

# AGMA's Go-To Gear Guys

## Ray Drago and Bob Errichello Discuss Their Tenures as AGMA Gear Instructors

Jack McGuinn, Senior Editor

### “He who can, does; he who cannot, teaches.”

So goes the pithy George Bernard Shaw observation.

And then you have gear guys like Bob Errichello (Geartech — *geartech.com*) and Ray Drago (Drive Systems Technology (DST); *GearDoctor@Verizon.net*), who have been teaching *and* doing for many years. Indeed, collectively they total roughly a century's worth of in-the-field gear technology experience as well as unparalleled classroom instruction. And while they have or have had at one time or another other teaching gigs (U. Wisconsin Madison-Drago; U. California-Berkley-Errichello), it is their extended runs presenting AGMA gear courses that get the most attention here. Drago's and Errichello's AGMA courses continue to be the most highly attended (or viewed) classes available of AGMA coursework, and attract worldwide interest.

While the two have taught a variety of AGMA courses over the years, without question their most popular courses are *Gear Failure Analysis* (Errichello with longtime colleague Jane Muller) and *Gearbox CSI: Forensic Analysis of Gear & Bearing Failures* (Drago). Drago currently teaches *Manufacturing & Inspection* (with AGMA instructor Joseph W. Lenski, Jr.) and *Gearbox System Design: The Rest of the Story... Everything but the Gears and Bearings* (with AGMA instructor Steve Cymbala) as well.

Please note the remaining AGMA instructors giving their valuable time and priceless expertise to students include: Allen Bird; Roy Cunningham; Steve Cymbala; Peter Grossi; Jane R. Muller; and Dwight Smith. In addition, AGMA's gear school at Chicago's Daley Community College continues to provide invaluable instruction to those in or seeking to enter the gear industry. (Go to *agma.com* for more information regarding these folks and the important work they do.)

With that, we were able to slow down Drago and Errichello long enough to answer some questions for us regarding their long tenure and the material they teach.

### **Gear Technology (GT). Which is your most popular class, and why do you think that is the case?**

**Bob Errichello (BE).** The AGMA Gear Failure Analysis Seminar is by far AGMA's most popular seminar. It has been taught twice a year for the past 26 years and is always sold out. It is the premier course because it was carefully constructed, using the best teaching techniques and directed to the students' needs.

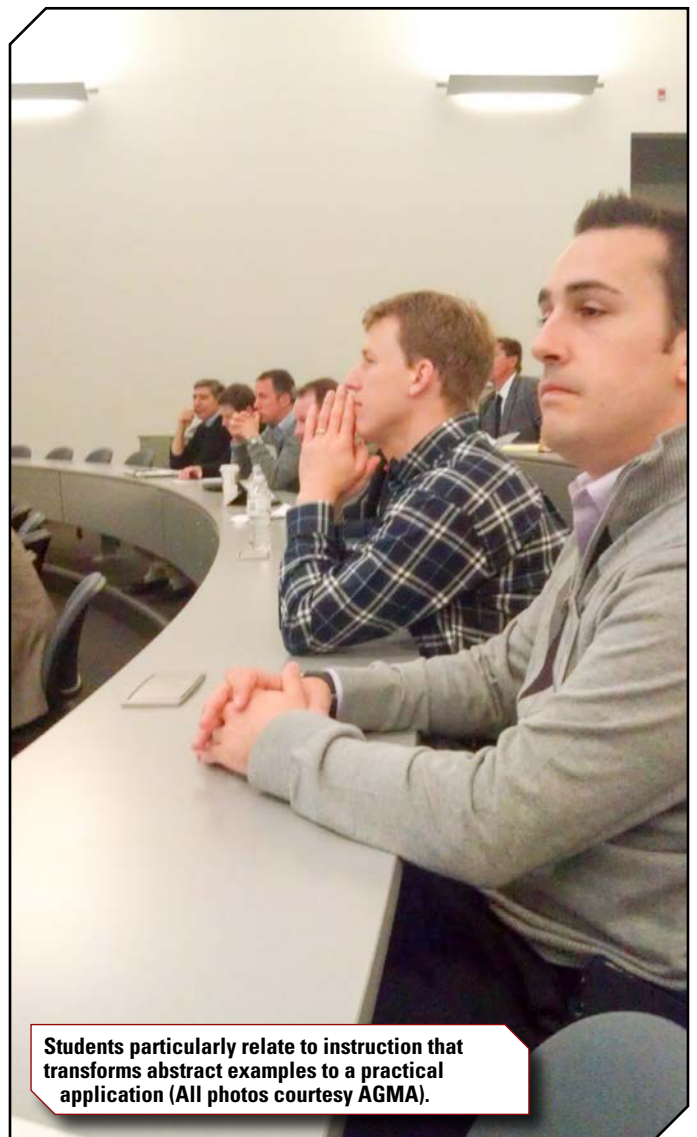
**Ray Drago (RD).** That is a tough question. I teach or co-teach more than a dozen courses, however, the mainstays of the group are three that I teach at the University of Wisconsin and seven that I teach for AGMA on a regular yearly schedule. Of these two groups, it appears that the

