of dent is die of PIC1 process. From Fishbone Diagram, Figure 3.10, it can identify the probable root cause into two ideas, which are as follows:

(a) Scrap hole plugs

From assumption of symptom in that there are remain scraps on surface of die, researcher understands that scrap holes which are used to drop scrap into the bottom plug and may concern with size of scrap hole which may be small so that scrap can not drop to the bottom and is the cause of dent later.

(b) Scrap can jump on the die

From both assumptions, it creates idea to solve dent problem that there are few scraps which are in the surface of die or on the product sheet. Scraps, which occur from cutting of punch, may attach at the end of punch so that it is the cause of jumping on the die later.

3.7 Developing Solution Alternatives

To improve the product quality, this project will focus on the preventive program to solve and protect the dent defect. Refer to preceding part, both the problem and the root cause are identified by technique of Pareto Diagram and Cause and Effect Analysis respectively. In order to meet the main factors and select the solutions to solve dent problem, we need to implement them.

About the project, the researcher will implement all of three causes and will select only the solution, which is effective to produce in mass production and be benchmark for other products, which may have the same problem.

3.7.1 Foot Switch

The concept of foot switch is to use operator's foot for turning on switch because switch of this tool will be setup at the floor. Refer to the root cause the period of blowing is so long that is every 10 sheets per time. So the solution of this cause is to reduce the period of blowing. However if operators must use air gun which needs to stop the operation of PIC1 process to blow the surface of die in the short period, the researcher thinks productivity must be reduced also.

Thus we fix foot switch at both right and left side of the die and arrange the direction of wind to surface of die. Then the operator who is responsible for piercing1 will use his/her foot to press switch, which is at the floor and if the operator moves his/her foot out from switch, the wind from foot switch will stop suddenly.

From foot switch method, operators can pierce the product continuously without stopping to pick up the air gun for blowing.

3.7.2 Expansion Scrap Hole

With reference to Figure 3.10, the other cause which is identified by cause and effect analysis is scrap hole that is so small that scrap is difficult to drop and pass into scrap hole. To drop and pass easily of scrap into scrap hole, the researcher has a new idea to enlarge the scrap hole. The purpose of this solution is to drop and pass easily of scrap into scrap hole. About expansion of scrap hole, the researcher would like to illustrate in Figure 3.11.

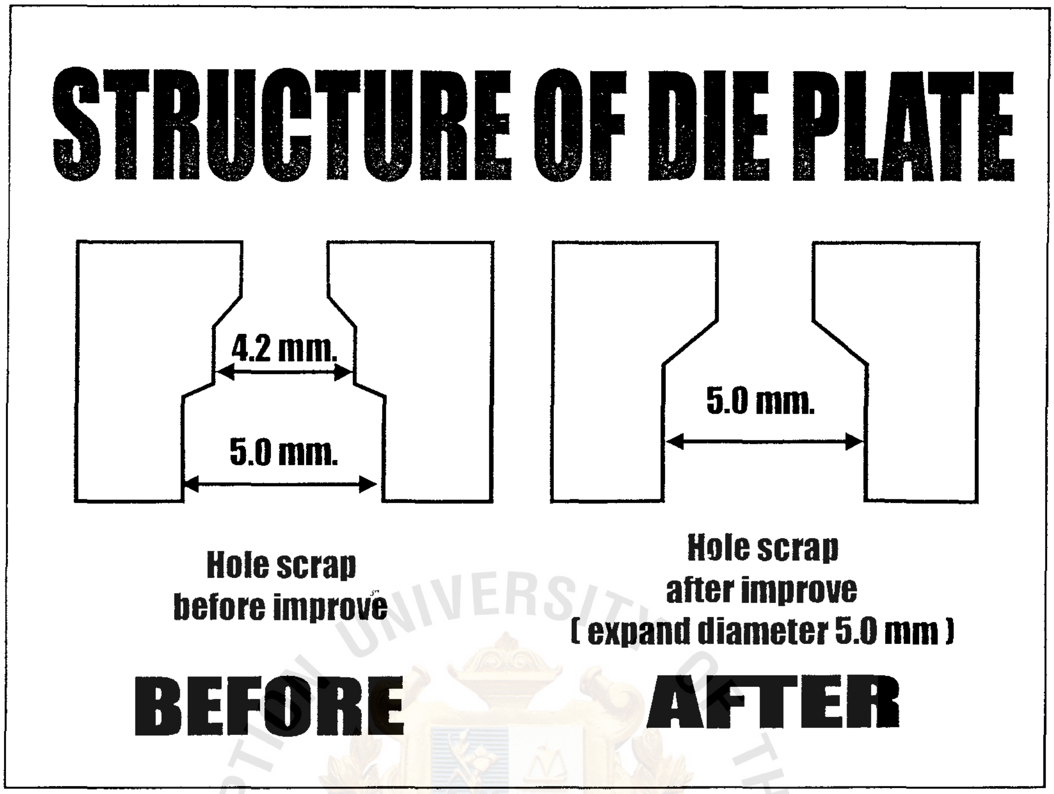


Figure 3.11. Die Plate Structure of PIC1 Process.

In Figure 3.11, the left side is the normal scrap hole before modified. The right side is the proposed scrap hole after it is expanded.

3.7.3 Rod Punch

From the root cause, scrap jumps on the die, the researcher attempts to search the solution and sets the question on how to protect scrap jump on the die. So we solve this question by the new method or called "Rod Punch". The concept of rod punch is to push or press scrap into the scrap hole completely.

Firstly the researcher would like to explain the working step of normal punch before rod punch will be described. The working step of normal punch can be illustrated in Figure 3.12.

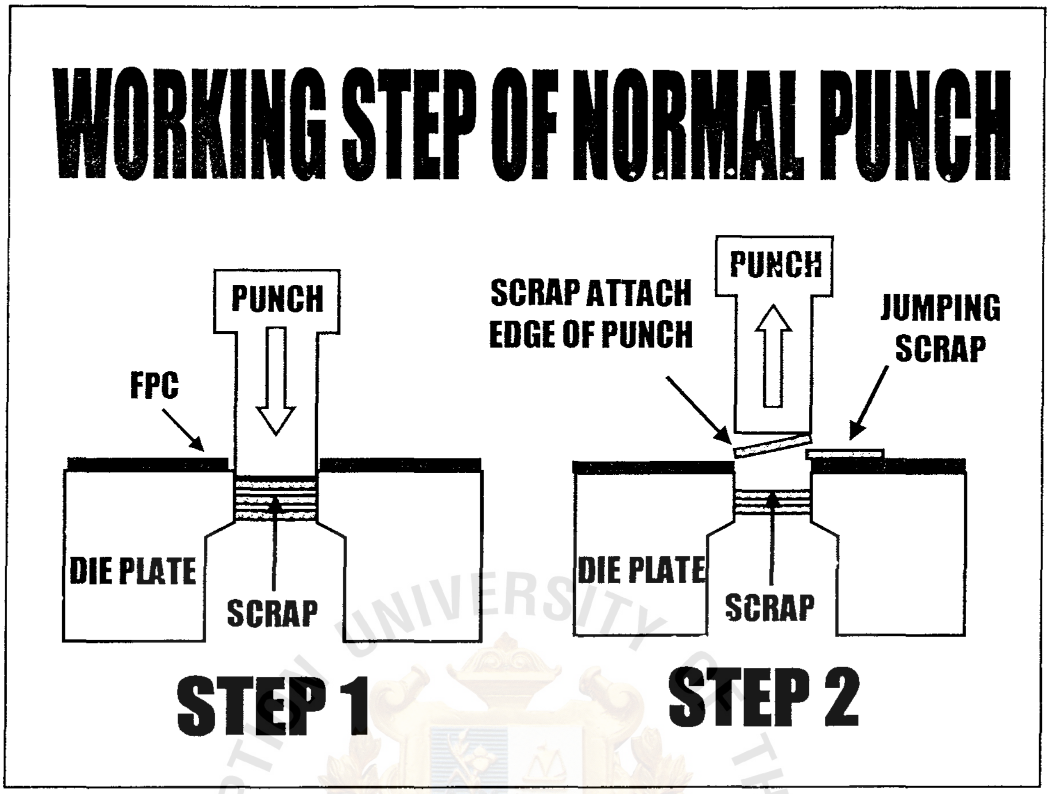


Figure 3.12. Working Step of Normal Punch.

