

Automotive Engine Metrology

Salah H. R. Ali



"Automotive Engine Metrology is an advanced and excellent work on precise and accurate two- and three-dimensional measurement techniques for the surface metrology of industrial equipment, engine inner surface quality evaluation, and fault diagnosis."

Prof. Hassan H. Dadoura
Helwan University, Egypt

"This book excellently illustrates the interrelation between the fields of dimensional metrology and automotive engineering. I strongly recommend the book."

Prof. Monir M. Koura
Ain Shams University, Egypt

Metrology has garnered a great deal of scientific interest in the recent decades owing to its unique advanced soft engineering techniques in design and diagnostics. Used in a variety of scientific applications, these techniques are now widely regarded as safer, more efficient, and more effective than the traditional ones.

This book compiles and details the cutting-edge research in science and engineering from the Egyptian Metrology Institute (National Institute for Standards), under the umbrella of the Egyptian Ministry of Higher Education and Scientific Research, which is currently revolutionizing advanced dimensional techniques through the development of coordinate and surface metrology for accurate and precise engineering. Authored by Prof. Salah H. R. Ali, a prominent researcher in micro- and nanotechnology and automotive metrology, this book will appeal to anyone involved in dimensional metrology, measurement strategies, accurate and precise measurement science, coordinate metrology, CMM error separation, CMM verification, Talysron accuracy, new and overall engine efficiency, warm-up engine diagnosis, or manufacturing quality of automotive engine research in the area of engine machining and coating surface.



Salah H. R. Ali is professor and head of the Engineering and Surface Metrology Department, National Institute for Standards, Egypt. A prominent automotive metrology researcher, he obtained his BSc and MSc in automotive engineering from Helwan University and his PhD in mechanical design and production engineering from Cairo University in 2003. He teaches undergraduate and postgraduate (PhD, MSc, and MEng) students and is an academic advisor for several MSc and PhD students at various universities. Prof. Ali has

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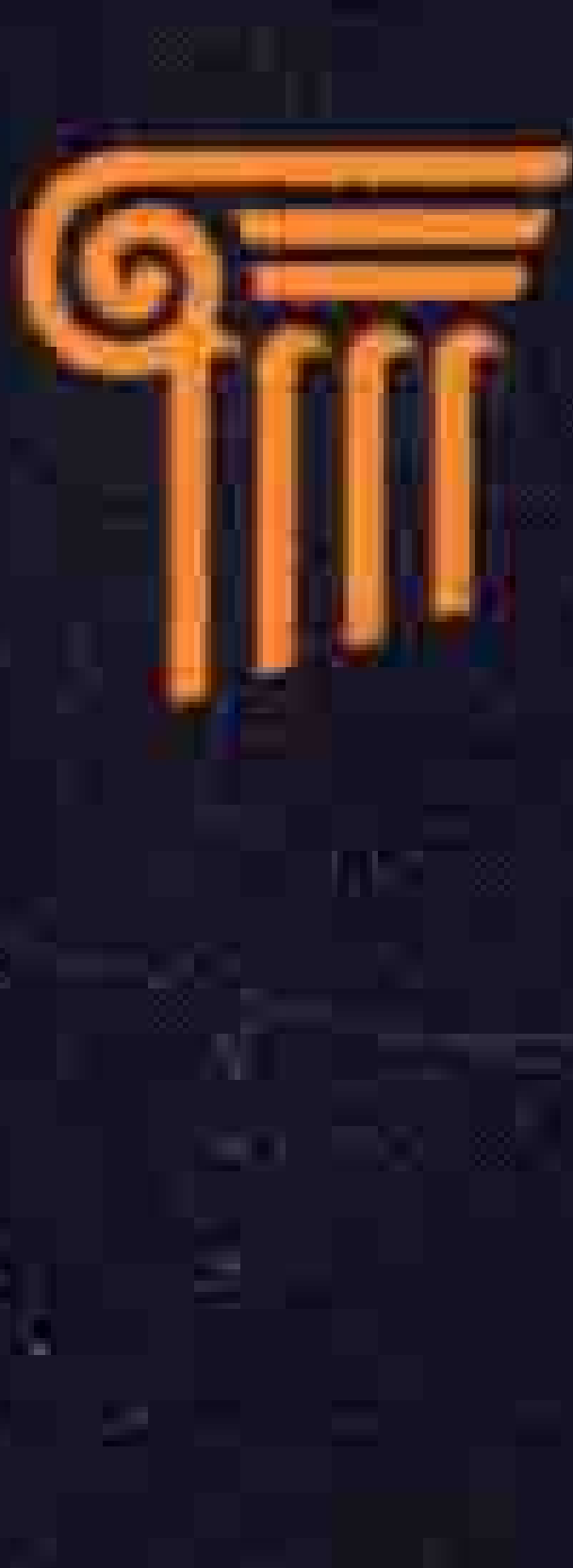
PAN STANFORD PUBLISHING

