

Need for Standardization of Manual Inspection in Small and Medium-Scale Manufacturing Industries

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Abstract—In the field of production, characterization of surface roughness plays a vital role in assessing the quality of a manufactured product. The defined parameters for this assessment, each, have their own drawbacks in describing a profile surface. From the purview of small-scale and medium-scale industries, an increase in time spent for manual inspection of a product for various parameters adds to the cost of the product. In order to reduce this, a uniform and established standard is necessary for quantifying a profile of a manufactured product. The inspection procedure in the small and medium-scale manufacturing units at Jigani Industrial area, Bangalore, was observed. The parameters currently in use in those industries are described in the paper and a change in the inspection method is proposed.

Keywords—Efficiency of quality assessment, areal profiling technique, manufacturing, standardization, Surface Roughness Characterization.

I. INTRODUCTION

MANUFACTURING industries today produce a variety of products which have various functions. These functions need to be considered when inspecting the surface profile of the final goods. Quantities of a surface aid or hinder the function of the finished product. The two basic quantities viz., roughness and wavelength play a major role in determining the suitability of the manufactured product for a particular job. For instance, a functional parameter that measures the roughness- Fluid Retention index (S_{ci}) indicates the amount of fluid that the surface can retain. If the value of this parameter is high, it indicates that the product is suitable for functions which necessitate easy dissipation of heat through lubrication [1].

There are two textures of a surface that need to be assessed in order to assert the usage of the product for a particular function. While the primary texture of a surface (texture obtained as a result of the rupture of the product surface by the tool) can be advantageous, the secondary texture (caused by wear, vibrations and defects) needs to be avoided or, at least earmarked during inspection [2]. Not all parameters need to be quantified during this inspection, but only a few that are essential for the product and the function in question. However, the inspection procedure lacks a standardized approach since the process is carried out manually and few basic roughness parameters are considered regardless of the function of the product. Moreover, the products manufactured for different functions at the site are inspected in a similar method and the same parameters are quantified for each

product. Hence, the quality of the finished product cannot be assessed properly since its function is not taken into consideration while inspecting.

This approach needs to be rectified and standard procedures must be employed in order to minimize the cost and ensure feasibility. Although close-to ideal standards have been achieved using computers and technological advancements that require almost no human interference, it is necessary to work towards similar standards for small industries wherein the usage of computers for quantification of a surface profile is not economically viable [2].

II. SURFACE ROUGHNESS PARAMETERS

The parameters used in tribology to measure surface roughness can be broadly classified into 2-D and 3-D parameters. While 2-D parameters are easily determined through different techniques, they provide limited information about the profile. 3-D parameters, on the other hand, are much harder to determine but at the same time provide a much accurate detail about the specimen surface. In all mass-production inspections, 2-D parameters are preferred over 3-D parameters in order to maintain economic viability. The 2-D or 3-D parameters can be classified as shown (Table I) [3]-[5].

TABLE I
CLASSIFICATION OF 2-D OR 3-D PARAMETERS

Types	Definition
Amplitude Parameters	They indicate the vertical characteristics of the surface profile.
Spatial Parameters	They indicate the horizontal variations and the spacing characteristics of the surface profile.
Hybrid Parameters	They are a combination of amplitude and spacing and are dependent on them.
Functional Parameters	They help determine a particular and unique aspect of the profile.

Each of the four categories of surface parameters contains numerous parameters. These parameters find use in scientific research and only a few of them are utilized for assessing quality in mass production. In mass production, a method called the *areal profiling technique* is utilized. Here, one particular part of the surface is scanned using profiling methods (contact or non-contact methods) and an average is taken throughout the surface. There are three typical area techniques in practice viz., ultrasonic scattering, optical scattering and areal capacitance probe [4]. The information is processed by a computer and results can be obtained with optional extension of the profile in 3-dimensions (a computer generated and approximated 3-D profile). However, the use of computers is not feasible in small or medium-scale industries,

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necessitating standard procedures in manual inspection for assessing the quality of the surface of a manufactured product based on their function.

Among the surface roughness parameters used in mass production, only a few are capable of being practically employed in small or medium-scale industries. In the industries at Jigani the following parameters are used (Table II). Profiling devices or stylus instruments are used instead of high-tech instruments or computers to measure these roughness parameters.

