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Economical Methods to Reduce Time Required for Product Quality Inspection in Small Scale Industries

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Abstract: ***Quality plays a vital role in improving the productivity and acceptance of the final product. Different aspects of the product like dimensions and appearance can be measured and analyzed to attain the required quality of the final product as per the customer requirement. Data collection and recording also play a major role in problem detection and analysis. The paper tries to explore economical methods for improving the quality inspection process by reducing the time required to inspect products and automate the data collection process.***

Keywords: Quality Inspection Time Reduction, Small scale industries, Digital Vernier Caliper System, Data Recording.

1. Introduction

1.1. Definition of Small Scale Industries

In India, small scale industry sector is included in the MSME (Micro Small and Medium Enterprises) category. The Government of India has enacted the Micro, Small and Medium Enterprises Development (MSMED) Act, 2006 in terms of which the definition of micro, small and medium enterprises is as under:

(a) Enterprises engaged in the manufacture or production, processing or preservation of goods as specified below:

1) A micro enterprise is an enterprise where investment in plant and machinery does not exceed Rs. 2.5 million;
2) A small enterprise is an enterprise where the investment in plant and machinery is more than Rs. 2.5 million but does not exceed Rs. 50 million; and
3) A medium enterprise is an enterprise where the investment in plant and machinery is more than Rs.50 million but does not exceed Rs.100 million [1].

1.2. Impact of MSME on GDP of India

The Small Scale Industries in India has today become a growth engine for the economy, contributing substantially to increase in the GDP, employment and exports. This sector has continued to increase its contribution in India's economic development. Micro, Small and Medium Enterprises (MSME) contribute nearly 8 percent of the country's GDP, 45 percent of the manufacturing output and 40 percent of the exports. They provide the largest share of employment after agriculture. They are the nurseries for entrepreneurship and innovation. They are widely dispersed across the country and produce a diverse range of products and services to meet the needs of the local markets, the global market and the national and international value chains [2].

1.3. Reluctance by MSME Industries Towards Investment in Quality Enhancement Process

There is a mistaken notion that achievement of better quality requires higher costs. It has been a myth that prevents many Indian companies to invest more on quality cost related programs. Traditionally, recommendations were made to management that a choice had to be made between quality and cost, the so called trade off decision, because better quality would somehow cost more and make production difficult [3]. The paper intends to present economical methods to improve the quality inspection process which speeds up the inspection process which in turn helps in increasing the productivity.

2. Literature Review

Large scale industries are outsourcing most of the manufacturing activities, and have essentially become assemblers of parts, resulting in ever expanding global supply network. Traditionally, large scale industries had a few small scale industries as vendors to chose from, and the only criteria for accepting a particular vendor was the lowest price offered for the product. Nowadays, large scale industries have so many options of vendors to chose, due to the ever growing MSME sector. And more importantly, optimum pricing and good quality of the product are the two most important factors to select a vendor. Small scale industries find it difficult to manufacture products of good quality with a competitive price due to lack of latest technological advance, skilled labor and organized work practices. The lack of financial support leads to buying of cheaper available outdated technology and unskilled labor, and the lack of training program leads to unorganized work practices. The consequences of these factors are poor quality practices and higher probability of rejection.

Most products manufactured by small scale industries are high volume-low cost type of products. This results in high volume production per day. Hence, inspection of every part in a lot is not feasible and seems illogical. But huge number of products leads to reduction of the sample size inspection of a lot. And manual inspection by less skilled workers further reduces the number of part inspection capability per day. Data Recording of the inspection process further slows down the quality inspection process.

There are many technologies available which resolve the

problem of the slow inspection process. But most of them are out of the reach of a small scale industry's budget and capability to operate it, as they cost more than two hundred thousand rupees. Hence, an economical system is required to increase the speed of the inspection process with data recording capabilities.

3. Methodology

Automation of the dimension measurement instrument and complete measurement checking by gauges (Go/No-Go gauges like limit, plug, ring, snap etc) are the two viable and economical solutions which can be implemented to eradicate the high amount of time required for inspection processes. These two methods were tested in a small scale industry producing automobile parts in Pune, Maharashtra. The manual inspection with simple vernier caliper with data recording on paper was also observed to compare the results of the two new methods introduced to replace it. A worker with good experience in the inspection process was observed while he used all three processes, namely, manual inspection with hand-written data recording with a simple vernier caliper, limit gauges and its data recording, and digital vernier caliper system one at a time. The time required for inspection was the main observation made during their application. 10 observations were recorded for each inspection method and an average value was calculated for knowing the average time required for that specific inspection method. These observations were tested on a product with the dimension of total length 30.00 mm and tolerance of 0.3 mm on both sides.

