Productivity on Demand

ADAPTATION KEY TO SUCCESS FOR GEAR SOFTWARE DEVELOPERS

Matthew Jaster, Associate Editor

In 1995, *Gear Technology* urged readers to jump aboard the computer manufacturing bandwagon. For most engineers, trading their pencils and paper for computer technology was a daunting task. Learning new software meant starting from square one with each upgrade. By the time employees were properly trained on software programs, they could be outdated or obsolete.

The concept of full automation was originally associated with the aerospace and automotive industries. Large manufacturers utilized CAD programs, CNC machines and PCs in their design departments. Companies like Boeing and Chrysler began creating models entirely on the CAD system. The computer had become an intricate part of the day-to-day routine for manufacturers.

The gear industry had no choice but to follow suit.

Today, the computer has its hard drive in everything from human resources to the shop floor in an effort to help gear manufacturers increase production and minimize costs. Companies like KISSsoft AG, Romax Technology and Dontyne Systems Limited began designing practical software applications with these goals in mind. Goals that have led developers to collaborate with research institutions, consultants and universities all in the name of technology.

***RomaxNVH*: Exaggerated 3D view of a normal mode shape in a transaxle gearbox.**

Gear Software, Then and Now. According to Dr. Mike Fish of Dontyne Systems and retired Prof. R.G. Munro from the University of Huddersfield in England, the earliest benefit of gear software appeared before many current engineers were ever involved in gearing.

"This arose from the fact that gear geometry often involves calculating a small difference between two large numbers using 7-figure logarithm tables or involute trigonometry tables. It was a big step forward to be able to solve the transcendental involute function equation with just a simple iterative program," Fish says. "The development of computers in the 1970s and 1980s allowed designs to be calculated quicker than on a drawing board. Today, the calculation speed has significantly improved to the point that more comprehensive data analysis can be carried out beyond linear methods of design."

Fish and Munro add that gear metrology has made great use of software, in conjunction with the advent of precise instrumentation for large displace-

ment angular and linear movements such as optical gratings and laser devices. Software has also improved presentation formats, simply by replacing "the old rolls of curly chart paper" with data that can be read and easily filed.

"The rapid expansion of computing power in the early 1990s made calculations practical in the sense that a comprehensive analysis of 'what if' possibilities could be played out in the model in a practical time scale," Fish says. "The interpretation of the result is equally as important as the quality of the analysis itself."

L. Kissling & Co. was an early developer of software for the calculation of machine components. In order to ensure the upkeep and maintenance of their software, KISSsoft AG was founded as an independent company in 1998.

"*KISSsoft* was first written on a Commodore PET in *BASIC*," says Dr. Stefan Beermann, vice president at KISSsoft. "It has come a long way since then. Fortunately, the programming needed is comparably simple. It's the technical background in machine design that's most important."

Beermann says the *KISSsoft* product is 25 years old and is constantly being modified and maintained. The company's strategy is simply evolution over revolution. They take pride in the fact they've managed a large project like *KISSsoft* over the years with maximum effort and reliability.

"Our software is under permanent maintenance. Once in awhile a complete module is rewritten because of the problem of maintaining very old code," Beermann says, "but we're hesitative with this because 25 years of debugging is part of the main capital our company has, so we're always looking for a method to keep the calculation code as is."

Romax Technology has been developing software tools and performing technical consulting to major automotive OEMs and suppliers for over 20 years. Their software package, *Romax Designer*, was first released in 1993 but can trace its philosophical roots back to an NIST funded research program from the late 1980s.

"Romax tends to perform one major release per year with additional interim updates," says Andy Poon, director of software & strategy at Romax. "We believe incremental updates enable our customers to have access to new features as soon as possible rather than waiting for major releases in order to benefit from improvements to the software."

The software development team at Romax has grown enormously over the last 10 years. Poon says the most significant changes have occurred with its internal development processes and the way the company interfaces with its customers.

"In the very beginning, we pored over classical reference papers, documents from the standards committees, published technical papers and other technical documentation to figure out the requirements and how to program the algorithms," Poon says. "Today, we work very closely with our customers on joint software developments and spend an increasing amount of time on research and development projects and university-based research programs."