III. FACTORS AFFECTING EFFICIENCY

The efficiency of assessment of quality is influenced by various factors (Fig. 1) [6]. As represented in the Ishikawa diagram, the four prime reasons need to be tackled in order to ensure effective quality assessment. Change in the overall

perspective of manual inspection must be introduced without an addition in equipment, labor, cost or time. Clearly, the factor to be targeted is the training of workforce. Considering the function that the product must serve, a standard method of inspection is to be established and the labor is to be trained with the same.

The factor that greatly determines the efficiency of assessment in Industries at Jigani or, in general, any small or medium-scale manufacturing industry, is the requirement of quality for a particular product. Any change introduced in the system is to be supported by a reason irrespective of the advantages that it brings to the plant. Improvement of quality that ensures longevity of the product and overall improvement of efficiency which, in the long run, would help the industry economically are the reasons that form the premise for the proposed changes.

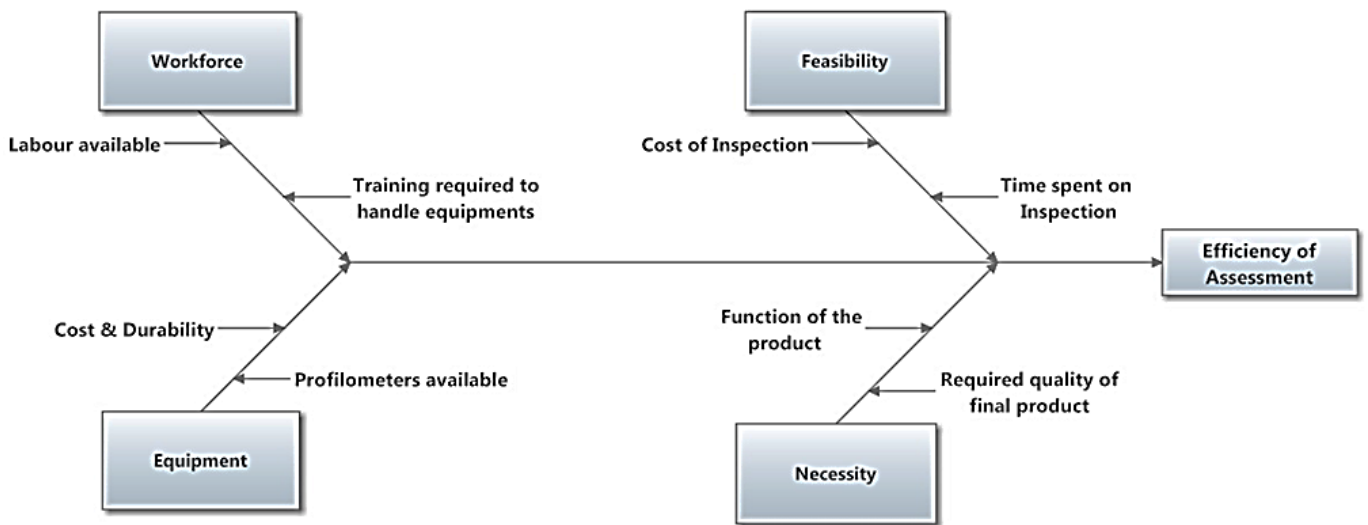


Fig. 1 Ishikawa diagram of factors affecting efficiency of assessment

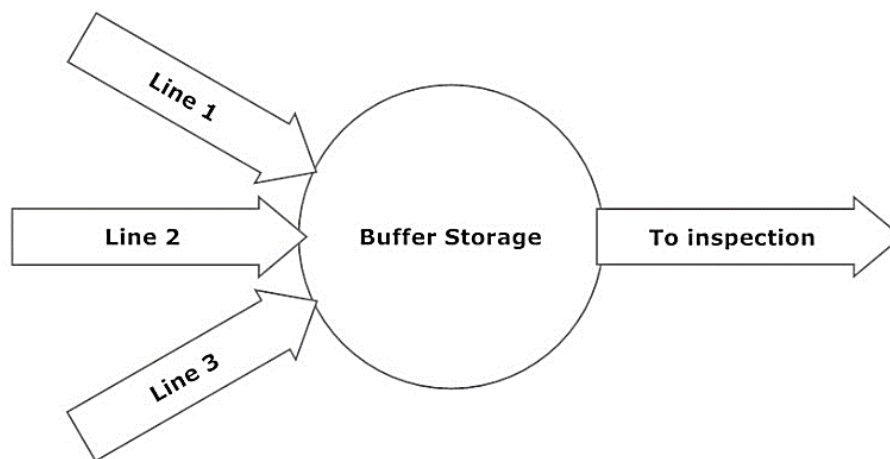


Fig. 2 Buffer systems in use in the industries at Jigani

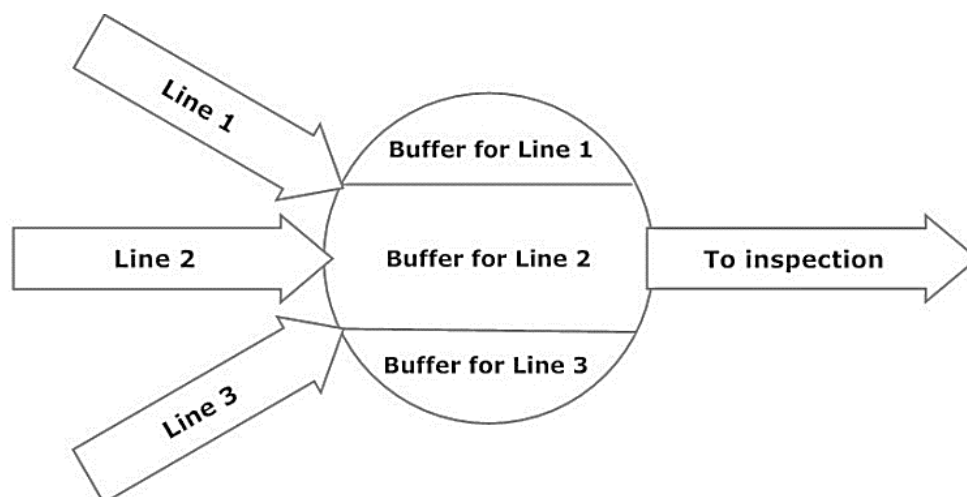


Fig. 3 Proposed change in buffer system preceding inspection

TABLE II
 ROUGHNESS PARAMETERS USED IN THE INDUSTRIES AT JIGANI

Symbol	Parameter	Explanation
R_a	Arithmetic Height Parameter	Avg. of absolute deviations in surface irregularities from the mean line.
R_q	RMS Averaging Parameter	The root-mean-square of the value of the parameter R_a .
R_z	Ten-Point Height Parameter	Avg. of the sum of five highest peaks and five lowest valleys.
R_t	Maximum peak-to-valley height	The distance between the peaks and the valleys.
S_m	Mean Spacing	Avg. spacing between peaks at the mean line of the profile.
HSC	High Spot Count	Measure of the number of crossings of the profile through the mean line
S_f	Stepness factor	The ratio of the arithmetic height to the mean spacing parameter of the profile.

All parameters have been defined with respect to a standard evaluation (or sampling) length.

IV. PROPOSED CHANGES

A. Changes in the Procedure