In Figure 3.12, there are two working steps of normal punch which are as follows:

(1) Step 1

In the first step of the picture, normal punch will move down and cut FPC at defined position. Then normal punch will still move down into scrap hole. It displays that scrap will be pushed and collected tightly into scrap hole.

(2) Step 2

In the second step, it shows the step of normal punch moving up. While moving up, there is scrap attaching at the end of punch. Then when normal punch moves up until it is higher than the surface of die, such scrap will drop to be either product sheet or surface of die. After that next shot of piercing will be cause of dent problem.

Researcher thinks working step of normal punch was explained clearly. So we would like to start and describe about Rod Punch technique. The beginning of Rod Punch is to show parts and structure of Rod Punch, which are shown in Figure 3.13.

With reference to Figure 3.13, Rod Punch consists of three parts which are explained as follows:

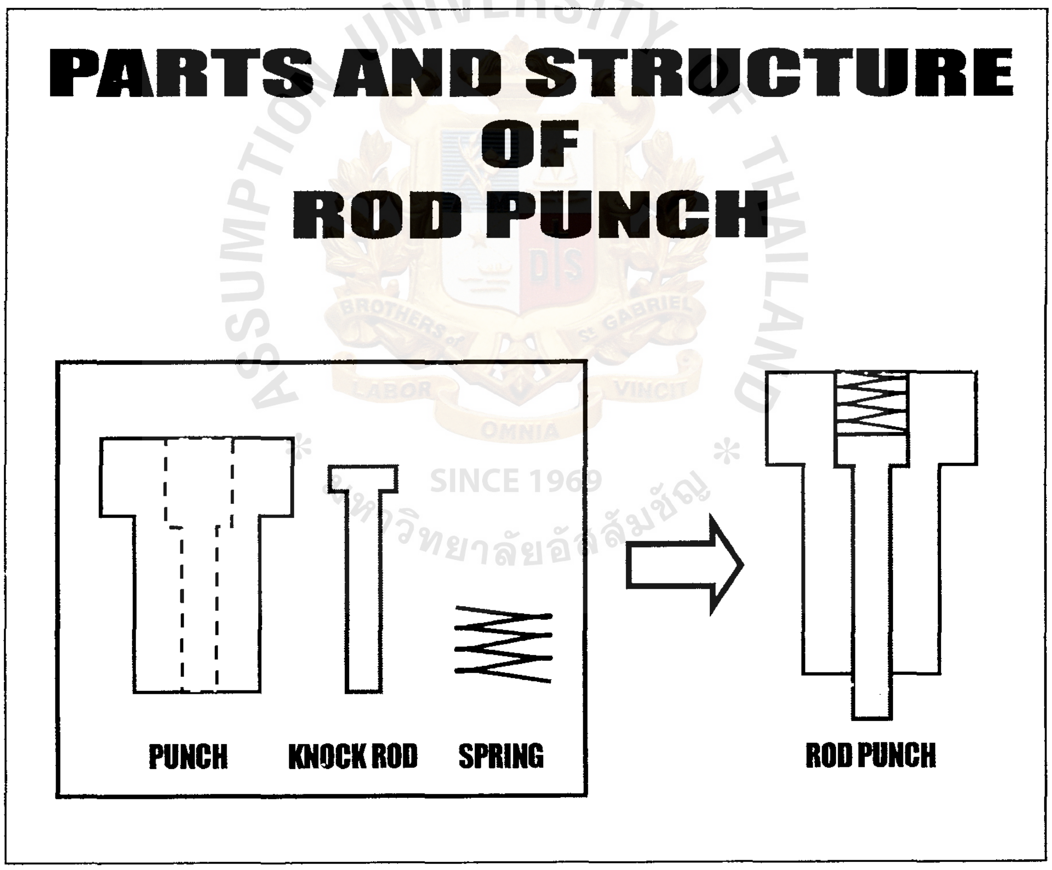


Figure 3.13. Parts and Structure of Rod Punch.

(1) Punch

Normal punch will be drilled at the center of punch. The diameter of drilling will depend on the size of knock rod which will be inserted into the drilled punch.

(2) Knock Rod

Knock rod is equipment which is inserted into drilled punch and used to push scrap cut into scrap hole, in addition, it is available to protect scrap that may attach at the end of the punch.

(3) Spring

Spring is responsible for elastic knock rod.

After all of the parts are prepared, they will be assembled that is called as Rod Punch. Then Rod Punch will be replaced at area1 of die. Figure 3.14 shows various areas on die of PIC1 process that impact to quality of this product.

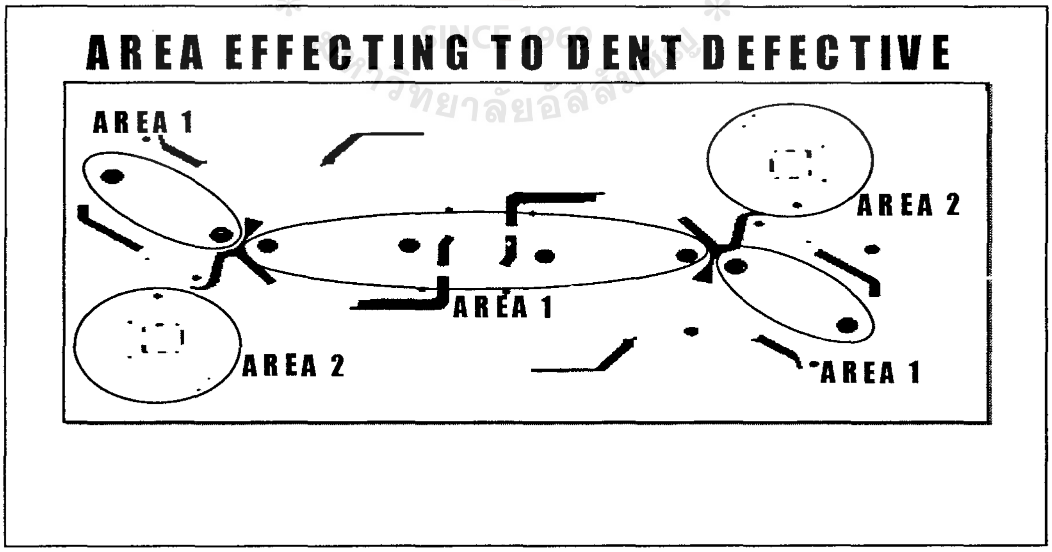


Figure 3.14. Area Effecting to Dent Defect.

After Rod Punches are replaced with normal punchs at area1 of PIC1 die, they are tested and analyzed about their working step. In Figure 3.15, it shows the working step of Rod Punch while operating. In Figure 3.15, there are three steps of Rod Punch which can be explained as follows:

(1) First Step

It is showing Rod Punch while standing-by before it moves down to cut FPC. At this step, we can observe knock rod will protrude at the end of the punch.

(2) Second Step

Rod Punch will move down and cut FPC at defined position. While Rod Punch is moving down and cutting FPC, knock rod will move into drilled punch to cut completely without burr defect.