AGMA Detailed Gear Design and UWM PC Applications in Parallel Axis are the most popular in each grouping.

**GT:** How do you update your course over time to keep abreast of today's technology and sophisticated “smart” requirements?

**BE:** We continuously revise the course based on student evaluations and the latest achievements in our knowledge gained from our consulting practice.

**RD:** We have a very active consulting practice that involves gear systems used in everything – from electric toothbrushes to space craft and just about anything in



Students particularly relate to instruction that transforms abstract examples to a practical application (All photos courtesy AGMA).

“We, the citizens of each school district, must pressure our school boards to include shop or, more politically correct – ‘technology’ classes – back into the mainstream curriculum.”

Ray Drago

between. We use this experience to generate “examples” that we use in our course presentations. So as we gain new experiences we add or update material through these real-world, sometimes very unusual, experiences. We find that the students react with extreme interest when we can relate a “dry” fact to an actual application, especially if it is an unusual one. We have a two-page comment sheet that we hand out with the printed notes for every course. We guarantee return of this comment sheet from every participant by holding their Certificate of Completion “hostage” until each person turns in a comment sheet on the last day of the seminar. This sheet covers everything from meals and facility to the applicability of the course material to the participant’s work and the level of the seminar presented. It also has a section for suggestions regarding (new) topics.

**GT: What pre-qualifications are required of the students?**

**BE:** We don’t insist on pre-requisites, but recommend the AGMA webinar on gear metallurgy.

**RD:** My AGMA courses are generally single topic, in depth, focused, and require a good solid basic gear technology understanding. My AGMA “Gear Materials: Selection, Metallurgy, Heat Treatment, and Quality Control” course is an in-depth treatment unavailable anywhere.

**GT: What is the general age demographic of the class?**

**BE:** All ages attend, starting with new hires through retirement-age engineers. Often, young, non-degreed students do so well that they are awarded prizes for their achievements.

**RD:** The class makeup is very diverse age-wise, ranging from young engineers typically out of college a few years to much older engineers who have many years’ experience, but not necessarily in gear technology. We also see folks who have lots of gear technology experience, but in a limited area (e.g., parallel axis gearing but not bevel gearing, etc.). Since the Design Systems Technology (DST) group’s experience ranges over almost every type and size of gearing, our group is a good resource for transitional technology. In addition to my “adult” classes, over the last 10 years or so, I have also been teaching classes to school kids as young as preschool! These are, beyond any doubt, my very favorite classes.

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**GT:** What significant differences exist between now and when you began teaching these courses decades ago?

**BE:** We started with a one-day seminar, increased it two days, and finally settled on three days. All these changes were based on student input from their evaluations. We added a written test, a practical test, and a case history. The practical test and the case history include student presentations of

their failure analyses.

**RD:** Without a doubt—presentation technologies. When I started I used overhead transparencies! I had some “video” that I used which was on 16mm reel-to-reel film and the printed handouts were all simple black and white copies of the transparencies. Today, everything is on my computer via PowerPoint presentations in full color, using digital projectors. Several years ago, we

committed to bringing the printing of our course handout materials in-house. Although we choked on the price of the printer, it actually paid for itself in about one year in savings from outsourcing this expensive part of any class. We have also done some webinars and one video (for AGMA).

Another major change over these years has been the appearance of women at my courses! When I was in college there were virtually *no* female engineering students. Similarly, when I first started teaching there were *no* women in any course. Today, virtually every course has at least one woman and usually several in the group. In my courses for little kids I take special pains to talk directly to the girls (without singling them out of course) so that they simply grow up thinking that engineering is one of many career choices for them.