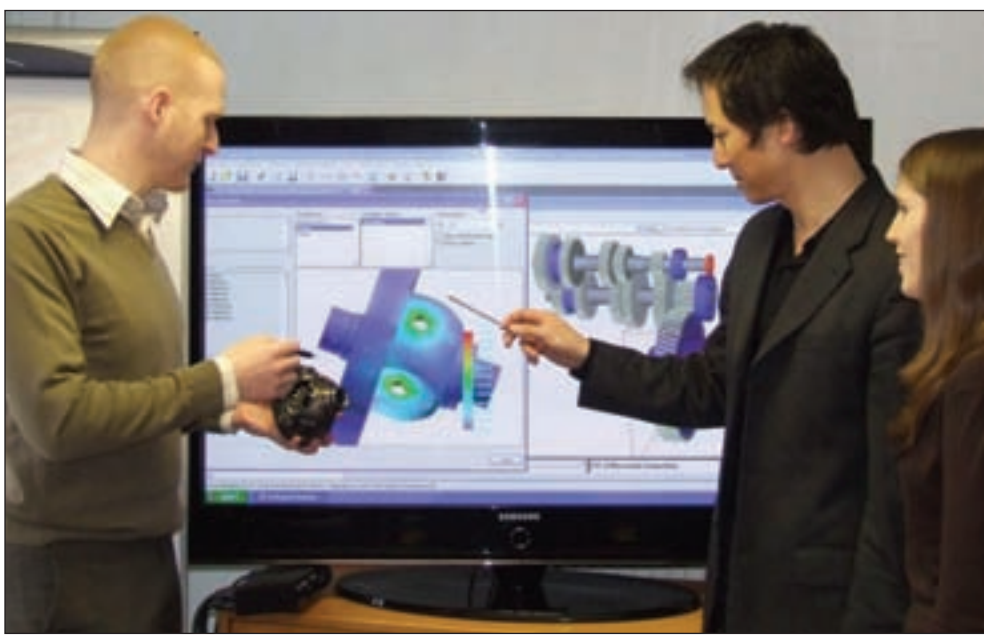
The Growing Needs of the Customer. The satisfaction of a job well done comes when the developers see customers solving real-world problems with their software. Poon says engineers at Romax believe the software is built with their customers in mind, noting its ready-to-use features and accessibility as being vital to the market.

"Though we had access to a number of similar software packages, we continued using Romax for its ease of use and accuracy," says Jon Adler, engineer at McLaren Performance Technologies, Inc. "Romax gives us a quick and complete way to evaluate the effects of design parameters on components within a gearbox. By evaluating loads in three dimensions, we can avoid over- or under-designing bearings and shafts."

Fish explains the relationship with Dontyne's customers is vital to enhance the "off-the-shelf" product. "In order to do justice to our products, we work closely with our customers to ensure that the software is properly implemented," Fish says. "This has a dual benefit in that it allows the customer to become quickly adept, and allows us to realize where future product development will be most effective."

With relatively few software developers in the gear industry, companies are forced to maintain a strong customer base globally. Dontyne, Romax and KISSsoft maintain offices around the world to keep up with customer demands. Although KISSsoft is headquartered in Switzerland, the company works regularly with clients such as Brad Foote Gear Works in Illinois. (Now Tower Tech Holdings)

"Our interaction with KISSsoft has been excellent," says Chuck Schultz, vice president of engineering at Brad Foote Gear. "My senior engineer went to a training session and came back fully confident he could use the software efficiently. When questions have come up



Collaborative gearbox development with Romax Software.

Software Bits 2008

Dontyne Systems Ltd.

Dontyne's *Gear Production Suite* is a package of software products to design, machine and inspect gears during production. Each module has been developed with three levels of operation including basic, standard and advanced. The functionality of one or more of the tools can be embedded in existing metrology or machine tool equipment to form part of an expert system. Highlights for the software package include *Gear Design Pro* to define gear pair geometry and the calculation of their rating according to ISO standards and *GATES* software, a program for the calculation of stress and transmission error conditions in loaded gear systems. Dontyne's website notes that a concept design tool for calculation speeds and torques in a planetary system is currently being developed. The company recently confirmed an exclusive deal with partner Gaudlitz GmbH in the plastics field until 2010 for the implementation of a module for the optimization of tool forms.

KISSsoft AG

There are currently two major new developments in the works at KISSsoft AG. The first is a completely new interface (GUI) for *KISSsoft*, replacing a 10-year-old concept. The second is that shaft calculation is now based on a Finite-element core, which gives the company the ability to model the loads applied to the shaft more realistically. Furthermore, the company has some new developments with *KISSsys*, a set of models for typi cal wind turbine gearbox kinematics and a gearbox model that implements a thermal analysis of the gearbox. *GEARCALC*, a software package for sizing and rating cylindrical gears includes three parts for engineers including *GEARCALC, RATE2001 and LUBE925*. The software package was recently launched in the United States.