(3) Third Step

While Rod Punch is moving up, knock rod, which is in drilled punch will move out by spring force to push scrap into scrap hole.

3.7 Methodology Conclusion in Phase 1

In part of project methodology, to improve quality of MKT-042S-0A reduce percentage reject of final process. Quality improvement is applied in many ways which come from three solutions.

(1) Reducing period of time to blow by using Foot Switch.

(2) Expanded scrap hole to drop scrap easily.

(3) Pushing scrap into scrap hole by Rod Punch.

From all of three solutions, this project arranges to implement these solutions in four ways, which are as follows:

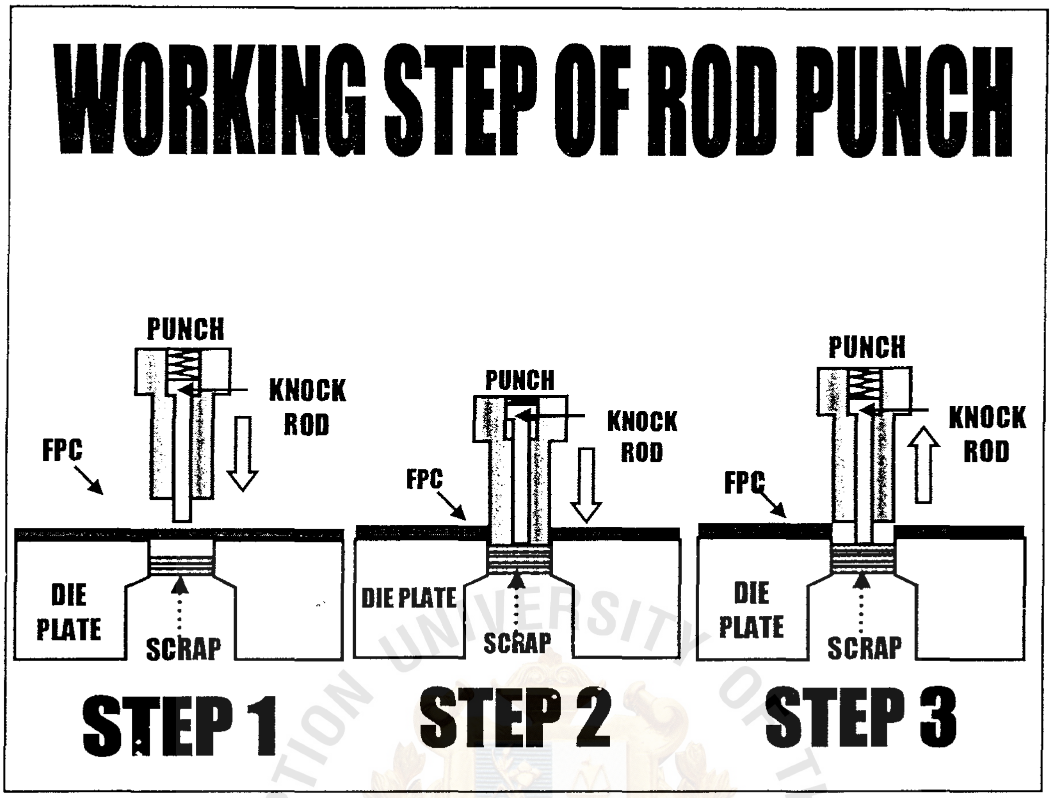


Figure 3.15. Working Step of Rod Punch.

(1) Foot Switch

(1) Expanding Scrap Hole

(2) Rod Punch

(3) Combine Foot Switch with Rod Punch

3.9 Data Collection in Phase 2

To improve quality of MKT-042S-0A continuously, the data after improvement were gathered again to summarize the defect types and quantity of each defect. In Table 3.4, it shows data summarized for around one month.

Table 3.4. Defect Summary of Final Process of MKT-042S-0A after Dent Improved.

No.	Item	Total (Pcs)	Reject (%)
22	Adhesive Misposition	0	0.00
23	Stiffener Misposition	1	0.00
24	Stiffener Bubble	4	0.00
25	Dent	2,566	0.18
26	Scratch on FPC	241	0.02
27	Burr	82	0.01
28	Creasing	30	0.00
29	Blanking/Piercing Misposition	3,592	0.25
30	Tear	299	0.02
31	Others	242	0.02
31.1	Material Peel Off	3	0.00
31.2	Contamination	1	0.00
31.3	Stiffener Crack	0	0.00
31.4	No Material	0	0.00
31.5	No Piercing/Banking	0	0.00
31.6	Emboss Defect	0	0.00
31.7	Metal Dome Defect	0	0.00
31.8	Dirt	6	0.00
31.9	Lost	160	0.01
31.10	Adhesive Flow	0	0.00
31.11	Defect Mix Level	0	0.00
Total Input (Pcs.)		1,445,166	
Total Final Reject (Pcs.)		7,227	
Total Final Reject (%)		0.510	

3.10 Pareto Analysis in Phase 2

Refer to data collection, we use data both defect quantity and defect types of MKT-042S-0A which was improved already for one month. These data will be used to make Pareto diagram again.

Absolutely, it is necessary for making the table to collect data and to tally both the number in each category and accumulative percentage. The highest number of occurrences is main defect. The categories are listed by number of occurrences as shown in Table 3.5.

Table 3.5. Defect Category and Percentage Accumulative of MKT-042S-0A after Dent Improved.

Item	Total (Pcs.)	Percent (%)	Acc. (%)
Blanking Misposition	3,592	0.25	49.70
Dent	2,566	0.18	85.21
Tear	299	0.02	89.35
Scratch on FPC	241	0.02	92.69
Lost	160	0.01	94.90
Burr	82	0.01	96.03
Creasing	30	0.00	96.45
Dirt	6	0.00	96.53
Stiffener Bubble	4	0.00	96.59
Material Peel Off	3	0.00	96.65
Stiffener Misposition	1	0.00	96.66
Contamination	1	0.00	96.67
Others	242	0.00	100.00

Refer to Table 3.5, the percentage column shows Blanking misposition 0.25%, Dent 0.18%, Tear 0.02%, Scratch on FPC 0.02%, Lost 0.01%, Burr 0.01% and Others 0.02%. It can be concluded that the main defect are Blanking misposition because the number of occurrences has the highest frequency.

From Table 3.5, these are prioritizes by descending order which are as follows:

(a) Blanking/Piercing misposition is the defect which some defined position of product is cut excessively. In this project, it means warning marker and target mark for customer.

(b) Dent which are explained as the surface of FPC has a small pit that affect to circuit. The defects concern with pierce process.

(c) Tear is the defect which FPC tear.

(d) Scratch on FPC can explain that scratch occurs on the surface of FPC.

(e) Lost which lost during the process.

(f) Burr which are described as incomplete outline.

(g) Creasing which are described as creasing of FPC.

(h) Dirt is explained as dirty on FPC.

(i) Stiffener bubble is the defect which has little bubble between STF and FPC.

(j) Material Peel Off is explained that release paper of adhesive does not attach to FPC.

(k) Stiffener Misposition can describe in that stiffener over from required FPC.

(l) Contamination which has particle between stiffener and FPC.

(m) Others are the defect which cannot classify in any defined item.

All of collected data kept in Table 3.5 can be made in tool called as Pareto diagram and shown of the Figure 3.16.

