

To: The AGMA Foundation

From: William D. Mark, Ph.D. (wdm6@psu.edu)

Date: February 25, 2009

Subject: *First Progress Report on the Project “Documentation of Technology to Enable Accurate Determination and Diagnosis of Gear Vibration/Noise Generation Caused by Gear Manufacturing Errors”*

Performance Period: 1 December 2008 – 25 February 2009

Most of my efforts on this project during the above-cited reporting period were devoted to completely reorganizing the subject material contained in the nine documents cited in the proposal, written by me, that form the basis for the proposed book. This is a total of 269 pages of dense technical developments and explanations.

My plan for the overall organization of the book is as follows. Detailed gear measurements (completely compatible with present-day dedicated CNC gear metrology equipment) are a requirement for implementation of the overall methodology. Thus, after a chapter on involute helical gears, my plan is to treat next the relevant gear measurement requirements necessary for implementation of the overall methodology. Following that, it will be shown how the rotational-harmonic *rms* manufacturing-error spectrum can be computed, and utilizing that spectrum, how the manufacturing-error pattern on the teeth causing any particular rotational harmonic (or group of rotational harmonics), specified by the user, can be computed. (This is a manufacturing-error diagnostic tool). Chapters explaining transmission error and computation of the manufacturing-error contributions to transmission error will then follow. This will fully explain how some rotational-harmonic spectrum contributions are very strongly attenuated by the meshing action of the teeth, while others may not be attenuated at all (ghost tones). The method for computing these attenuating effects will be documented. A full treatment of “sideband” generation also will be given, with an explanation of their causes. Many example computations will be included in this portion of the book. The later chapters will be devoted to detailed derivations of the material explained in the earlier chapters. (During this reporting period, I have completely reorganized, and simplified where possible, these derivations.)

My purpose in the above-described organization is to provide accessible explanations in the early chapters that will enable a reader to obtain a basic understanding of the material, and its usefulness, without getting bogged down in the detailed derivations, which will be fully documented in the later chapters. The essential gear

metrology aspects of the methodology, which alone are new and very useful, are placed as early as possible in the book. This overall effort has been a substantial reorganization of the already developed material.

The chapter on involute helical gearing has been written, and the treatment of gear metrology, required to implement the overall methodology, will be written next.

Anyone wishing to review what this overall methodology is capable of might consider reading the AGMA Technical Paper 01FTM6 “Performance-Based Gear-Error Inspection, Specification, and Manufacturing-Source Diagnostics” by W. D. Mark and C.P. Reagor (October, 2001).

I greatly appreciate the funding the AGMA Foundation has provided for carrying out this project.