**GT:** What has stayed pretty much the same?

**RD:** I know it sounds like a cliché but I very much enjoy teaching and courses such as these allow me to have the satisfaction of teaching and the thrill of “passing it on.” This has remained the same. Gear system technology is part of just about all mechanical engineering programs, but the treatment is almost universally very superficial—typically, a few one-hour class sessions in total. A skilled gear technologist (will also) gain a vast amount of the required knowledge by virtue of experience and association.

**BE:** The teaching technique; I spent many years as a student in undergraduate and graduate courses, and carefully selected the best teachers. This experience, together with my own teaching experience as adjunct professor at San Francisco University and the University of California at Berkeley, allowed me to hone my teaching skills to what is most effective for student learning.

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**GT: What have you had to do to keep current with today's technologies in order to teach your classes? Like, how do you keep current with all the machinery updates, and bearings improvements, to name just a couple?**

**BE:** I gain state-of-the-art knowledge from my consulting practice of failure analysis. Because failure analysis requires expertise in diverse disciplines such as stress analysis; kinematics; dynamics; material science; solid mechanics; tribology; applied lubrication; condition monitoring; manufacturing technology; and design of gears, shafts, bearings, and housings, it is a continuous learning experience. In other words, the best way to learn something is to try to teach it.

**RD:** Easy one! Earlier in my career, when my "primary" employer was Boeing, I was in a new group (whose) focus was gear system technology development and application to the aerospace environment. This allowed us to work on a variety of both research and design development projects, each of which provided somewhat unique insight and technology development. As our consulting practice grew, and certainly now that consulting and teaching are our two sole "occupations," those varied consulting projects provide all the current knowledge updating that is needed to keep current.

**GT: Are today's classes any harder to "reach" than say, 10-15 years ago?**

**BE:** Not at all; I find students are entirely attentive, and they continually impress me with their insights and cleverness.

**RD:** I would not say that today's students are "harder to reach," but today's students certainly have much higher expectations regarding the quality of the presentations at each session, especially the visuals. PowerPoint is a great asset in this regard; adding videos and, depending on the course, in-class workshop-type problems add to the "drama" of today's

“We use many techniques to ensure the student absorbs the material so that when they take their written and practical tests they nearly always “ace” them. If we have a struggling student, we give him or her extra assistance.”

**Bob Errichello**

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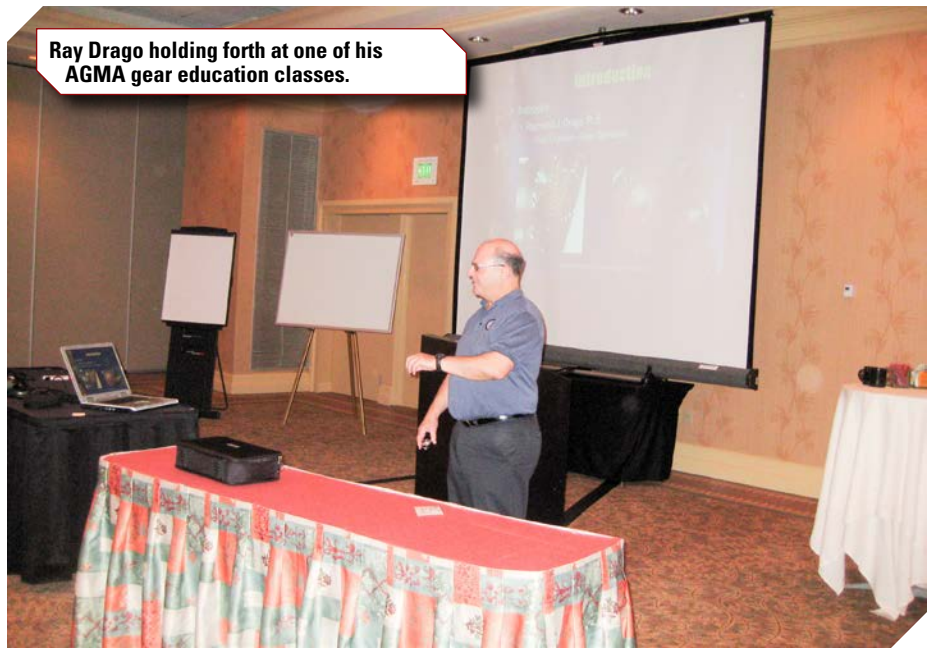
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tech-savvy engineering student. Today's student also wants the opportunity to interact with the instructors, not just in class but also informally, outside of the formal class setting. In our classes, for example, we take questions during the presentations but we also take frequent breaks during which we can interact individually with each student. We have found that many students will not ask a question out loud in class but will do so while holding a cup of coffee just standing around. We also have lunch together and we try to sit at a different table each day to foster individual discussions.