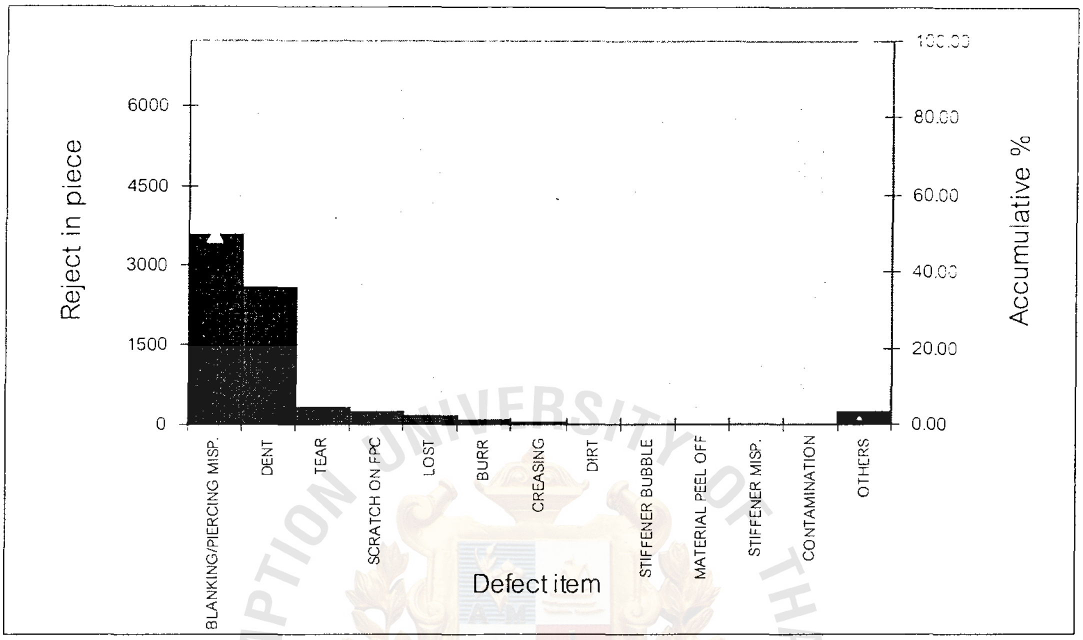


Figure 3.16. Pareto Diagram of Defect Priority in Phase 2.

3.11 Cause and Effect Analysis in Phase 2

As Figure 3.16, it can identify that Blanking misposition is main defect. Therefore Blanking misposition will be selected to solve and improved quality of MKT-042S-0A continuously again.

To analyze and investigate the blanking misposition, we bring reject sample of Blanking misposition to find out the root cause. From all reject samples in Blanking misposition item, there are two symptoms of Blanking misposition, which are out of specification. Researcher will explain this defect as two main symptoms, which are as follows:

(1) Warning Marker is cut

About company specification, it defines that warning marker which appears on the product could not be cut by hole. This character concerns with PIC1 process because this hole that can cut warning marker occurs from PIC1 process. As Figure 3.17, it can show character both accept and reject.

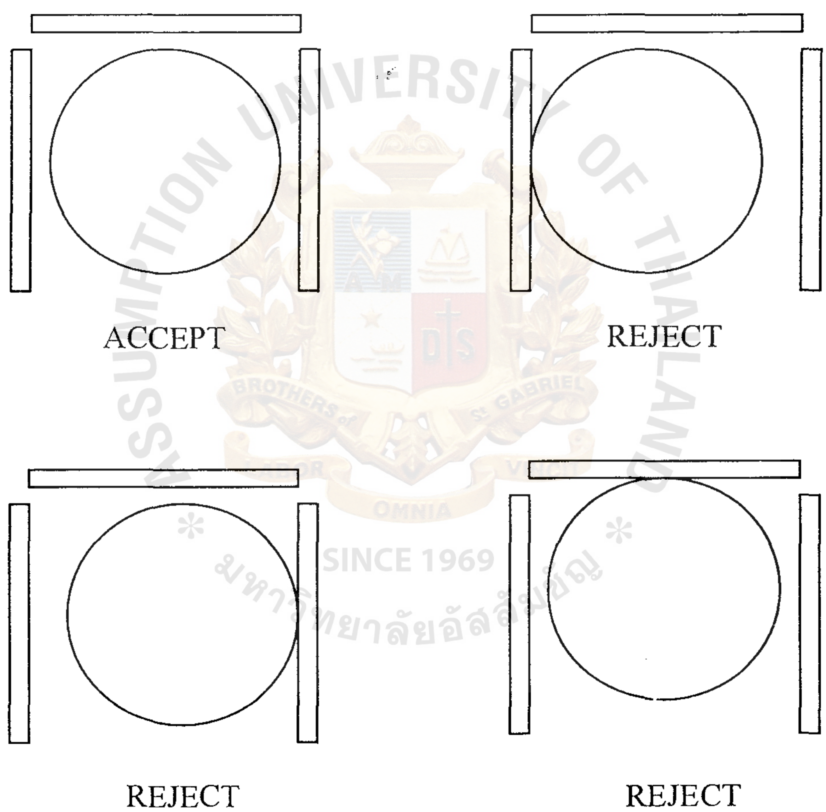


Figure 3.17. Warning Marker for Checking Blanking Misposition.

(2) Target Marker is cut

This problem is the wrong cutting of target mark during VIC process. Surely it concerns with VIC process. Normally, around the product sheet, there are many target marks for usage of customer such as Mark Z1, Mark C and Mark B. These marks are necessary for customer because they must be used to mount any components on the product sheet. The sensor of machine will refer to these marks in Figure 3.18.

Note: O = Mark Z1, ⧅ = Mark C, ▣ = Mark B

Figure 3.18. Target Mark around the Product Sheet.

In Figure 3.18, all target marks will stay near the out line of product sheet. It means that is easy to occur any defect on these target marks.

From Pareto Diagram and Cause and Effect Analysis, they can define the problem and find out the root cause from symptoms of Blanking misposition which is shown in tool of Cause and Effect Analysis or Fishbone Diagram. These tools will lead to the root cause and the process concerns. Cause and Effect Analysis is displayed in Figure 3.19.

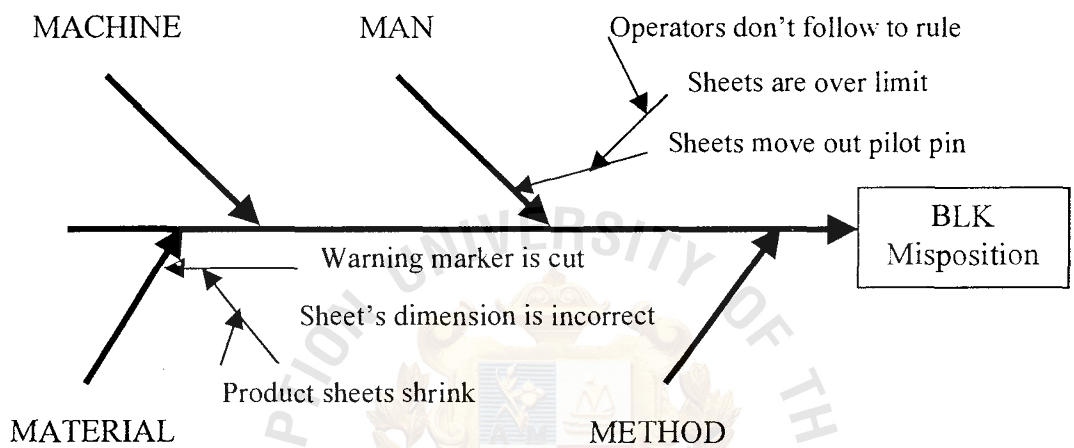


Figure 3.19. Cause and Effect Analysis for BLK Misp.