Data recording pattern, the number of parts inspected per hour, downtime when new product is to be inspected, ease with which the method can be used, advantages and disadvantages of all the methods were also observed.
The processes are discussed in detail below.

3.1 Implementation of Gauges

Gauge, also spelled Gage , in manufacturing and engineering, a device used to determine, either directly or indirectly, whether a dimension is larger or smaller than another dimension that is used as a reference standard. Most gauges merely indicate whether the dimensions of the test object are sufficiently close to those of the standard i.e., whether they are in the range between set limits, known as the tolerance, for a particular object[4].

3.2 Automation of Measuring Instruments

Around eighty percent measurements of a product are linear measurements. Total length, diameter, step length, radius, depth, height are a few type of linear measurements. Vernier Caliper and Micrometer are mostly used to measure these linear dimensions from 0 to 150 mm. Most small scale industries produce small parts which fit in this range and hence, making them the ideal measuring instruments. But manual reading of these instruments takes up quite a bit of time and slows down the process. Digital vernier caliper and digital micrometer reduce the observing time considerably as a digital value is shown directly and does not require observation of alignment of vernier scale to calculate the measurement. Use of a data cable connected to a digital measuring instrument allows one to record data. More importantly, the use of a data cable, digital vernier caliper or micrometer, a computer and an excel sheet can be used as a perfect system to measure, record data and accept or reject parts within a very short time period. The programmed excel sheet tells the operator whether to accept or reject the part as soon as the digital output of the measuring instrument is fed into the excel sheet by a click of a button on the data cable. The operation of this system is shown in figure 1.

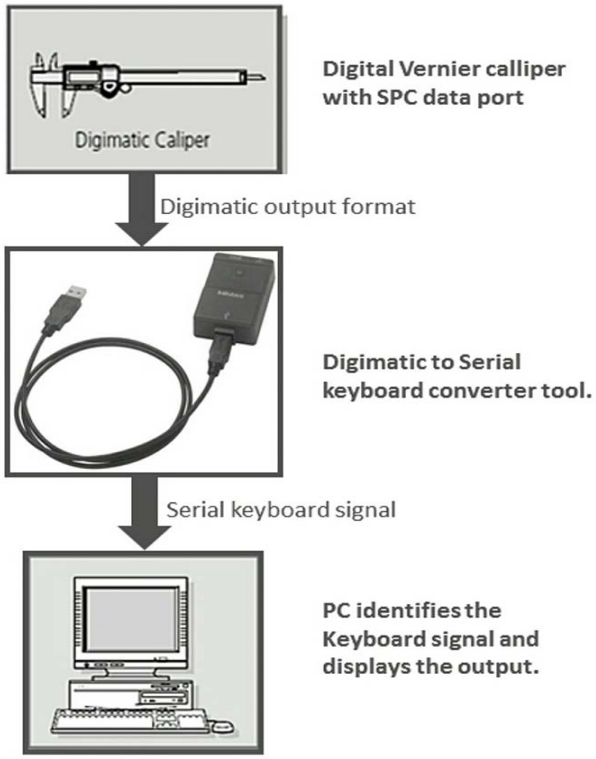

Figure 1: Digital Vernier Caliper System

4. Problem Definition

The time taken for old, manual-method quality inspection process of a product is relatively high, thus reducing either one, productivity or sample size for inspection. Sample size reduction in turn reduces AOQ (Acceptance of Quality). Hence, the main problem is the long time duration of the quality inspection process.

5. Results

5.1 Time Measurement Results

The results of the observations of the time measurements are:

1) Manual Inspection with a simple vernier caliper and hand written data recording requires an average time of 10 seconds per dimension reading.
2) Limit Gauges with hand-written data recording requires an average time of 6 seconds per dimension reading.
3) Digital vernier caliper system with self data recording process requires an average time of 4 seconds.

5.2 Advantages and Disadvantages

The other observations made are classified as an advantage or a disadvantage of that method.

5.2.1. Gauges

The advantages of using gauges are:
(i)Simple process
(ii)Inspection time is relatively low
(iii)Low investment
(iv)Negligible training required for use

Although it has great advantages, there are a few disadvantages which are of serious concern:
(i)Every dimension requires a different gauge
(ii)Wear out is relatively faster.
(iii)Actual dimension cannot be known. Only its acceptance or rejection can be found.
(iv)Data recording of dimensions not possible.