The *process-oriented inspection* model that prevails in small and medium-scale industries at Jigani is to be revised with an approach that would ensure that the surface of a finished good is inspected for the purpose that it must serve. For example, a painted metallic part is to be checked for R_p , which would indicate if there is a region where the metallic part has not been coated with paint. Checking for the R_p parameter would make sure that the region of unpainted metal is not subjected to rust, thus improving the longevity of the product. Thus, standards of manual inspection must be introduced *product-wise* within an industry.

B. Changes in the System

In the industries at Jigani, the Buffer preceding the inspection station is one that receives products from multiple lines onto a single line (Fig. 2). Hence, the manual inspection procedure followed is similar for all the products. Consequently, if a new procedure must be introduced, it should also make room for the current situation prevailing at the site.

In order to introduce a new *product oriented inspection* model in the industry without drastic changes in cost or equipment, a simple buffer sorting technique can be employed (Fig. 3). This sorting technique essentially consists of bifurcation of the products received from different lines. This

changes the successive stations into a *batch-wise configuration*. Consequently, inspection can be carried out product-wise. Thus, an introduced standard procedure in product oriented inspection process can be implemented on a plant level.

V. CONCLUSION

Based on the observations of the working of manual inspection in the industries at Jigani, it is evident that inspection needs to be product-oriented and not process-oriented. Also, since inspection is not a value adding process, it is essential to reduce the capital spent on the same. Nonetheless, quality assessment must be made for a product based on the requirement of the consumer.

These product specific changes proposed in the paper can be achieved in the small and medium-scale units of Jigani industrial area with employee training and awareness programs. Manufacturers can employ specific standards of inspection for different types of products manufactured. This is to be done without drastic changes of the factors mentioned in the Ishikawa diagram. If such a standard is achieved, it would aid in the improvement of quality and overall efficiency of the plant.

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