3.12 Analyzing Problem and Process Concerned in Phase 2

With reference to preceding phase 2, both the problem and the root cause are defined. In Figure 3.19, Blanking misposition will lead to the root cause and the process concerns. Cause and Effect Analysis show that man and material are concerned with this problem:

(1) Man

Refer to Figure 3.19, it shows the root cause which impact to the problem. It concerns with operation of operator during working that is operators do not follow to work instruction. From symptom of this problem, target marks around the product sheet are cut by blade of Vic die. It means

VIC process concerned with this symptom. Normally the operation of VIC process will be defined the quantity of product sheet to be inserted into pilot pin and to cut only three sheets per time. Actually there are more than three sheets to cut per time because product sheet only three sheets can be inserted to the height of pilot pin. But in fact, the product sheets are inserted over the defined limit so that some sheets on the top move out pilot pin. So defined position for cutting on product sheet is not suitable for blade of Vic die. It is reason for Blanking misposition.

(2) Material

In this project, researcher means size of product sheet is not correct that effect to Blanking misposition. In Figure 3.19 again, it identifies the root cause which concerns with material part.

Refer to reject samples of this symptom, warning marker for checking Blanking misposition is cut by punch of PIC1 die. We confirmed both accuracy of punch by using master film of this product tested and operation of operators which may affect to this symptom. From confirmation both accuracy of punch and operation of employees, master film is cut by punch accurately, in addition, operation of operators is normal. Thus we ensure that both things are not cause of Blanking misposition. Then we confirmed the dimension of product sheets by measuring guide "N" to guide "N" of both X-axis and Y-axis and comparing with dimension in drawing. From the measuring data of product sheets, the average of X- axis is 176.24 mm. and Y- axis is 220.02 mm. After actual measuring data are compared with drawing which X-axis is 176.35 mm. and Y-axis is 220.15 mm. We found that the dimensions of product sheet are shorter than real size. Therefore it means the product sheets shrink so that defined position to cut are moved and affect to Blanking misposition.

3.13 Developing Solution Alternatives in Phase 2

As in the previous developing solution, the project will stress on the preventive method to solve and protect the occurred defect. To meet the effective solutions, they need to implement in order to know which solution is effective or not. From Figure 3.19, there are two causes of Blanking misposition which means the solution is needed for them.

3.13.1 Re- train about Work Instruction

One of two causes of Blanking misposition is operators do not follow work instruction. Thus re-train is necessary for operators to recognize their knowledge about the operation of VIC process. From analysis of this problem in the previous section, operators want to work quickly to increase finished goods. However operators do not know that their activity affect to this problem.

So the re-train about operation of VIC process, especially, a number of product sheets which are inserted into pilot pin is necessary.

3.13.2 Compensation Master Film

The purpose of compensation is to enlarge dimension of product sheet. The master film is the model used in Exposure process to produce circuit pattern. So if we want to enlarge the dimension of product sheet, we can calculate the percentage of compensation in each axis as below:

$$\text{X-axis (\%)} = \frac{176.35 - 176.24}{176.35} \times 100$$

$$= 0.06$$

$$\text{Y-axis (\%)} = \frac{220.15 - 220.07}{220.15} \times 100$$

$$= 0.04$$

In case of this compensation, researcher cannot operate it by himself. Because this solution concerns with Circuit Forming the researcher just sent the data for compensation to concerned person.

3.14 Methodology Conclusion in Phase 2

In part of the second methodology, improve quality continuously of MKT-042S-0A by reducing percentage reject of final process. Quality improvement is applied in two ways.

(1) Re-train about work instruction at VIC process to operators.

(2) Compensate master film to expand size of product sheet.

This project will select both solutions to implement and improve quality of product in two ways.

(1) Compensate master film.

(2) Combine compensating with re-train together.

3.15 Continuous Improvement

As Table 3.6, the results of data collecting to monitor the defectives at final process are shown. Both Dent and Blanking misposition defects still exist in the final process but it has only small percentage as 0.15% and 0.05% respectively. After we monitor it to find out we analyzed the root cause of both defects.

Table 3.6. Summary of Final Process of MKT-042S-0A after Improvement in Phase 2.

No.	Item	Total (Pcs)	Reject (%)
22	Adhesive Misposition	0	0.00
23	Stiffener Misposition	0	0.00
24	Stiffener Bubble	0	0.00
25	Dent	847	0.15
26	Scratch on FPC	150	0.03
27	Burr	138	0.25
28	Creasing	66	0.01
29	Blanking/Piercing Misposition	276	0.05
30	Tear	61	0.01
31	Others	105	0.02
31.1	Material Peel Off	22	0.00
31.2	Contamination	22	0.00
31.3	Stiffener Crack	0	0.00
31.4	No Material	0	0.00
31.5	No Piercing/Banking	0	0.00
31.6	Emboss Defect	0	0.00
31.7	Metal Dome Defect	0	0.00
31.8	Dirt	0	0.00
31.9	Lost	39	0.01
31.10	Adhesive Flow	0	0.00
31.11	Defect Mix Level	0	0.00
Total Input (Pcs.)		552,960	
Total Final Reject (Pcs.)		1,726	
Total Final Reject (%)		0.31	

Finally, the Pareto analysis will be made again to monitor the defect quantity and to ensure the quality improvement can reach to the goal.

These techniques are used to confirm that many various actions of quality improvement are suitable. From the result, even though the percentage of both defects including final process will be reduced efficiently it does not mean that the quality improvement is the optimal position. So we are still to improve the quality of final process continuously.

Table 3.7. Defect Category and Percentage Accumulative of MKT-042S-0A after Improvement Both Dent and Blanking Misposition.

Item	Total (Pcs.)	Percent (%)	Acc. (%)
Dent	847	0.15	49.07
Blanking Misposition	276	0.05	65.06
Scratch on FPC	150	0.03	73.75
Burr	138	0.03	81.74
Creasing	66	0.01	85.56
Tear	61	0.01	89.09
Lost	39	0.01	91.35
Material Peel Off	22	0.00	92.62
Contamination	22	0.00	93.89
Others	105	0.02	100.00

With reference to Table 3.7, the percentage column displays Dent 0.15%, Blanking misposition 0.05%, Scratch on FPC 0.03%, Burr 0.03%, Creasing 0.01%, Tear 0.01%, Lost 0.01%, Material Peel Off 0.00%, Contamination 0.00% and Others 0.02% respectively. It still shows that the problems still occur with this product so quality should be improved continuously.

From the collected data and tabulated in Table 3.7, we can make Pareto diagram as shown of the Figure 3.20 again after both Dent and Blanking misposition were solved efficiently to monitor and improve this product continuously.