www.panstanford.com



Autonomous Engine Electrology

Ali



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PAN STANFORD  PUBLISHING

Published by

Pan Stanford Publishing Pte. Ltd.
Penthouse Level, Suntec Tower 3
8 Temasek Boulevard
Singapore 038988

Email: editorial@panstanford.com

Web: www.panstanford.com

British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library.

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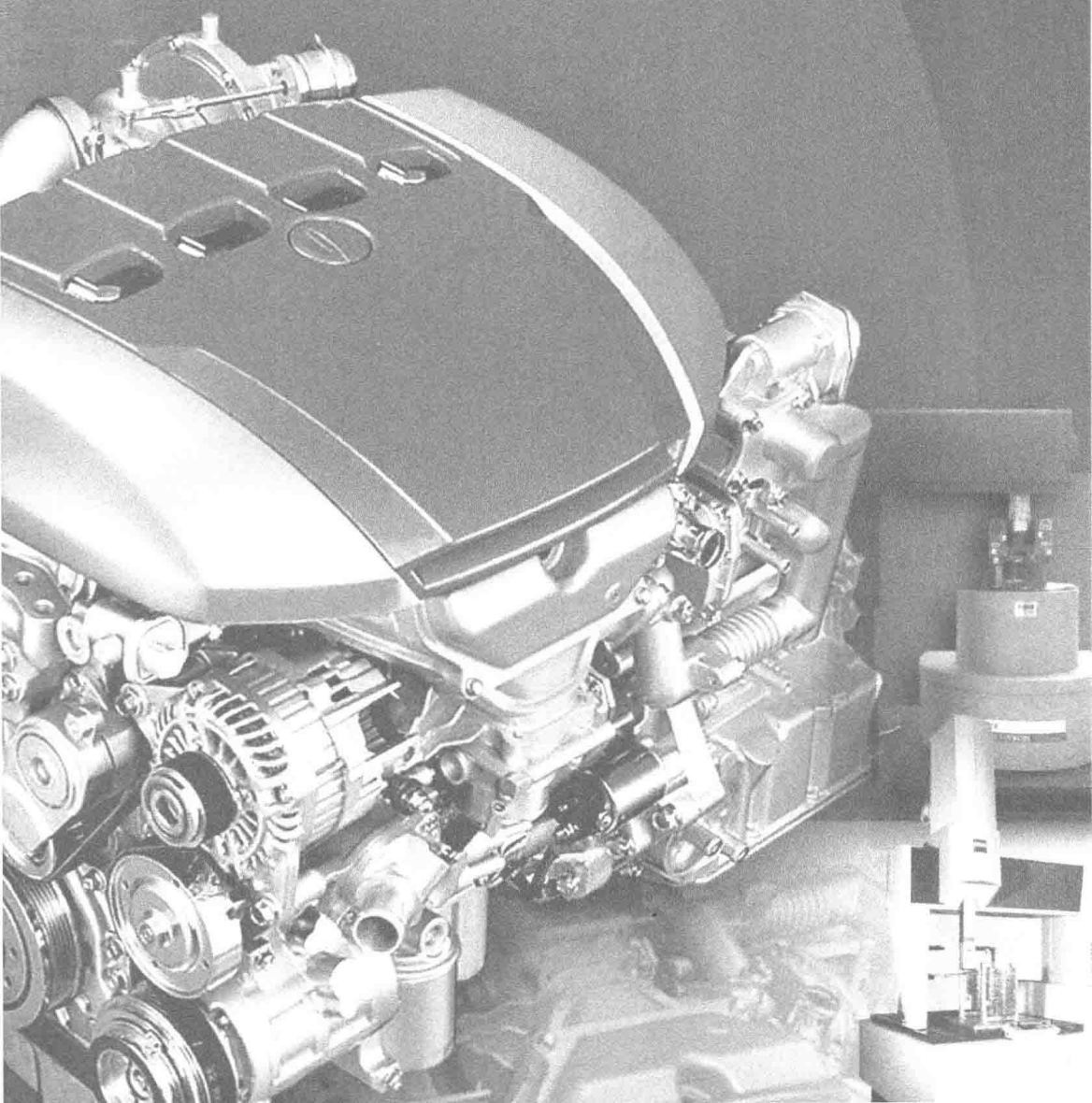
ISBN 978-981-4669-52-8 (Hardcover)

