245: Reverse Gear System Engineering – Why, When & How – (Avoiding Pitfalls …& *Litigation!*)

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COURSE INFORMATION

Course Description
Reverse engineering a gear system is a not too unusual task and in many, but not all, cases the process goes fairly well, thus it is easy to become complacent. It is important, however, to fully understand the process and the best practice procedure for reverse engineering a gear system. Failure to fully follow best practice can result, at best, in an unhappy gear user, but in the worst case it can lead to very expensive, time consuming and reputation damaging litigation.

We will discuss the basic types of reverse engineering projects (e.g. upgrading an existing system to increase power or extend operating life or improve noise level; replacing gear that has simply reached the end of its otherwise successful useful life; emergency, short term, interim gear replacement resulting from an unexpected failure; responding to a system that is not providing acceptable performance, etc.). The need for understanding the operation of the system in which the gears will be used, the conditions that led to the need for the project and especially, the specific nature of the failure that occurred, if that is the reason for the project, are key, often ignored, elements of the process.

In some cases, no drawings are available at all thus a design must be developed that will yield gears that provide equivalent load capacity, life, noise performance and smoothness of operation. This scenario will be discussed with recommended analyses resented. In other cases, where no drawings are available, the correct procedures to follow in developing a reverse engineered gear that truly meets the system requirements will be discussed in detail with cautionary procedures outlined.

The concept of applying the AVO (avoid verbal orders) process to the overall reverse engineering process will be discussed with fact based but names and identifying details eliminated case studies to emphasize the importance of this concept. The "amnesia" issue will also be addressed in this context. The author's experience in serving as an Expert Witness provides first-hand information that will aid in avoiding this aspect of a reverse engineering project completely…. if followed!

It is recommended that you spend a minimum of 1 hour reading and reviewing the material each day.

Course Rationale/Students Course Designed to Serve
Gear and gearbox design and manufacturing engineers, management and quality control engineers involved with design and manufacture of reverse engineered parts, especially where minimal or no original, detailed gear design information is available.

Learning Objectives:
- Recognize the detailed engineering and application understanding required to properly reverse engineer a gear

- Understand the difference between designing from scratch and designing to duplicate an existing part and its function
- Consider the reasons why reverse engineering an existing gear set, or, especially, a single gear can often considerably more difficult than designing a new gear or gear set from scratch
- Discuss the possibilities for misunderstanding, which are legion, between purchaser and supplier
- Address the need for all parties involved to agree regarding the purpose of the reverse engineering effort and the expected results and costs
- Apply an understanding of forensic analysis of gearbox failures to avoid simply duplicating the original failure
- Understand the difference between a temporary replacement and a duplicate of the original gear and the discussion and documentation required to avoid misunderstandings that can lead to litigation

Required Textbooks (Provided by MPMA)
MPMA's Reverse Gear System Engineering — Why, When, How & What − (Avoiding Pitfalls … & Litigation!) - a Practical Guide for the Design Engineer by Raymond J. Drago, PE

COURSE OUTLINE

I. Why is the gear being reverse engineered rather than replaced by OEM or to the OEM drawing?
II. What is the reason for the reverse engineering effort – unavailability or failure or poor performance of the original?
III. Who is the primary focus of the reverse effort, gear engineer or customer and?
IV. Understanding the need for communication between customer and supplier and the need for detailed documentation of expectations
V. Steps required to avoid the possibility of misunderstanding leading to litigation
VI. Discussion of the need to clearly define who owns the design including drawings and processing procedures which result from the reverse engineering effort
VII. Address the need for both purchaser and supplier to clearly understand exactly what the purchaser requires.
VIII. Address the difference that can occur between the purchaser's and designer's understanding of the rating and usage of the reverse engineered gears
IX. Guidance in developing a detailed reverse engineering plan that clearly addresses and documents the responsibilities and expectations of both purchaser and supplier (more difficult that most engineers recognize)
X. A real case study will be presented as an example of the importance of fully understanding and applying the Reverse Gear System Engineering process.

STUDENT FEEDBACK AND GRADING PROCEDURES

Assignments
A Pre-test and post-test are administered during this course. Immediate feedback is given, and the material is reviewed by the instructor.

COURSE MANAGEMENT

Weather Delays and Cancelations
We will communicate any cancellations, delays or other concerns for safety prior to class via email, voicemail, and/or text message. Please be sure that we have all pertinent contact information as you travel to your class location.

Attendance for Domestic and International Students
Please be mindful that these are short, accelerated courses. Attendance is extremely important. If you are going to be absent from any class day, please contact the course coordinator.

Plagiarism, Cheating and other types of Misconduct
Plagiarism[1], cheating and other types of misconduct are unacceptable.

Students with Disabilities
Students requiring assistance and accommodation should complete the Special Accommodation Request form and submit it to out Education inbox at education@motionpower.org. Or we can be reached by calling 703-684-0211.

Grievance Procedures
Students who have concerns about the class are encouraged to contact any Education Department staff at education@motionpower.org or by calling 703-684-0211.

Outline Changes
The instructor reserves the right to modify the outline during the course of the class.

LEARNING AND OTHER RESOURCES

Links for writing resources:

- grammar.ccc.commnet.edu/grammar
- www.merriam-webster.com

Links for Math resources:

- www.sosmath.com
- Khan Academy on www.youtube.com

Links for time management, study skills and note taking resources:

- www.mindtools.com
- www.testakingtips.com

Links for career resources:

- https://www.agma.org/newsroom/jobs/

Industry News:

- https://www.agma.org/newsroom/industry-news/

1 Plagiarism is defined as "the use or close imitation of the language and thoughts of another author and the representation of them as one's own original work."