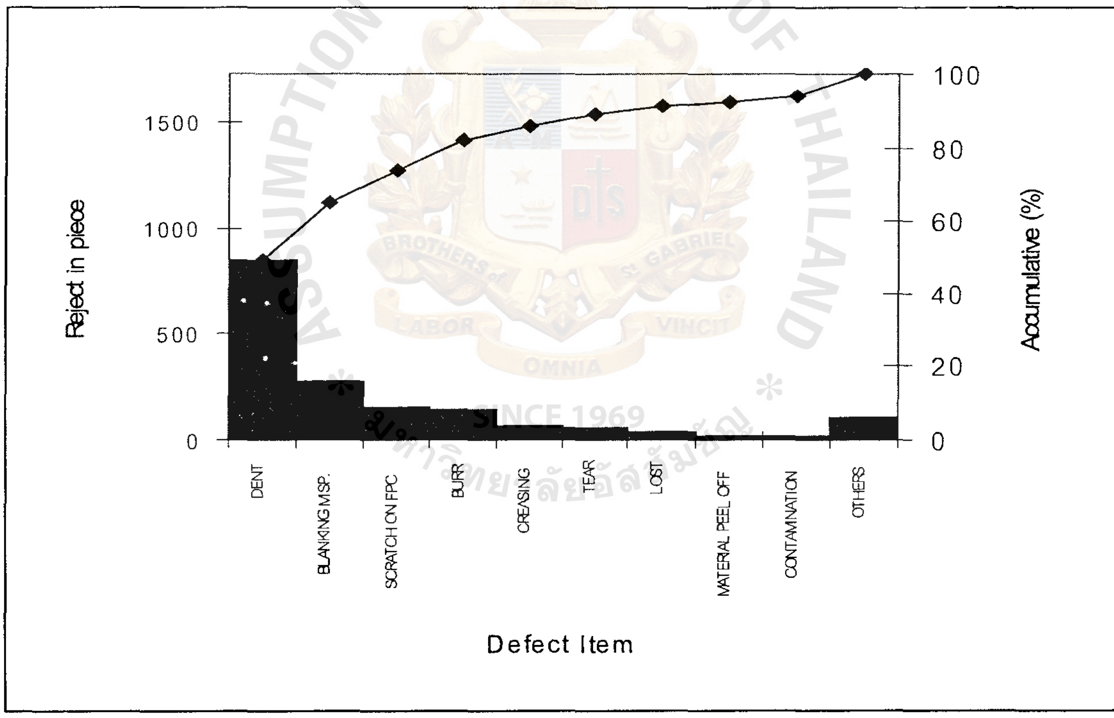


Figure 3.20. Pareto Diagram of Defect Priority for Phase 3.

IV. IMPLEMENTATION RESULTS AND DISCUSSIONS

In part of methodology, we conclude that this project will present quality improvement for MKT-042S-0A, which is one element in Hard disk drive, by reducing quality of defect.

In the implementation results and discussions part will show and explain the result of each solution implemented to improve quality of MKT-042S-0A.

About this project, researcher improves quality of MKT-042S-0A by using tools and different technique to solve and improve it continuously which impact to quality of product. In part of methodology, we solve the problems in two defects which are as follows:

(1) Dent Defect

(2) Blanking Misposition Defect

4.1 Implementation Results for Dent

In the first problem of improvement, dent, there are four implementations needed to implement them which consist of the following:

(1) Foot Switch

As Cause and Effect Analysis, Figure 3.10, one of many causes is the period of blowing which is a long time. So we replace the foot switch with air gun which operators must use their hands to pock up and blow air gun. We collect the data after foot switch is implemented about one month. The implement result of foot switch is shown in Table 4.1.

Table 4.1. Defect Summary Implemented by Foot Switch.

No.	Item	Total (Pcs)	Reject (%)
22	Adhesive Misposition	0	0.00
23	Stiffener Misposition	0	0.00
24	Stiffener Bubble	0	0.00
25	Dent	3,715	0.51
26	Scratch on FPC	150	0.02
27	Burr	35	0.01
28	Creasing	7	0.00
29	Blanking/Piercing Misposition	1,360	0.19
30	Tear	10	0.00
31	Others	274	0.04
31.1	Material Peel Off	0	0.00
31.2	Contamination	0	0.00
31.3	Stiffener Crack	0	0.00
31.4	No Material	0	0.00
31.5	No Piercing/Blanking	0	0.00
31.6	Emboss Defect	0	0.00
31.7	Metal Dome Defect	0	0.00
31.8	Dirt	0	0.00
31.9	Lost	0	0.00
31.10	Adhesive Flow	0	0.00
31.11	Defect Mix Level	0	0.00
Total Input (Pcs.)		728,064	
Total Final Reject (Pcs.)		5,551	
Total Final Reject (%)		0.76	

Refer to Table 4.1, we have total input as 728,064 pieces. Total reject can compile a number of reject in each item occurred as 5,551 pieces. So we can calculate the percentage of total reject as shown below:

$$\text{Total reject (\%)} = \frac{\text{Total final reject (Pcs)}}{\text{Total input (Pcs)}} \times 100$$

$$= \frac{5,551}{728,064} \times 100$$

$$= 0.76$$

(2) Expand Scrap Hole

This solution has influence from reject samples of dent still occur after foot switch was implemented. We sampled 400 pieces of dent reject as of 5,371 pieces by classifying into 2 areas as shown in Figure 3.14. We found that there are 313 pieces occurred from area1, 35 pieces occurred from area2 and 52 pieces occurred from other areas. In each area, we can calculate the percentage of each area affecting to dent defect as shown below:

$$\text{Area1 (\%)} = \frac{\text{Dent reject from area1}}{\text{Total reject samples}} \times 100$$

$$= \frac{313}{400} \times 100$$

$$= 78.25$$

$$\text{Area2 (\%)} = \frac{\text{Dent reject from area2}}{\text{Total reject samples}} \times 100$$

$$= \frac{35}{400} \times 100$$

$$= 8.75$$

$$\text{Other areas (\%)} = \frac{\text{Dent reject from other areas}}{\text{Total reject samples}} \times 100$$

$$= \frac{52}{400} \times 100$$

$$= 13$$

So all of each area of die PIC1 process which affect to dent defect can be summarized in Table 4.2.

Table 4.2. The Result of Classification Comparing with Each Area of Dent Sample.

Area	Quantity (Pcs.)	Percent (%)
Area 1	313	78.25
Area 2	35	8.75
Other area	52	13.00
Total	400	100.00

In Figure 3.14, area1 is area of hole which occur dent around this hole. Thus this solution will expand only scrap hole of area1.

From implement of expansion scrap hole about 5 lots, the implement result of expansion scrap hole can be shown in Table 4.3. From the result in Table 4.3, the enlarged scrap hole are less effective to dent problem. This solution can only reduce the percentage of dent from 0.92 to 0.80.

Table 4.3. Defect Summary Implemented by Expansion Scrap Hole.

No.	Item	Total (Pcs)	Reject (%)
22	Adhesive Misposition	0	0.00
23	Stiffener Misposition	0	0.00
24	Stiffener Bubble	0	0.00
25	Dent	55	0.80
26	Scratch on FPC	2	0.03
27	Burr	1	0.01
28	Creasing	0	0.00
29	Blanking/Piercing Misposition	13	0.19
30	Tear	0	0.00
31	Others	3	0.04
31.1	Material Peel Off	0	0.00
31.2	Contamination	0	0.00
31.3	Stiffener Crack	0	0.00
31.4	No Material	0	0.00
31.5	No Piercing/Blanking	0	0.00
31.6	Emboss Defect	0	0.00
31.7	Metal Dome Defect	0	0.00
31.8	Dirt	0	0.00
31.9	Lost	0	0.00
31.10	Adhesive Flow	0	0.00
Total Input (Pcs.)		6,912	
Total Final Reject (Pcs.)		74	
Total Final Reject (%)		1.07	

(3) Rod Punch

Refer to the result of expansion scrap hole, it is less effective to dent problem. Rod Punch is modified from normal punch and replaced in area1 of die. We test rod punch and another punch or normal punch together in die of PIC1 process with the product about 15 lots.

From the result of test, we found dent defects which occur from another punch as 111 pieces and occur from rod punch as 5 pieces. Thus we can calculate the percentage of dent defect occurred from another punch and rod punch as shown below:

$$\text{Normal Punch (\%)} = \frac{\text{Another punch (Pcs)}}{\text{Total dent (Pcs)}} \times 100$$

$$= \frac{111}{116} \times 100$$

$$= 0.48$$

$$\text{Rod Punch (\%)} = \frac{\text{Rod punch (Pcs)}}{\text{Total dent (Pcs)}} \times 100$$

$$= \frac{5}{116} \times 100$$

$$= 0.02$$

From the implementing results of rod punch comparing with another punch, they can be compiled and shown in Table 4.4. Refer to Table 4.4, it can verify that rod punch can be effective to dent problem.

Table 4.4. The Result of Rod Punch Implemented and Compared with Another Punch in Same Die.

