Development of Gear Technology and Theory of Gearing

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Dr. Faydor. L. Litvin is director of the Gear Research Laboratory at the University of Illinois at Chicago. His research interests include the theory of gearing, application methods for the generation of gear tooth surfaces, the computerized simulation of meshing and bearing contact, the generation and design of new types of gears, and the computer controlled generation of surfaces.

Dr. Litvin's current research emphasizes the computerized design, generation and simulation of meshing and contact of aligned and misaligned gear drives. The primary goal of this work is the localization and stabilization of bearing contact as well as the reduction of transmission errors.

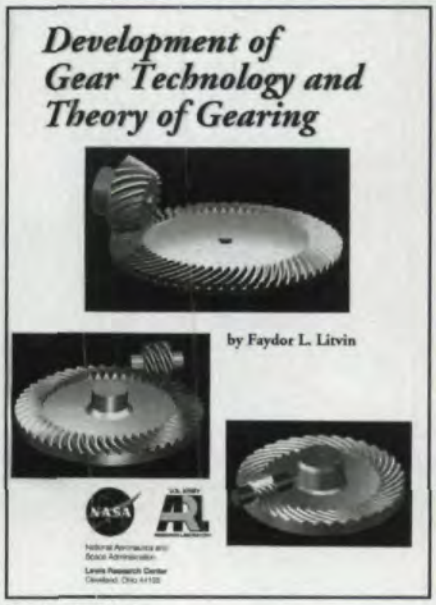
In a recent letter to *Gear Technology*, Dr. Litvin expressed his great appreciation for our review of his work. "The author is very gtrateful to the reviewers who have found time to read the book and introduce it to the readers of *Gear Technology*. The review is a keenly insightful piece that captures precisely what inspired the book's author to pay tribute to the Gear Pioneers.

"The author understands that due to the barrier caused by difficulties of the theory of gearing, differential geometry and kinematics, the audience for his book is limited. However, even difficult topics can be transferred to an engineering audience, if they are represented and discussed conceptually. Such a goal is the next one for the author, and he hopes to fulfill it in the near future."

EDITOR'S NOTE: *Gear Technology* is working with Dr. Litvin to develop an article that presents the theory of gearing from a conceptual standpoint. We hope to present the readers with a demonstration of some of the practical applications of the research in an upcoming issue.

I must admit that after thumbing through the pages of this relatively compact volume (113 pages, 8.5x11 format), I read its three chapters (theory of gearing, geometry and technology, and biographical history) from rear to front. It will become obvious later in this discussion why I encourage most gear engineers to adopt this same reading sequence!

While the main text (Chapters 1 and 2) provides an excellent summary of recent (and some not so recent) developments in gear tooth geometry and geometry modification, I found the last thirty pages (Chapter 3) most compelling. Here the author, through material gathered from first hand sources, presents an excellent biographical summary of the people, machines, and theories from all over the world that have influenced and, in many cases defined, the development of gear technology over the last 120 years.



Faydor L. Litvin,
NASA Reference Publication 1406,
Glenn Research Center, Cleveland OH 44135

As a gear engineer with more than a passing interest in the history of the subject, I found this treatment original in many aspects and thoroughly enjoyable to read. I found the author's own historical observations especially fascinating, some of which were, I would imagine, based on his own experience.

In one chilling example, the closure of the author's discussion of C. F. Ketov (a Russian professor of engineering who taught and wrote in the former Soviet Union during the early 1900s) reads "... as dean of the College of Mechanics and Machines, he was accused of resisting the policy of 'selection of personnel,' making his dismissal, if not his sudden death, inevitable. An ironic coincidence darkened the last day of his life when his request that a talented student be granted a position was declined because of the selection policy." After reading every word of the historical section, I found myself wishing for a more complete treatment, but one must recognize the space limitations of a book whose subject is gear technology and theory. Still, Chapter 3 puts the modern gear engineer's daily battles of budget, time, and research priorities in perspective. This section, alone, makes this book worth a read.

Chapter 1 begins with a review of basic principles of gear kinematics. Although highly mathematical in orientation, this section is well presented and interesting. While most practicing gear design engineers would seldom have the need for these fundamental underlying principles, they are valuable to both researchers and students. It is my belief, obviously shared by Dr. Litvin, that all gear engineers should be schooled in these basic principles to better understand the daily design tasks which form the bulk of their work. This presentation provides an excellent summary, which should be required reading for all aspiring, young gear engineers.

A detailed study of Chapter 1 certainly requires a thorough understanding of not only vectors but differential geometry as well. While the material is well presented, it will challenge all but the most mathematically oriented gear engineers. Still, this material can be very valuable and enlightening, even without a full understanding of the detailed mathematics involved. By following the general development of the equations, the interested reader can obtain a good appreciation for the nature of gear tooth contact and, more importantly, a better appreciation for the inherent complexity of gear mesh theory.

Chapter 2 is much more readable than Chapter 1. It is also of generally more interest and certainly more pertinence to the daily activities of most gear engineers. This treatment starts with a simple development of the theory of involute gearing and then moves rapidly to other gear tooth forms including face gears, cycloidal tooth forms, and worm gears.

The discussion of these various tooth forms also includes some detail related to the manufacturing methods and motions required to generate each. Unfortunately, a disproportionate amount of this detail is devoted to noninvolute forms, while needed emphasis on the various modifications frequently used for involute forms is treated somewhat superficially.

Overall, this volume has something to offer to most serious gear engineers. It has earned a place in my personal library of both current and historical gear literature. ○

The entire publication is available for free download at ftp://ftp-letrs.lerc.nasa.gov/LeTRS/reports/1997/RP-1406.pdf (Adobe Acrobat format).

Ray Drago
lives a dual life. He is a Senior Technical Fellow of the Boeing Company specializing in gear technology, and he is also Chief Engineer of Drive Systems Technology, Inc., a gear engineering consulting company which he founded in 1976.

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