ISBN 978-1-315-36484-1 (eBook)

Printed by CPI Group (UK) Ltd, Croydon, CR0 4YY

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Automotive Engine Metrology



To Egypt and the World

To the soul of my parents, my mother, Hakemah Ahmad El-Banna, and my father, Hamed Ramadan Ali

To my respected professors, and teachers

To my lovely wife, Hayam, our son, Amr, and our daughter, Maryam

To all those who helped me in my career and to my colleagues at the National Institute for Standards, the Academy of Scientific Research and Technology, and the Ministry of Higher Education and Scientific Research in Egypt

To my postgraduate and undergraduate students, production and quality engineers, automotive engineers, metrology engineers, each researcher and science student, and all interested

Salah H. R. Ali

Preface

Advanced soft metrology techniques play an important role in improving the *quality* and *function* of automotive engines with regard to both manufacturing and diagnostic processes. Advanced accurate and precise measurement techniques are based on two fundamental approaches: hard measurement techniques and soft measurement techniques. Advanced soft computing measurement techniques include a coordinate measuring machine (CMM), Talyrond roundness tester, surface roughness device, interferometric methods, confocal optical microscopy, scanning probe microscopy, and computed tomography technique at the micro- and nanometer scales. Now, utilizing the CMM or the Talyrond machine is a challenge for advanced coordinate metrology in modern engineering applications, especially in automotive and aerospace industries. Deviation from dimensional tolerance or geometrical features can produce a number of engineering problems, vibration, frictional wear, noise, material fatigue, and failure. The basic function of the CMM is to measure the actual dimension and geometrical shape of an object according to the ISO and evaluate the collected data using the metrological aspects of size, form, location, and orientation.

In this book, we focus on advanced coordinate measurement machines and their performance with respect to accurate and precise measurements for automotive engine metrology. The book is organized into six parts. The first part presents the general introduction, the objective of the book, and its usefulness for academic scientists and professional and general readers. The second part introduces the important industrial subject of advanced soft measurement techniques for dimensional and surface metrology in micro- and nanometer scales. The third part discusses the performance and error analysis methods of the CMM as a new common technique for dimensional and surface metrology in the industry. The fourth part studies error analysis

and roundness determination using the Talyrond technique. The fifth part discusses the inspection and diagnosis of new, overhauled, and worn-out automotive engines using the CMM technique. It also discusses the applications of surface metrology in quality control for automotive engines. New technologies for engine coating and surface characterization are also presented. The last part, Part 6, discusses the developments in the field and future prospects.

It is hoped that the book will encourage the development of techniques in instrumentation metrology for automotive engines and strengthen readers' understanding of the importance of metrology in automotive engines.

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April 2017

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