Lot No.	Normal Punch (Pcs)	Rod Punch (Pcs)	Total Dent (Pcs)
1	0	0	0
2	0	0	0
3	5	0	5
4	0	0	0
5	3	0	3
6	2	0	2
7	0	0	0
8	1	0	1
9	19	1	20
10	0	0	0
11	6	0	6
12	0	0	0
13	0	0	0
14	69	0	69
15	6	4	10
Total Reject (Pcs)	111	5	116
Total Reject (%)	0.48	0.02	

(4) Combination between Foot Switch and Rod Punch

From the result of both solutions, researcher combines both solutions and implements them together. The implement result of both solutions is shown in Table 4.5.

Table 4.5. Defect Summary Implemented by Both Foot Switch and Rod Punch.

No.	Item	Total (Pcs)	Reject (%)
22	Adhesive Misposition	0	0.00
23	Stiffener Misposition	0	0.00
24	Stiffener Bubble	0	0.00
25	Dent	16	0.21
26	Scratch on FPC	3	0.04
27	Burr	1	0.01
28	Creasing	0	0.00
29	Blanking/Piercing Misposition	17	0.22
30	Tear	2	0.03
31	Others	1	0.01
31.1	Material Peel Off	0	0.00
31.2	Contamination	0	0.00
31.3	Stiffener Crack	0	0.00
31.4	No Material	0	0.00
31.5	No Piercing/Blanking	0	0.00
31.6	Emboss Defect	0	0.00
31.7	Metal Dome Defect	0	0.00
31.8	Dirt	0	0.00
31.9	Lost	0	0.00
31.10	Adhesive Flow	0	0.00
31.11	Defect Mix Level	0	0.00
Total Input (Pcs.)		7,680	
Total Final Reject (Pcs.)		40	
Total Final Reject (%)		0.52	

4.2 Implementation Results Analysis

(1) Analyzing Implemented Result of Foot Switch

As Table 4.1, Foot switch can solve the dent problem efficiently. With the old method of blowing, air gun, it is defined to blow every 10 sheets per time. It means that the first shot is only cleaned by air gun but the second shot to eightieth shot (tenth sheet) are without blowing. So there may have scrap on the die or the product sheet, which occur the dent problem.

From the concept of foot switch, it is easy and comfort to blow by blowing every shot. It means that since the first shot of piercing until the eightieth shot are blown by foot switch so the remain scrap on the die will be blown and moved out from surface of the die.

(2) Analyzing Implemented Result of Expanding Scrap Hole

From the effective result of foot switch, there are still dent defects. So scrap holes of area1 are enlarged due to the result of classification dent in Table 4.2. The purpose of this way is to drop easily of scrap cut by punch but Figure 3.10 shows that we enlarged scrap holes at the bottom which do not concern with position of scraps plug. We can not enlarge at the top of surface scrap hole because it has limit that if diameter at the top of scrap hole is so big, piercing of the die will burr. Thus expanding scrap hole at such position is not effective to dent problem.

(3) Analyzing Implemented Result of Rod Punch

Refer to the ineffective result of expanding scrap hole, we still implement rod punch at area1. Because foot switch will blow at surface of the die, there may have some scrap to attach at the end of punch and drop on the product sheet. From concept of Rod Punch, knock rod will push scrap into scrap hole without attaching at the end of punch which effect to dent defect.

(4) Analyzing Implemented Result of Combination between Foot Switch and Rod Punch.

From the effective result of both Foot Switch and Rod Punch, surely the result of combination is more effective. Because foot switch blow scraps which are on surface of die, rod punch will push scrap into scrap hole to prevent scrap which may attach at the end of rod punch until dropping on the product sheet.

Thus both ways can eliminate dent problem efficiently which can reduce the percentage of dent reject from 0.92 to 0.21. From reduction of dent defect, it can be calculated that the percentage of effectiveness and shown below:

$$\text{Reduction of dent(\%)} = \text{initial dent(\%)} - \text{last dent(\%)}$$

$$= 0.92 - 0.21$$

$$= 0.71$$

$$\text{Effectiveness of reduction (\%)} = \frac{0.71 \times 100}{0.92}$$

$$= 77.17$$

4.3 Implementation Results for Blanking Misposition

To improve quality continuously of MKT-042S-0A, we use tools and techniques which are same as the first defect. The implementation of Blanking misposition consists of two ways as follows:

(1) Compensation Master Film

From part of analyzing problem in phase 2, warning marker of MKT-042S-0A is cut because defined position is changed which has causes from shrinking of product sheet.

So compensating of master film is used to enlarge the product sheet and effect to dimension of sheet later. The implemented result of compensation master film will be shown in Table 4.6.

(2) Combination between Compensation Master Film and Re-train

Refer to work instruction of VIC process, only 3 sheets per time, we concentrate on the operation to follow to work instruction. In case of compensation, we request to circuit forming process, which is responsible for compensating to produce one lot test.

After that we combine both compensating and re-train operators and implement them with one lot test. The result of this implementation is shown in Table 4.7.

Table 4.6. Defect Summary Implemented by Compensation Master Film.

No.	Item	Total (Pcs)	Reject (%)
22	Adhesive Misposition	0	0.00
23	Stiffener Misposition	0	0.00
24	Stiffener Bubble	0	0.00
25	Dent	3	0.20
26	Scratch on FPC	1	0.07
27	Burr	0	0.00
28	Creasing	0	0.00
29	Blanking/Piercing Misposition	1	0.07
30	Tear	0	0.00
31	Others	0	0.00
31.1	Material Peel Off	0	0.00
31.2	Contamination	0	0.00
31.3	Stiffener Crack	0	0.00
31.4	No Material	0	0.00
31.5	No Piercing/Blanking	0	0.00
31.6	Emboss Defect	0	0.00
31.7	Metal Dome Defect	0	0.00
31.8	Dirt	0	0.00
31.9	Lost	0	0.00
31.10	Adhesive Flow	0	0.00
31.11	Defect Mix Level	0	0.00
Total Input (Pcs.)		1,536	
Total Final Reject (Pcs.)		5	
Total Final Reject (%)		0.34	

Table 4.7. Defect Summary Implemented by Combination between Compensating and Re-training.

No.	Item	Total (Pcs)	Reject (%)
22	Adhesive Misposition	0	0.00
23	Stiffener Misposition	0	0.00
24	Stiffener Bubble	0	0.00
25	Dent	30	0.20
26	Scratch on FPC	4	0.03
27	Burr	3	0.02
28	Creasing	0	0.00
29	Blanking/Piercing Misposition	6	0.04
30	Tear	0	0.00
31	Others	3	0.02
31.1	Material Peel Off	0	0.00
31.2	Contamination	0	0.00
31.3	Stiffener Crack	0	0.00
31.4	No Material	0	0.00
31.5	No Piercing/Blanking	0	0.00
31.6	Emboss Defect	0	0.00
31.7	Metal Dome Defect	0	0.00
31.8	Dirt	0	0.00
31.9	Lost	0	0.00
31.10	Adhesive Flow	0	0.00
31.11	Defect Mix Level	0	0.00
Total Input (Pcs.)		15,360	
Total Final Reject (Pcs.)		46	
Total Final Reject (%)		0.31	

4.4 Implementation Results Analysis

(1) Analyzing Implementation Result Compensating Master Film

As Table 4.6, compensating can reduce the percentage of blaming misposition reject from 0.25 to 0.07. It verifies that this symptom of blaming misposition problem occur from shrinking of product sheet at the curing process. It is different with some products, which have same symptom but it has caused from operating of operators such as inserting the product sheet into pilot pin is not complete because it means the position of product sheet is not in the position defined. Another one concerning with the operation of operators is hole misposition. It can explain that hole used to insert the product sheet is not in the position or the limit defined. When this hole for inserting is in the incorrect position, the product sheet will stay in the wrong position also. Then, the cutting of PIC1 process will be misposition later.