Romax Technology

Romax is constantly working to increase both its breadth and depth of coverage for gear applications. Underlying many new developments are two key ideals the company is striving for: 1) Analysis should not be done using idealized (nominal) parameters. For simulation to accurately reflect the real world, it must embrace the fact that the real world is full of imperfections, and the variations of manufacturing, assembly alignment and loading should be considered in the design stage. 2) The different analysis disciplines should not be spread amongst different tools. You should not have to duplicate the building of analysis models to look at different phenomena such as fatigue life, modal response, transient dynamic events, efficiency, etc. The company provides an integrated approach to gearbox design, analysis and virtual testing with a software suite that includes *RomaxDesigner, RomaxDurability, Romax Dynamics, RomaxNVH* and special industry packages including *RomaxWind* and *RomaxBearing*.

concerning the software, our local rep has been able to get the answers within a day or so; as fast as you'd expect given the time difference. We went with KISSsoft originally on the recommendation of our own customers," Schultz says.

Beermann says language barriers pose additional challenges when servicing a global community.

"Our software is currently available in five languages," Beermann says. "We not only have to build a system and manage it, we have to know the technical terms of each language. We have an employee on staff strictly for language. It's not just translating, it's localization. It's separating each technical term. Challenging work, but well worth it to get the product out to our global customers."

Success in this industry, however, is achieved first and foremost in one's own backyard. Fish says companies need to improve their own products with good housekeeping and effective data transfer between departments.

"Many companies have developed in-house calculation procedures based around international standards suited to their own manufacturing capability," Fish says. "A major consequence of leaving this to a single person in the company is not often felt until that person leaves or retires."

Is There a Qualified Engineer in the House? Effective software tools begin and end with a well-trained engineer. Beermann is concerned the most educated crop of experts might be on their way out. The company is preparing itself for a significant decline in gear industry expertise. He believes the typical "hardcore" gear expert in the U.S. is close to retirement.

"Our tools do not replace an engineer," Beermann says. "You need someone in place with some know-how concerning the implemented methods." (*Editor's Note: Please see our feature on engineering tuition/education on page 25 for additional information.*)

Fish says there's currently a major move to re-train engineers in the industry. The focus will be to ensure that any knowledge contained in software can be formatted and applied by engineers.

"Much of what was learned by sound and analytical techniques in the 60s and 70s has had to be relearned by a generation of engineers implementing a soft-

ware routine."

Dontyne has been working within the industry to help define the design procedures as well as the interpretation of equations and graphs in common standards. Along with a group that includes the ISO, BGA and AGMA, they're currently looking at the influence of these decision-applying standards. Romax has also been involved in these discussions.

With the limited pool of experts in the field, it's no surprise how important collaboration is to the success of software development in the gear industry.

Beermann believes most gear conferences often have the air of a family gathering.

"In my experience, most of the gear engineers are open to exchanging know-how and ideas with each other. The same is valid for companies providing gear design software."

While the designers tend to split between independent software vendors (ISVs) and academic institutes, Poon doesn't think there are any hard and fast rules to collaboration.

"Some ISVs are quite secretive. Likewise, the academic institutes or consortiums have to serve their members, although they do collaborate with industry partners. However, even the academics do specific work which is often subject to non-disclosure agreements."

Dontyne's *GATES* software was developed in collaboration with the Design Unit at Newcastle University, U.K.

"Our industrial development partners and beta testers test the analysis tools before they are released and form an important bridge from theoretical analysis to the engineering tool," Fish says. "The most rewarding part of the job is seeing the change in attitude when a company realizes the benefits of our products to their operation. We're delighted to promote our collaboration as much as possible. It publicizes the fact our capabilities extend beyond the software itself."

Moving Forward. For Dontyne, gear software development in the coming years rests on bridging the gaps that sometimes exist between design, machining and inspection.

"Digital data from CNC equipment can be directly accessed to enhance the models. Machines can have value-added by incorporating further analysis features. A machine tool with on-board correction capability can also have on-board modeling of the component. Advanced modeling ensures that variables in the production processes can be calculated and analyzed, and the corrective action defined before the machining process even begins.

KISSsoft AG has also been adapting to the learning curves associated with software development. "CAD programs change, hardware platforms change, operating systems change and gearing standards are under continuous modifications," Beermann says. "These are not problems, but a necessary part of our customer service to keep our software ahead of the industry. Due to the higher performance of computers, we can now implement features today that would have been out of discussion 20 years ago."

Emerging manufacturing markets in China, India and Korea appear to be the focus for many developers in the months ahead. Beermann is quick to note the market is large enough for all the software developers to coexist.

"There are only a few companies left that develop this technology. It's important to maintain connections and have good relationships with everyone involved."

At Romax, the future involves ensuring their software remains at the cutting edge. They're currently working on some long-term solutions to enable a larger proportion of mechanical engineers to have easy and affordable access to the tools they need.

