



## TenStep Supplemental Paper

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### **Enhanced Quality through Statistical Analysis**

Ask a Ferrari customer what is so good about this particular car? The customer will say a thousand good things about the company and the car. There is a reason that customers develop a liking to specific brands. If companies provide high product quality and good customer service, customers think twice before switching to a new product.

In today's competitive environment, high quality products are the trump cards to success and provide many advantages to companies. Contrary to the common misconception that high product quality increases manufacturing cost, high quality products can actually reduce overall manufacturing costs. One can better understand this argument by observing the cost incurred at different stages of defect testing.

#### **Early Defect Detection is Vital**

Automated optical inspection is one such test system that allows manufacturers to test objects during their initial manufacturing stage. This system instantly identifies components that are out of place. The repair and reinstallation at this stage does not cost much.

Automated optical testing system is the next stage. After the first stage of defect detection and correction, the product is now re-inspected. Defects found at this stage will double the repair cost.

Circuit testing is the third stage, and defects detected here cost a lot if they have to be repaired. Therefore, defects must be detected and eliminated as early as possible. The mantra companies should remember is "prevent and prepare, do not repent and repair."

Identify defects as early as possible. If a defect is spotted in the initial stages on the assembly line and rectified, the cost incurred is negligible. However, substantial costs will be incurred if the defect passes through the assembly line undetected. It will be worse if a substandard quality product is delivered to the customer. Customer backing could erode, meaning disaster for the company.

#### **Can You Achieve Zero Defects?**

The highest possible quality means zero defects. Zero defects in turn demand a defect-free manufacturing assembly line. A completely defect-free assembly line is, of course, practically impossible. However, the probability of defects can be substantially reduced. One way this is done is by conducting tests on the assembly line, as the product passes from one stage to another. Statistical analysis is one such testing system that facilitates failure/defect prediction.

#### **Statistical Analysis**

The need to increase quality is crucial for most companies. Companies use various types of quality control checks to scrutinize quality. Statistical analysis is one such method. An



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efficient statistical analysis would facilitate early defect detection, improved quality and enhanced return on investment (ROI).

Statistical analysis reveals any variation in the process that could lead to a defect. This 'proactive' nature of defect prediction allows field engineers to stop the defect from entering the assembly line. Statistical analysis can be customized to any working environment and hence can be pre-programmed depending on specific manufacturing constraints.

### **An Example of Statistical Analysis**

Consider a computer monitor manufacturing assembly line. Excessive soldering temperatures will crack the monitor. To ensure that this does not happen, oven temperatures can be preset depending on the tolerance limits. When the temperature increases beyond permissible limits, the statistical analysis software automatically alerts the engineers, who can take corrective actions to avoid cracks in the monitor.

Statistical analysis is popularly classified into Statistical Process Control (SPC) and Statistical Quality Control (SQC).

### **Statistical Process Control (SPC)**

SPC gives companies the benefits of a scientific management style where decisions are based on facts. SPC is a powerful technique for improving process quality since it systematically eliminates all causes of variation.

The philosophy behind SPC is that process output can be statistically controlled by means of engineering and management action. SPC edges out the traditional approach of inspection-based quality control systems, which are rather expensive, inefficient, and unreliable. SPC helps manufacturing companies to:

- Identify critical problem areas in a process.
- Reduce variation check for abnormal variations.
- Determine the capability of a process.
- Understand and optimize processes.
- Determine the reliability of your product

### **Statistical Quality Control (SQC)**

Statistical Quality Control (SQC) is a more outdated method of quality check. SQC calls for the selection of an entire batch of products and runs a quality check on them. Since this can be very time-consuming, over time SPC has replaced/overridden SQC.

### **History of Defects**

The efficiency of a statistical analysis system in predicting failures/defects depends largely on its practical application. In short, statistical analysis must encompass all constraints and working environment conditions encountered. Many factors have to be addressed in this regard. One such aspect is the history of defects.



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Accurate defect prediction demands that comprehensive tests are conducted on the assembly line. To make the tests both conclusive and comprehensive, it is necessary to determine the sections of the assembly line that are prone to defects. This prevents wasting time in testing sections of the assembly line that were never defective in the past.

Hence, a section of the assembly line that is usually defect-free need not be fully tested. Instead it can be subjected to a preliminary test, just in case a defect occurred. Sections that are prone to defects can be fully tested to ensure defect free products.

Nevertheless, the best way to make testing more reliable is to create a case history of the assembly line sections. This can be achieved by categorizing all the assembly line sections based on their prior history of defect probability. For example, a defect-free section can be marked as a rare defect section. However, sections that were in the past defect-prone can be marked as critical areas.

A case history of the entire assembly line can thus be generated. Consequently, the comprehensiveness of the tests is decided based on this case history. Software protocols can be installed to use this case history data more effectively. This will help in automatic scheduling of tests on the assembly line sections.

A case history is primarily developed to minimize the time spent in testing defect-free sections of the assembly line. This reduces man-hours spent on testing and yields high product quality apart from saving costs.

### **Find Defects As Early as Possible in the Assembly Line**

Most companies have high-tech software that tests products after they exit the manufacturing assembly line. Nevertheless, companies no longer want to detect defects, after the product exits the assembly line. Instead, they want to eliminate defects as early as possible.

In this age of cutthroat competition, even a single batch of substandard products delivered to the consumer can cause substantial financial and economic losses. Hence, it is crucial that the testing system identifies and rectifies defects well before the final product leaves the assembly line.

Defect detection systems must be able to detect the defects and allow front line personnel to rectify the defect. All this before the defects becomes irreparable. A feedback loop to the assembly line helps in this regard. The feedback loop software automatically detects every single defect and sounds an alarm to alert the front line personnel.

### **An Example of a Manufacturing Feedback Loop**

Midway through a Printed Circuit Board (PCB) assembly line, a manufacturer realized that the solder paste template was misaligned. This resulted in faulty soldering of the PCB's. Since the problem came up midway through the manufacturing, the problem was considered serious.

The company realized that due to this problem, they faced substantial financial losses. Each PCB was made up of components worth \$2500 and worth \$500 in manufacturing



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costs, bringing the overall PCB value to \$3000. Because the PCB's were manufactured before the problem was detected, 80 out of a 100 PCBs proved defective. The total defect repair and reinstallation costs amounted to \$240,000. Furthermore, the repair and reinstallation of new spares for the entire batch of products cost \$12,000. The man-hour labor charges and purchase of new spares cost \$65,000. Hence the total loss was a staggering  $\$240,000 + \$65,000$ .

The company then incorporated a software protocol to provide feedback to the assembly line in case of a defect. The feedback-software protocol signaled an alarm when it detected poor soldering on the PCBs. Production engineers immediately scrutinized the process, corrected the defect, and ensured that the batch was defect free.

Few products, however, were found defective. The repair and spare part reinstallation cost to the company was only \$7000 compared to huge costs incurred earlier. Therefore, even the worst possible setbacks can be prevented if proper measures are taken.

### Summary

High quality can be achieved by focusing more on the process than the product. Often it is the process that yields a defective product. Most companies have realized that when the processes are controlled, defects in the products can also be controlled. With the paradigm shift from product control to process control, companies can generate economically priced high quality products.