

# A “Whodunnit?!” IN GEARBOX FAILURE

Forensics isn't just for tough-talking crime-busting scientists—most commonly found on your television; the tactic also holds the key to successful gearbox design and manufacture. At AGMA's Gearbox CSI: Forensic Analysis of Gear and Bearing Failures—Useful Tools for Optimizing Gearbox Design, find out just how to follow the integrated process of identifying gearbox failure and determining the conditions that lead to specific failures, in order to avoid future errors.

B-10 bearing life and basic gear service factor calculations may be the most well-known methods to predict gearbox failure, but upon forensic analysis, failures result from any number of contributing factors: design, fabrication, lubrication and the handling of gears and bearings. “If a failure is not properly addressed, the problem will continue to occur and will result in greater downtime and cost to the



Joe Lenski.



Ray Drago engages a student in discussion.

gearbox manufacturer,” says Raymond Drago, who presents the course along with colleague Joseph Lenski.

“The seminar will present methodologies that can be used to solve fatigue, scoring and wear problems,” Drago says. “Each failure discussed is also accompanied by a discussion of the actions taken to avoid a recurrence of the failure and to avoid trading the problem solved for one created by the solution.”

Primarily aimed towards gearbox designers, many other gear professionals can benefit from the seminar, including purchasers, specifiers and users who can learn how to get the most out of their gearboxes and help solve and do away with service problems. Gearbox maintenance people, overhaulers and operators who are often responsible for purchasing, maintaining and replacing gear systems will benefit by understanding the underlying causes of failure, which “is a crucial factor in the economical and long-lasting solution of problems that may occur in these very expensive [gearbox] systems,” Drago says. “Further, by understanding the specific nature of the failures and their causative agents, these operators are also better prepared to specify exactly

the gearbox systems that will operate well in their specific environment.”

Drago and Lenski have worked with each other for over 40 years in the gear industry spanning an array of concentrations that include aerospace, consumer products, medical devices and various industrial applications. They have performed extensive R&D developing new gear and bearing designs. Drago currently serves as the chief engineer and founder of Drive Systems Technology, Inc., a mechanical power transmission consulting organization, and Lenski holds the title of chief bearing specialist for the firm.

This seminar “addresses a broad range of topics that include design,

continued



Ray Drago.

fabrication, lubrication and handling of gears and bearings that will have a great impact on the operation and service life of gearboxes,” Drago says. “Interactions between the gears and bearings will be addressed and what should be done to optimize the gearbox for maximum life of both the gears and bearings.”

The seminar’s outline topics cover analysis of both gear and bearing design and failure, material and manufacturing related issues such as inclusions, hydrogen embrittlement, residual tensile stresses,

porosity, heat treating and grinding burns. Preventive measures will also be covered in the seminar as well as appropriate cures—simple and complex ones—to eliminate root causes of failure.

“For gears, a simple change might be specifying an improved surface finish on the gear teeth while a more complex solution may be a tooth redesign to include appropriate lead and profile modifications to accommodate system and gear tooth deflections,” Drago explains. “In many cases, simple cures

can result in significant improvement in gearbox performance if incorporated early in the design. Complex cures are not recommended for all gearboxes but should be known to the designer in case these are the only way to improve or correct the problem.”

The instructors choose to limit the course size to allow ample opportunities for questions, either during class time or during the breaks and lunches, at which times Drago and Lenski remain with the group for this explicit purpose. They invite questions after each topic and hold a Q&A exchange to encourage a group experience and foster a class discussion.

Lenski and Drago also use photographic data presentations coupled with case studies they are intimately familiar with. “Every situation discussed is one in which we have been personally involved and thus we can speak with first party knowledge and insight. The photos presented are from actual case studies done for various problems ranging from wind mills, boats, satellites and space applications to gearboxes used in mines, steel mills and many other commercial applications,” Drago says.

The next Gearbox CSI is being held at the Sheraton Sand Key Resort in Clearwater, Florida from November 12–14. Registrations costs start at \$1,695 for AGMA members and range up to \$2,395 for non-members. Fees encompass the educational materials, scheduled meals, an opening evening network reception and an AGMA certificate once the seminar is completed.

This year’s course has sold out and has a waiting list, but AGMA is looking into expanding the seminar size. The 2009 course is scheduled for October 13–15. In consideration of the Gearbox CSI’s popularity, AGMA is exploring options as far as offering it more, according to Jan Potter, AGMA vice president, membership. For more information contact Potter at (703) 684-0211.



Drago examines a SAG mill gear, which is about 35 feet in diameter, at a copper mine in Chile in order to determine the cause of tooth surface fatigue damage.