Although gauges speed up the inspection process, they tend to increase the financial investment with the increase in the variety of products and the number of dimensions per object, as every dimension requires a different specific gauge. Every time a product is changed on the inspection table or line, the setup of gauges changes and results in down time. The gauges have to be calibrated every month or two as the wear out is relatively fast which in turn increases the costing. The cost of a gauge depends upon the size, quality, accuracy and precision of its measurement. An average Go No-Go gauge set measuring about 30 mm of length or diameter costs around 5000 rupees. If we consider a minimum of 10 products with 3 dimensions each, the cost of the complete sets of gauges will be about 150,000 rupees with an additional maintenance cost of calibration per month. This seems to be a heavy investment with add on costs per month. Therefore, a careful decision has to be taken keeping in mind of a long term investment.

5.2.2 Digital Vernier Caliper System

The advantages of using the digital measuring instrument with a digital cable and a computer are:
1) Easy Process to use
2) Inspection time is very low
3) Low investment
4) All the linear dimensions requires the same instrument.
5) Actual dimension and its acceptance or rejection is known.
6) Data recording is possible.

Although it requires some initial training to use this system, its results are overwhelming. The digital vernier caliper plus the data cable costs around 15,000 and a simple desktop costs around 15,000, which sums up to 30,000 rupees which is considerably low than the cost of gauges. The time required for inspection processes with data recording and decision making by digital vernier caliper with a computer is less than half of the manual inspection with simple vernier caliper.

6. Conclusion

The results achieved clarified all the doubts of the management committee of the industry and pin pointed out the digital vernier caliper system as the obvious choice. The comparison depicts all the advantages of the digital vernier caliper system over the other methods and stands out tall as a clear winner. The digital vernier caliper system is cheaper, with less maintenance issues, having complete data recording capability and the fastest decision taking system which reduces the time required for inspection process by more than half of the manual inspection. Although the time required for inspection process with gauges is comparable with the digital vernier caliper system, the downtime due to changing of products for inspection and its relatively high cost makes it a less opted choice as compared to the digital vernier caliper system. The digital vernier caliper system increased the sample size of inspection per lot to double as the inspection time was halved. In other words, the productivity of the inspection process increased by a considerable amount.

For complex products having linear as well as other characteristics like threading, taper, etc, we can use a combined digital vernier caliper system with specific gauges required for characteristics other than linear dimensions. These characteristics can be introduced in the excel sheet and the acceptance or rejection can be entered manually as 'A' or 'R' respectively.

7. Future Scope

There will be a few micro and small scale industries where employees on the shop floor may not have the knowledge to operate a computer. This would create the basic problem of operating the digital vernier caliper system as the computer is one of the most important parts of the system which records data and takes decisions. The computer is also used to select the product of which the inspection process is to be carried out. Hence a system should be developed where in the use of the computer will be replaced by a simple input device paired with a microcontroller and a decision displaying system. The input device will be used to select the product of which the inspection will be carried out with simple numerical inputs. The software installed microcontroller with memory to store tolerance values will take a decision whether the measured value is acceptable or not. The lighting system involving a green and a red LED will display the decision of acceptance or rejection respectively. The design of the system is illustrated below in figure 2.

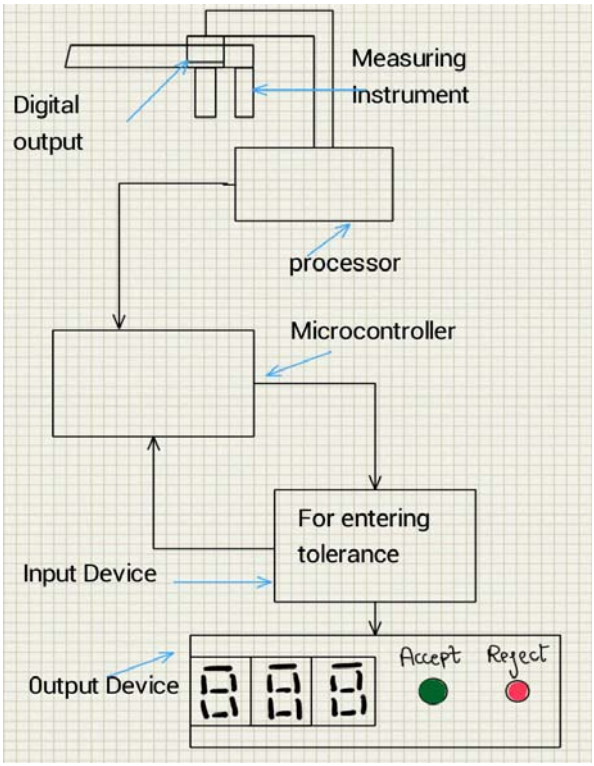

Figure 2: Digital Vernier Caliper System without a computer

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