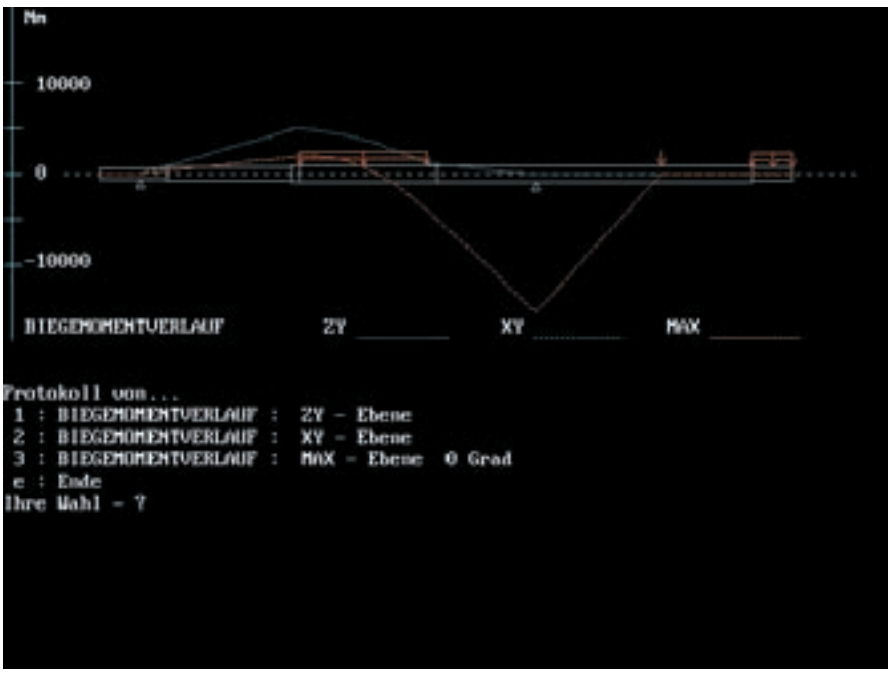
"When Romax first entered the market with *RomaxDesigner* in 1993, it was a unique approach. Our challenge is to continue to innovate whilst delivering solutions that give our customers the competitive edge," Poon says.

Still, the biggest concern for most developers comes back to the education and training needs of the engineers.

"A common trap in a great deal of engineering software use is thinking it will do the work of an engineer. With very few exceptions, software is still only a labor-saving device," Fish says.

The problem isn't just replacing the engineer; it's getting each one on the same page. Fish says there's still extreme confusion in comparative software programs. He states that even experienced gear engineers that make one different choice from a well-recognized standard can result in two completely different sets of analysis for the same set of problem parameters.

"It's essential to understand this concept to improve software training on a



***KISSsoft* shaft calculation 20 years ago.**

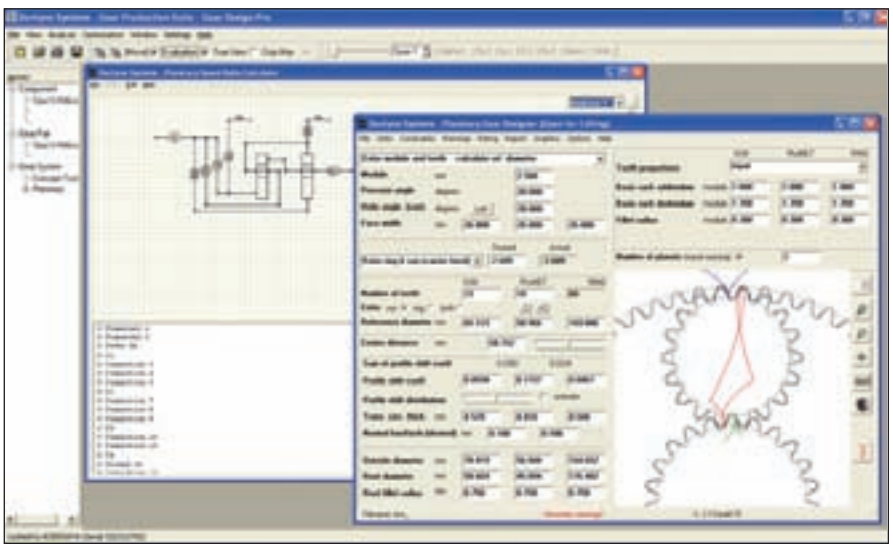


Image concept and planetary design tools by Dontyne Systems.

global scale, especially when entering new and emerging markets," says Fish.

As technology evolves, companies must be prepared to adapt to the ever-changing face of software development. While the programs of the early 1990s look prosaic by the standards in place today, one can only speculate what short-cuts and tricks will be available five years from now.

"The speed and scope of analysis and data in gear software is incredible," Fish says, "but it will only ever be as good as the engineer using it."

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