**GT:** What else would you like to see happening in gear education in the industry?

**BE:** I would like to see gearing seriously taught at all schools including, high school, technical colleges, and universities – programs similar to those in European schools. Furthermore, there should be more emphasis on STEM programs for young women.



Ray Drago holding forth at one of his AGMA gear education classes.

**RD:** I'd say that better management support of younger engineers' desire to obtain practical knowledge offered by courses such as ours (and many others as well!) is a key element. In conversations with many students I sometimes hear that they were "sent" to the class by their supervisor or man-

ager, but more often I hear stories of the challenge it was to get management to approve the class. During major meetings, in conversations after I have presented a formal technical paper (not a course), I often hear management types lamenting how difficult it is these days to hire skilled

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gear system technologists. These are often the same folks who are reluctant to approve or, even better, advocate, attendance at courses such as ours so that they can train their own people. I find this dichotomy most astounding.

**GT: Employer-financed apprenticeship programs are regaining some traction here in the States — a good thing? Any drawbacks?**

**RD:** Unfortunately, I think that the word “apprenticeship,” when associated with a beginning engineering career here in the U. S., often has a somewhat negative connotation, thus gaining traction may be difficult. A better approach may be to encourage field and shop experience that is directly related to the engineer’s basic job. I do very firmly believe, however, that hands-on experience is an excellent teacher. In fact, every course that I teach includes this “guidance” as part of the introductory material.

**BE:** Apprenticeships are a wonderful way to stimulate interests in gearing. Furthermore, work-study programs and summer employment for young engineers should be encouraged.

**GT: Which of your courses do you find the most difficult to teach — and is that because the material is the most difficult or is it something else?**

**BE:** I only teach what I know, so it is never difficult. And always a very enjoyable, learning experience.

**RD:** I don’t find any course more difficult to teach than any other. I do find, however, that each class has its own set of requirements, including presentation style. For example, the PC Applications in Parallel Axis Gear System Design course is actually mostly a workshop. I lecture for only about 3 or 4 hours on the first day, while the remaining 2.5 days are devoted to guiding the class through their efforts in working out “problems” of increasing difficulty. Each student has a copy of our gear

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**Bob Errichello**”

analysis/optimization software (*PowerGear*) and the class typically breaks into self-defined work teams of two or three to work on the problems. A typical problem would deal with a large internal slewing gear driven by several pinions as would be used in a wastewater treatment plant clarifier system.

**GT: What happens if someone fails your course? What are their options? How does it affect their job prospects, if at all?**

**RD:** None of my courses is actually graded and there are no tests. Each participant who com-

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pletes the course is awarded a "Certificate of Completion," indicating the number of contact hours and the subject.

**BE:** In 26 years of teaching the AGMA Gear Failure Analysis Seminar, I've never had to fail a student. We use many techniques to ensure the student absorbs the material so that when they take their written and practical tests they nearly always "ace" them. If we have a struggling student, we give him or her extra assistance.

**GT:** On the other hand, how beneficial is a Certificate of Completion from your course in finding work in the gear industry?

**BE:** Most the gear industry knows about the AGMA Gear Failure Analysis Seminar, so a Certificate of Completion is valuable for applying for a job in the gear industry.

**RD:** We have received feedback that the Certificates of Completion are valuable "chips" in the annual

evaluation process, and a number of students have indicated that their raise was positively affected by their earning the certificate. Of much greater impact, however, is the AGMA-awarded "Advanced Gear Engineering Certificate" (requires taking five AGMA-sponsored gear technology courses). Feedback from students indicates that these certificates carry significant "influence" during annual performance reviews. AGMA has also taken the educational movement to heart, having created the "Advanced Gear Engineering Academy." Though we have worked with the new AGMA Education Director (taking over for recently retired Jan Alfieri) **Cassandra Blassingame** for just a month, it is clear that she has a good handle on the task of continuing the advancement of educational opportunities within the AGMA umbrella.