From confirmation of both operations, both operations do not concern with this symptom of the project. Compensating is the solution, which is the correct way.

(2) Analyzing Implemented Result of both Compensation and Re-train

From symptom of blaming misposition, there are two symptoms, which are warning marker cut by punch and target mark for customer tear. When we combine both of solution to implement them with MKT-042S-0A, we can reduce the percentage of reject efficiently. But the remaining rejects occur probably from the operators, because this product is produced both day and night shift especially night shift is different to control the operation of operators. It is difficult to reduce reject to 0.

4.5 Cost Saving

The pursuit of quality excellence does not come at the expense of financial excellence. Rather, financial results are another way of measuring the effectiveness of the system. Thus improving quality is one important way to save expense of company including cost of manufacturing. Due to occurred rejects, they are produced by many various material. At final inspection process, we know which one is good or reject. It means that we cannot correct or prevent the defects suddenly because they are rejects completely. So corrective or preventive action should be proceeded immediately in processes which are cause of defect.

Before product quality will be improved, it has high reject of final process as 1.23%. But after we improved it, we can solve dent and blanking misposition problem so that percentage of final process can reduce as 0.31%. We can calculate the reduction of percent final reject as shown below:

Reduction of final reject (%) = Total final reject before improvement (%) – Total final reject after improvement (%)

$$= 1.23 - 0.31$$

$$= 0.92$$

The selling cost of MKT-042S-0A is 25 baht a piece and order a day is 40,000 pieces a day. We can calculate cost saving as follows:

$$\text{Daily saving (Pcs/day)} = \frac{\text{Order (Pcs/day)} \times \text{Reduction of percent final reject (\%)}}{100}$$

$$= \frac{40{,}000 \times 0.92}{100}$$

= 368 Pieces/day

Daily saving (Baht/day) = Daily saving (Pcs/day) × Selling cost (Baht/pcs)

= 368 × 25

= 9,200 Bahts/day

Save (Pcs/monthly) = Daily saving (Pcs/day) × Working day (Day/month)

= 368 × 24

= 8,832 Pieces/monthly

Save (Baht/monthly) = Save (Pcs/monthly) × Selling cost (Baht/pcs)

= 8,832 × 25

= 220,800 Bahts/monthly

Annual saving (Pcs/year) = Daily saving (Pcs/monthly) × Working day (Month/year)

= 8,832 × 12

= 105,984 Pieces/year

Annual saving (Baht/year) = Annual saving (Pcs/year) × Selling cost (Baht/pcs)

= 105,984 × 25

= 2,649,600 Bahts/year

From result of improvement, we can save cost of manufacturing which can conclude and show in Table 4.8.

Table 4.8. Cost Saving after Improving Quality.

Total final reject before improvement (%)	1.23
Total final reject after improvement (%)	0.31
Reduction of final reject (%)	0.92
Selling Cost (Baht)	25
Order (Pcs/day)	40,000
Daily saving (Pcs/day)	368
Daily saving (Baht/day)	9,200
Save (Pcs/monthly)	8,832
Save (Baht/monthly)	220,800
Annual saving (Pcs/year)	105,984
Annual saving (Baht/year)	2,649,600

Refer to Table 4.8, various solution of improving quality can gain the profit as 2,649,600 bahts per year. So if we can solve the quality problem and reduce the percentage of reject, cost saving of manufacturing can still gain more.

From an economic perspective, when quality is emphasized and subsequently improved, waste is decreased or eliminated. Hours are not wasted reworking products. Material is not thrown away. Operations costs are reduced.

In addition, productivity can be expressed on a total factor basis or on a partial factor basis. Total factor productivity is the ratio of outputs over all inputs:

$$\text{Productivity} = \frac{\text{Outputs}}{\text{Labor} + \text{Capital} + \text{Material} + \text{Energy}}$$

Outputs relative to one, two, or three of inputs (labor, capital, material, or energy) are partial measures of productivity. Outputs per labor hour, often called labor efficiency, is perhaps the most common partial measure of productivity. There is a clear relationship between quality and productivity. Generally, when quality increases, so will productivity. Why? Because waste is eliminated. The amount of resource inputs (the denominator of equation) required to produce good outputs (the numerator) is reduced. Productivity increases.

In this project, the researcher looks at definition of productivity in cost because quality improvement will change the rejects to good products. It means finish goods or output increase as same capacity which influence profits from more selling of finish goods increase.

V. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

To improve FPC quality, production engineer has a role to apply strategies to improve quality. In this project, seven tools are selected to use improving FPC quality such as Pareto analysis to identify main defect, Cause and Effect analysis to find out root cause of main defect. About FPC manufacturing, all of main procedure consist of four main process (Circuit Forming, Cover Coat, Surface Treatment and Final Process). But all of this project concerned with only final process which still consists of many subprocesses.

This project selects MKT-042S-0A which is one of many products of FPC. We use Pareto analysis to identify main defect of MKT-042S-0A. The main defect is the dent problem. Then we use Cause and Effect analysis or fishbone diagram to find out the possible root causes. It shows the possible root causes are the less frequency of blowing die, small scrap hole and jumping of scrap out from scrap hole. Then we solve each cause of dent problem by setting foot switch, expanding scrap hole and pushing scrap into scrap hole by rod punch respectively.

From the result of improvement, reject of dent problem can be decreased from 0.92% to 0.18%. Concerning the dent problem, it is available to total reject final which is reduced from 1.23% to 0.51%.

After completed improving quality of dent, this project still improves quality of MKT-042S-0A continuously. In phase 2 of improvement, we still use Pareto analysis and Cause and Effect analysis to identify main defect and to find out the possible root causes. The main defect in phase 2 is blanking misposition problem. The possible root causes of blanking misposition are the shrinking product sheet and the omission to work instruction. Then we solve to improve them by compensating product sheet and retraining concerned operators respectively. The reject of blanking misposition can be reduced from 0.25% to 0.04% including total reject final which can be reduced from 1.23% to 0.31%.

Finally cost was also considered. In part of cost saving, improving quality can save around 2.65 million bahts per year. However it can still save cost more if we can improve quality and reduce reject continuously.

5.2 Recommendations

According to quality improvement, it never finishes to improve quality. Because defect and problem can occur and affect to quality of product every time in manufacturing. So quality improvement should be proceeded continuously. In this project, there are many defects which are displayed by Pareto analysis in phase 3. The main defect is still dent defect. For the person who is interested on quality improvement and want to apply for your manufacturing, the one interesting thing that should be continuous on this project is improvement of quality which is dent defect. There are many methods and techniques that recommended to help improvement of product, to effective improving quality as following:

(1) Data Collection

Data collection should be compiled in long period to make sure that every different information will be taken to analyze and to find out the main defect correctly.

(2) Cause and Effect Analysis

Cause and Effect Analysis is the tool used to find out the possible root cause. But the root cause will be the real cause or not, depends on symptoms of defect. Researcher would like to introduce that sample rejects should be analyzed extremely to find out the root causes because sample rejects can identify about root cause. Moreover, sample rejects are things that lead to the root cause. Hence the more the sample rejects, the easier it is to find out the root cause.

(3) Control chart

Control chart will help to monitor quality. We can set the maximum level of reject which can accept them and use control chart to monitor them. When a number of rejects increase over the setting target, it can warn us that has abnormality of quality.

In addition, there are still other tools or activities which can improve quality of product such as SPC, QCC, etc. These tools or activities are useful to your job depending on character of both data and usage.

(4) Continuous improvement

Continuous improvement is a good activity that can monitor quality of product. To improve quality effective, we always improve to better forever. In addition, continuous improvement will eliminate reject which increase finished goods indirectly.

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