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Measurement 33 (2003) 179–187

Measurement

www.elsevier.com/locate/measurement

New developments in fast 3D-surface quality control

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Abstract

Inspection is the process of determining if a product deviates from a given set of specifications. Fast inspection usually involves measurement of specific part features such as assembly integrity, geometric dimensions and surface finish. It is a quality control task, but is distinguished from testing tasks. The visual inspection of 3D parts (car body parts) is a special task within manufacturing that has been automated at a comparatively slow pace up to this time. Different optical methods, applied for 3D measuring at microscopic and macroscopic levels of sheet metal parts, based on the projected fringes method (PFM), electronic speckle interferometry (ESPI), the structured-lighting reflection technique (SLRT), white-light interferometry (WLI) and also SEM-, AFM- and laser scanning methods (LSM) will be discussed. In addition, stylus instruments and also colorimeter measurements are included. The presentation closes with the advantages and disadvantages of different contemporary intelligent methods for car body inspections: neural net based classification, fractal analysis and wavelet transformation.

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Keywords: Inspection; Surface, Optical methods, Intelligent interpretation

1. Introduction

In different companies Quality Assurance policy is established in order to guarantee the best quality products and technical support for its clients. In this way, in-process inspections must cover all levels of production to meet the requirements of ISO 9000.

The surface of a solid is that part of the solid that represents the boundaries between the solid body and its environment. Surfaces as physical entities possess many attributes, geometry being one of them. Surface geometry by nature is three-dimensional and the detailed features are termed topography. In engineer-

ing, topography represents the main external features of a surface.

Surface topography is, therefore, significant for surface performance and the importance of surface topography measurement as a means of functional analysis and prediction is indisputable. Engineering surfaces are created in various ways, typically by forming, surface treatment and coating. Surface topography modification is therefore performed by material removal, transformation or addition. Mostly a combination of various forming, treatment and coating operations are employed to produce surfaces with characteristics that are desirable for a particular application. Each surface generation process produces surface topography characteristic of the process and process variables used. Surface topography, therefore, contains signatures of the surface

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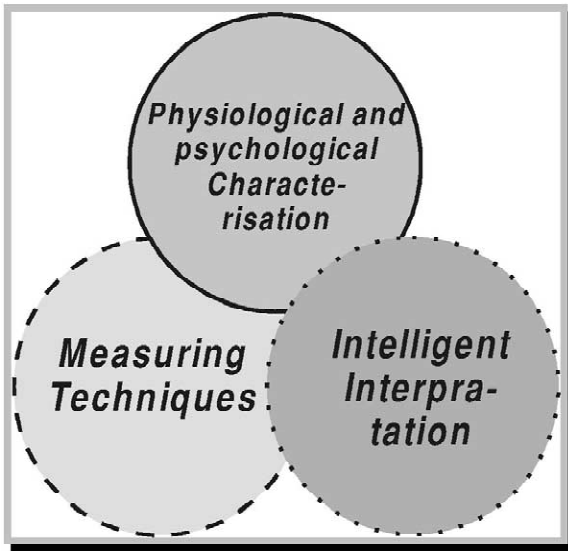


Fig. 1. Three basics of a surface characterisation [1].

generation process and as such can be used to diagnose, monitor and control the manufacturing

process. In an engineering sense, the ultimate objective of surface topography measurement, as a means of control and knowledge, is to establish a correspondence between an engineering surface phenomenon (e.g. wear, chatter, etc.) and its topographical characteristics (e.g. bearing area and oil retention volume, waviness power and periodicity, etc.). Surface topography measurement, therefore, serves as a vital link between manufacturing, functional performance analysis and prediction, and surface design. The relationships between surface design, function, manufacturing and assessment based on the measuring techniques, the physical characterisation and intelligent interpretation are schematically shown in Fig. 1. It is well known that the geometrical topography of tools and sheet metal parts depend on their manufacturing conditions. On the other hand the functional performance of the 3D-geometry and the quality is strongly related to the geometrical characteristics of the surface topography. Additionally the demands of high productivity manufacturing require that advanced processes control the balance between functional properties, 3D-topography and the surface characterisation.

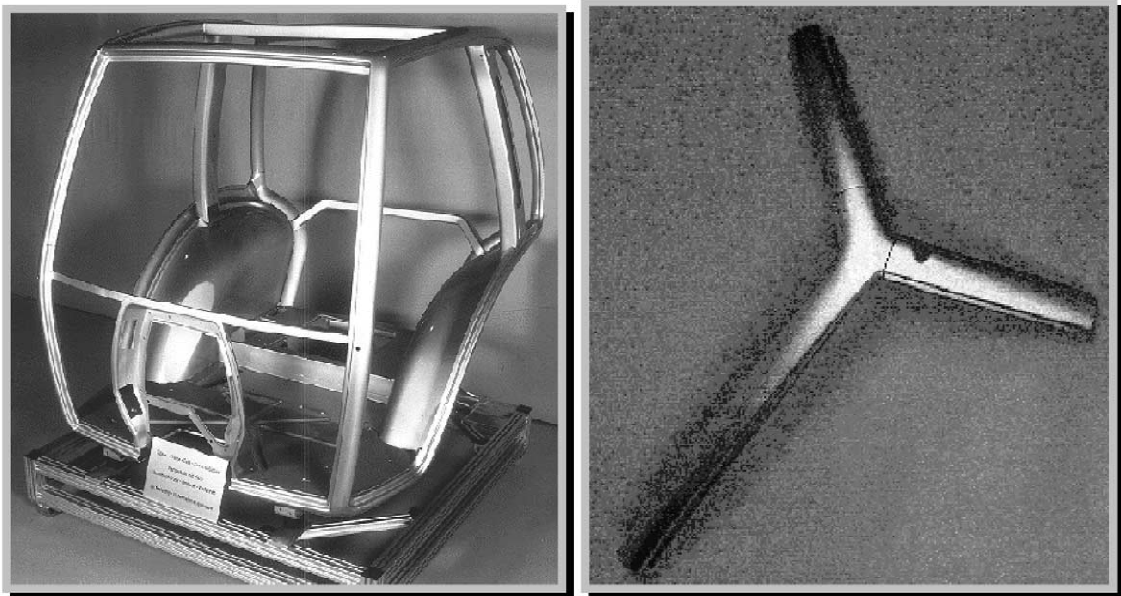


Fig. 2. Space frame cabin and a detail (Source: Dr. Meleghy, Hydroforming).

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