**GT:** What – if anything – can be done to bring "shop" classes back to the high schools?



**Errichello colleague Jane Muller (partially obstructed) sharing some nuts-and-bolts thoughts with a student.**

**BE:** It will take a major restructuring of the educational system in the U.S.

**RD:** We, the citizens of each school district, must pressure our school boards to include shop or, more politically correct – "technology" classes – back into the



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mainstream curriculum. We are becoming a generation of virtual experiences with smart phones and computer-generated materials taking the place of real hands-on experience. This *must* change. *Hands-on*, not virtual, computer world experience starting at the earliest possible time is essential to the development of great future engineers, both in the gear technology field and in general.

**GT:** Silver-lining the fact that a great many experienced workers have retired or are retiring, might there now be a ready reserve of recently pensioned gear guys willing, able and available to teach shop-type courses – even if the courses are not accredited?

**RD:** Ah – good question. It is not nearly as simple as it appears, to be an effective teacher. In addition to the basic requirement that the teacher be knowledgeable, he or she must also be able to relate to the student and convey informa-

“These (management types) are often the same folks who are reluctant to approve or, even better, advocate, attendance at courses such as ours so that they can train their own people. I find this dichotomy most astounding.”

Ray Drago

tion in a way that the students can understand and with a delivery that will cause the students to actually remember what is taught. All of my teaching efforts in the schools are completely uncompensated. In fact, our company, DST, underwrites all costs associated with these presentations. This includes purchasing prizes used during hands-on experiments and exercises to reinforce the concepts taught, and all materials required for the presentation, including color-printed handout materials of the same quality as those provided for our engineering courses.

**BE:** I believe so. Certainly I would be willing to teach such courses. ⚙️



**Raymond J. Drago** is Chief Engineer of Drive Systems Technology, Inc. (DST), a mechanical power transmission consulting organization that he founded in 1976. Prior to this, Drago worked for the Boeing Company — Helicopters Division until his retirement after 37 years of service. Currently Mr. Drago is involved in the analysis, design, manufacture, assembly, and testing of many gear systems. In his role with DST Drago is active in all areas of mechanical power transmission, including the design and analysis of drive systems in a very diverse field of application — from heart pumps to very large mining and mill gears. Drago also prepared and delivered more than 150 seminars dealing with various aspects of gear design and analysis.

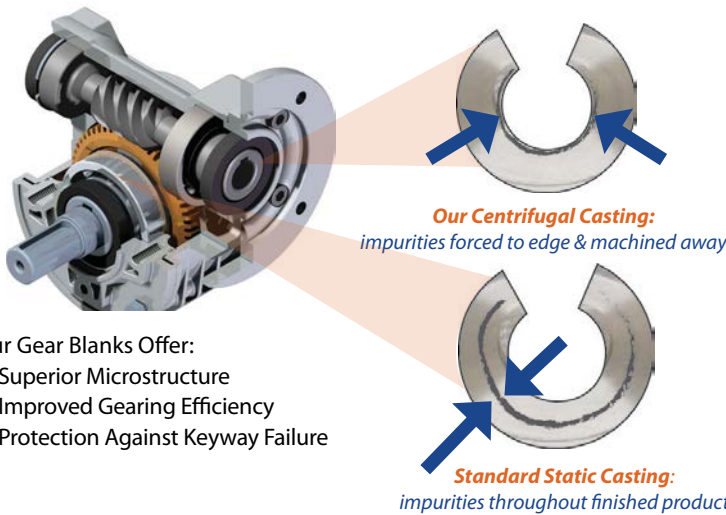


In a career spanning more than 40 years, **Robert Errichello** has earned a reputation for being the go-to person for instruction on gear failure analysis. Bob heads his own gear consulting firm, GEARTECH, and is founder of GEARTECH Software, Inc. He is a registered Professional Engineer who holds BS and MS degrees in Mechanical Engineering and a Master of Engineering degree in structural dynamics from the University of California at Berkeley. He is author of more than 60 articles on design, analysis, and application of gears, and has written three widely-used computer programs for the design and analysis of gears. He is a recipient of AGMA's Lifetime Achievement Award in addition to other awards from AGMA, AWEA, and STLE. Students come from all over the world to attend his course, and AGMA is proud to be able to extend this learning experience to you. Last, but certainly not least, Bob is also a longtime Gear Technology magazine Technical Editor.



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