Book Review

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Tribology for Engineers: A Practical Guide
by: J. Paulo Davim
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> "Even though we can't compute a coefficient of friction, we think we understand friction, 'more or less'." Richard Feynman (1957)

Friction and lubrication are well-known from the ancient days. Prehistoric man who produced fire by rubbing two sticks together was in fact the first tribologist who used friction for practical needs. Reduction of friction with the aid of oils followed with the advent of the wheel. Thus, it is no wonder that people wanted to study friction phenomena since time immemorial but it was only during the second millennium CE, with the intensive progress in mechanics, that the scientific foundation of tribology was laid. Beginning with Leonardo da Vinci, more than five centuries ago, friction and the attendant wear of materials have been the object of systematic interest and study, in view of the significant energy and material losses associated with friction. Lubrication by different agents was resorted to for reducing losses and increasing the lifetime of materials and machines. Accordingly, tribology represents today an outstanding branch of science, technology, and manufacturing. Unfortunately, in spite of significant investments and scientific efforts we cannot say that all problems have been solved by now such was the case in the middle of the 20th century (see epigraph) and such it is at the beginning of the current century. Interest in tribology is acquiring new impetus with its branching out in new directions such as bio- and nano-technologies, and also with the advent of new solutions in some classical applications – e.g., surface topography, thermodynamic lubrication and friction of roughened surfaces, machine friction diagnostics, numerical calculations, and others. Considerable attention is paid today to teaching of students and to training of qualified personnel capable of applying the accumulated knowledge. This is the purpose of the reviewed book that introduces students and engineers to classical and modern problems of tribology in simple form and on a high level.

The book is written by leading authorities (brief biographies of whom preface the book) from four continents, guiding the readers to such important areas of tribology as:

- topography of surfaces
- dry friction and attendant wear

- some aspects of hydrodynamic lubrication of roughened surfaces
- micro- and nano-tribology
- bio- and medical tribology
- tribology in manufacturing.

The material is presented in the six chapters, each chapter provided with an abstract giving a brief description of its content. These abstracts are given below.

The first chapter discusses the approaches to solid topography characterisation including the surface layers, roughness parameters and statistical aspects. The multiscale characterisation of surface topography in terms of fractal analysis, Fourier transform and wavelet transformation is also considered. The measurement techniques for surface roughness evaluation are discussed in terms of surface profilometry, optical methods and electron microscopy including the advanced techniques like scanning tunnelling microscopy and atomic force microscopy. The second chapter introduces dry friction and wear for sliding contacts. The concepts of friction and wear, their corresponding coefficients and their main mechanisms are described, including stick-slip effects, adhesion and ploughing. Adhesive, abrasive, erosive and erosive-corrosive wear mechanisms are described. Friction-wear relationships are discussed and wear maps are introduced. The third chapter introduces the basics of hydrodynamic lubrication theory and highlights its application to some machine parts with un-roughened (slider and cylindrical journal bearings) and roughened surfaces (parallel parts in relative motion). It first presents a theoretical analysis and results for two-dimensional sinusoidal and triangular wave roughened surfaces. The fourth chapter discusses the micro/nanosliding of materials in terms of adhesion, wear, friction and lubrication, using both experimental and theoretical methods such as SFA, STM, AFM, FFM and molecular dynamics simulation. It focuses on understanding some characteristic phenomena associated with micro/nano-tribology such as the scale effect of friction and wear deformation transition on no-wear, adhesion, ploughing and cutting regimes. The fifth chapter focuses on tribology in manufacturing processes from the viewpoint of the fundamentals of sliding friction in those processes and the use of lubricants to control friction in manufacturing processes such as machining, drawing, rolling, extrusion, abrasive process and processing at the micro- and nanoscales. It is assumed that this chapter will serve as a focal point for engineers concerned with the role of tribology in maximising productivity and reducing costs. The sixth chapter highlights some aspects of bio- and medical tribology. Bio-tribology has achieved great prominence in the last few years as a new interdisciplinary field in which contributions from engineers, medical doctors, biologists, chemists, and physicists are coordinated. The chapter focuses on hip and knee prosthesis. The main purpose of a joint prosthesis is pain relief and restoration of joint function. To do this, a suitable material that has an infinite life is desirable. Material selection and component design are important factors in the performance and durability of total joint replacements but, unfortunately, wear of hip and knee bearings exists and is a significant clinical problem. There is a need not only for more wear-resistant materials but also for concomitant improvements in the design and manufacture of the implant and the operative techniques to minimise the occurrence of wear. Wear simulation is an essential pre-clinical method for predicting the middle- and long-term clinical wear behaviour of prostheses, and one of the most important aspects of wear testing is simulation of actual wear conditions.

As can be seen the book covers many important but certainly not all problems of such a large field as modern tribology, but that permitted creation of a compact book and is perhaps additional advantage.

As a whole the book contains interesting, practically useful material perfectly tallied by the editor, who successfully organised a useful and timely guide that is equally necessary for under- and post-graduate students, tribo-engineers, material specialists, physics, and engineers specialising in nano-, bio-, and medical areas.

In addition, it is impossible not to note the excellent printing and design quality of the book with graphical materials having so high resolution that some of the white-black images provide every nuance of its coloured originals; in short, the book is a pleasure to hold.

To summarise all the above, I foresee a rather good market, with the appropriate publicity and interest for a wide audience of graduate and post graduate students, engineers and scientists in various areas, e.g., mechanics, materials, physics, biology, medicine, etc. I think the book can be also serve as a useful guide for professionals and engineers in many tribology-related industries.