# BOOK REVIEW

*High-Conformal Gearing*: *Kinematics and Geometry*, by Stephen P. Radzevich, CRS Press, Taylor & Francis Group, Boca Raton 2016, xxiv + 332pp, ISBN 978-1-4987-3918-4.

The present book is devoted entirely to the kinematics and geometry of conformal and high-conformal gearing. The important topics like gear accuracy, gear loading, gear wear, gear lubricating, vibration generation, and noise excitation, etc., are not addressed in this book.

Specifically, the *Introduction*, underline the main problem discussed in the book namely, transmitting a rotation smoothly from a driving shaft with the highest possible power density to a driven shaft. The importance of this subject requires the necessity of gear boxes of the smallest possible size that are capable of transmitting the highest possible power. The historical background and the organization of the book is given.

Chapter one - *A Brief Overview of Conformal Gearing*: *State of the Art*, begins with a terse consideration of the necessary and sufficient criteria that the geometrically accurate (ideal) gearing needs to meet. Ancient designs of conformal gearing, that is, pre-Leonardo da Vinci (1493) designs are briefly discussed here. The designs of conformal gearing proposed in the beginning of the twentieth century are also considered. Weakness of these designs is mostly because they were developed based only on common sense and not on scientific theory of gearing as such a theory was not known at this time. This is the reason all the proposed designs of conformal gearings, including Wildhaber's helical gearing to fail. Fortunately, in 1954 Novikov gearing - a perfect example of conformal gearing, is invented. At the end of this chapter, the features of tooth flank generation in Novikov gearing are considered.

In Chapter two - *Conditions for Transmitting a Rotation Smoothly*, the set of three necessary and sufficient conditions to transmit a rotation smoothly is established, namely: the condition of contact of the tooth flanks of the gear and the mating pinion, the condition of the conjugacy of the interacting tooth flanks, the condition of the equality of the base pitch of the gear, and the pinion of the operating base

pitch of the gear pair. This set is complemented by the requirement according to which the total contact ratio of the gear pair must be greater than one.

Chapter three - *Conformal Gearing*: *Novikov Gearing*, oriceeds with the analysis of the concept of the conformal gearing (of Novikov gearing) and evolve the concept of conformal gearing to the concept of high-conformal gearing. Novikov gearing, and more generally, conformal gearing can be constructed as a degenerate case of involute gearing when involute tooth profile is truncated, and only one point of the involute tooth profile is left. Novicov gearing is a type of helical gearing that has a zero transverse contact ratio. In this chapter, the essence of Novikov gearing is considered. Developed for parallel-axis gear trains, the concept proposed by Novikov may be used for design gear pairs featuring intersected axis gear pairs that have crossed axis of the rotations of gears. The transition from involute gearing to conformal (Novikov) parallel-axis gearing, as well as kinematics of parallel-axis gearing and the plane od action in parallel-axis gearing are considered. A procedure of constructing a boundary Novikov-circle of a conformal gear pair is outlined in this chapter. Possible tooth geometries in conformal gearing are described and it is payed attention to the tooth profile sliding in conformal (Novikov) gearing. The specific elements of the kinematics and geometry in conformal gearing are given since it differs from involute gearing or gearing if other designs. As an example, the calculation of design parameters of Novikov gear pair is given. Chapter three ends with a discussion of the configuration of interacting tooth flanks at the culminating point, and with the analysis of the local and global contact geometry of interacting tooth flanks.

Chapter four - *High-Conformal Gearing*, concerns a discussion which covers the contact geometry in conformal parallel-axis gearing and the accuracy requirements for the conformal parallel-axis gearing.

In Chapter five - *Contact Geometry of the Gear and the Mating Pinion Tooth Flanks*, a topic which is a corner stone in designing gearings with desirable performance is discussed in detail, namely: contact geometry of the gear and the mating pinion tooth flanks.

In Chapter six - *On the Impossibility to Cut Gears for Conformal and High-Conformal Gearings Using Generating* (*Continuously - Indexing*) *Machining Processes*, the infeasibility to cut gears for conformal and high-conformal gearing in generating gear machining process (by hobbing, shaping, shaving, worm, grinding, etc.) is proved. In this way, the reader can better understand the root cause of why almost all efforts undertaken to design, to manufacture, and to implement conformal gearings have failed.

Chapter seven - *Kinematics of Gear Pair*, a generalization to conformal and high-conformal gearing of other type (different from parallel-axis) is discussed. It is based on the fundamental analysis in the kinematics of gearing. A concept of vector representation of gear pair kinematics is presented, three different types of vector diagrams are constructed - vector diagrams of external spatial gear pairs, of internal spatial gear pairs, and vector-diagrams of generalized rack-type spatial gear pairs. At the end of this chapter, complementary vectors to the vector diagrams of gear pairs are briefly discussed and useful kinematic and geometric formulas along with the consideration of the tooth ratio of gear pair are proved.

In Chapters eight and nine, examples of the implementation of the classification of the vector diagrams of gear pairs can be found.

Chapter eight - *High-Conformal Intersected-Axis Gearing*, considers the kinematics of the instantaneous motion, the base cones, the path of contact and design parameters in high-conformal intersected-axis gearing.

Chapter nine - *High-Conformal Crossed-Axis Gearing*, is devoted analogically to the kinematics, the base cones, kinematics of the instantaneous relative motion, the path of contact and design parameters in high-conformal crossed-axis gearing.

The main scientific results obtained in the book are briefly outlined in the Conclusion. For the reader's convenience, a helpful glossary and index are given and as well as five appendices. The Appendix A is devoted on the concept of "Novikov Gearing", and brief sketches of the biographies of Mikhail Novikov (1915-1957) and Ernest Wildhaber (1893-1979) are given. The other Appendices explain the mathematics used in the book.

As the author points out, this book is intended to be used as a reference book as well as a textbook. This book is recommended to mechanical and manufacturing engineers involved in continuous processes improvement, researchers, and senior undergraduate and graduate students. The covered topics in the field of conformal and/or high-conformal gear pairs will help the readers in optimal design of gear pairs for high power density gear transmissions, and will meet the needs of the aerospace industry, the automotive industry, electric wind power stations, etc.

Clementina D. Mladenova
Institute of Mechanics
Bulgarian Academy of Sciences
Acad. G. Bonchev Str., Bl. 4
1113 Sofia, BULGARIA
e-mail: clem@imbm.bas.bg