

Getting the Right Tools

Charles D. Schultz, Technical Editor

Gear Technology readers work at many different companies, and no two readers have the same responsibilities. So there is little chance that they need the same software to assist with their work. Gone are the days when companies wrote their own code and process engineers thumbed the same tattered reference book. Software vendors have been amongst the most loyal supporters of this publication and regular readers have no doubt seen their advertisements, product announcements, and occasional editorial contributions.

As a service to readers, we have put together this survey of commercially available software and offer a bit of guidance on how to select the right package for your needs. We have not “tested” all of the products mentioned, and urge readers to contact the vendors for trial versions before committing to a purchase. Features vary as widely as cost, so verify that the package you test has the calculations you need.

Gear software used to be home-grown because there just wasn't a big market for such specialized calculations. Each company tasked someone with “mechanizing” the complex and often confusing gear geometry, rating, and manufacturing procedures to save time, get consistent results, and avoid costly mistakes. I was one of those guys for several years; it was very stressful waiting for the inevitable “bugs” to show up. As soon as an equivalent commercial product was available we bought it.

The software we purchased was great for designing gearboxes and included a routine to evaluate lubricant effectiveness. It did nothing for our manufacturing engineer; no span measurement, no over pin measurement, and no quality tolerances were calculated. Manual calculations and, sometime later, spreadsheets, had to be developed and maintained to obtain these very necessary numbers. Our shop also had at least four brands of hobbing machines with vastly different change gear formulas besides

those incredibly complicated bevel machines. I wouldn't want to attempt a bevel machine set-up with manually calculated numbers. Thankfully, the bevel machine builders were amongst first to offer dial up support services.

Another important aspect of commercial software is the availability of training classes for new users. Maintaining computer code is difficult enough; writing instructional material adds another level of complexity. Training will assist newer engineers in using the product as the supplier intended, while demonstrating features which may not be widely understood. It may also bring to light the use of non-standard nomenclature and hidden design rules within your organization. This problem cropped up the first time the American Gear Manufacturers Association (AGMA) offered training on its ISO 6336 software in 1997. Some rather experienced gear engineers got “schooled” in rack offset coefficients and their use of transverse tooth forms. These misunderstandings prevented them from learning the new program in the time allowed.

If your work is primarily the design of new products, your software needs are different from a co-worker who prepares shop routings or a consultant who studies gear failures. Many software packages are offered in modules so you can have the features you need without paying for things that will never be used. If you don't make bevels or worm gears, you omit those modules and save money. Others offer modules with “machine design” calculations such as key stress, bearing life, and shaft stresses. A growing trend links gear files directly to CAD modeling software such as *ProEngineer* and *SolidWorks*.

To assist you in finding the right software, we sent a list of questions to potential suppliers and tabulated their answers in the accompanying table. Here's what we asked them, along with a bit of background on why in fact the question was asked:

Does your software apply to spur, helical, internal, epicyclic, bevel, and worm gears?

Why buy a tool that you will never use? If your company never makes bevels or worms there is no value in having software to rate them. It is certainly possible to rate a planetary gearbox as individual meshes but a software package that looks at the entire system is a great time saver.

Does your software calculate ratings per AGMA? ISO? DIN? JIS? BS? API?

We live in a worldwide market and customers want to know how your products rate per the standards accepted in their industry. The ability to use the same input format and get multiple results saves time and aids in understanding the net results of the different rating methods.

Does your software consider lubrication (scuffing, scoring, wear, micropitting, flash temperature, specific sliding)?

Gears operate in a power transmission system. Gear proportions, geometry, tooth modifications, and surface finishes have an effect on lubrication requirements. A software package that can check on the lubricant selected will save time and money.

Does your software recommend rack offset coefficients?

There are many reasons why designers use non-standard, outside diameters. Also known as “long and short addendum,” several theories are used to determine the optimum amount of “rack offset” for a specific set of gears. A program that shows the user the minimum offset to avoid undercut or the maximum offset to avoid pointed teeth is good; one that understands durability or strength optimization is better.

Does your software recognize different materials and heat treats?

Especially with international sourcing, the ability to compare ratings between different materials and heat treatments is important. The ease with which a program does this can

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software

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greatly affect the designer's productivity. For manufacturers with unique material selections, it may be important that default settings can be changed.

Does your software allow for Miners' rule analysis?

Some applications involve varying loads, and speeds are best analyzed using Miner's Rule. If a software package doesn't handle this complex calculation the designer will have a lot of spreadsheet work to do.

Does your software calculate highest point of single tooth contact, lowest point of single tooth contact, form diameter, and tight mesh condition?

Profile modifications need start and top points. Gear grinders need to know what inspection limits apply. In some applications, tight backlash restrictions may affect center distance tolerances.

Does your software allow for high contact ratio ($M_p > 2.00$) gearing?

Automotive and aerospace designs are increasingly using deeper than standard tooth forms yet some soft-

ware won't run gearsets with the high contact ratio that results.

Does your software recommend crown and tip relief values?

Modern gear grinding machines can create almost any modification the designer can think of. But which modifications make the most sense? A program that recommends values based loading conditions would be appreciated.

Does your software calculate load distribution factors for complex modifications?

Load distribution factors (C_m) have a major influence on net gear rating. A variety of methods are in use to calculate load distribution factors—some of which require very complex analysis. Building this into the program and linking it to the tooth modifications would help determine the effectiveness of the modifications.

Does your software simulate actual tooth profiles?

The widespread use of 3-D software has made clients expect to see colorful "moving pictures" of new designs which require accurate tooth profiles.

Does your software export simulated tooth profiles to CAD programs or for use in EDM or water jet cutting?

Non-traditional manufacturing techniques like electro discharge milling and 3-D printing depend upon imported tooth profile coordinates.

Does your software calculate quality tolerances per AGMA A or Q levels?

Quality tolerancing systems have been revised a number of times in recent years and have sometimes gotten ahead of the inspection machines installed. A program with flexibility to provide values in both current and legacy standards is much appreciated.

Does your software calculate quality tolerances per ISO, DIN, JIS, or BS?

A worldwide market means worldwide sourcing and the quality standards of many organizations. Being able to calculate tolerances to a variety of standards is a plus.

Does your software calculate span measurements?

Calculating span measurements for highly modified gears is time consuming. Having it built into the software



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Software Article								
Question	Vendor>	MITcalc	Dontyne	Excellent	Romax	KissSoft	AGMA	PowerGear
1	Spur	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Helical	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Internal	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Eppicyclic	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Bevel	Yes	Yes	Future	Yes	Yes	Diff.Program	No
	Worm	Yes	Yes	Future	Future	Yes	No	No
2	AGMA	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	ISO	Yes	Yes	Yes	Yes	Yes	Yes	No
	DIN	Yes	Yes	Yes	Yes	Yes	No	No
	JIS	Yes	No	No	Partial	No	No	No
	BS	Yes	Yes	No	Partial	No	No	No
	API	Yes	Yes	No	Partial	No	Yes	No
3	Lubrication	Partial	Yes	Yes	Yes	Yes	No	Yes
4	Rack Coeff	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5	matl & HT	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6	Miner's Rule	No	Yes	No	Yes	Yes	Yes	Yes
7	HPSTC, etc.	No	Yes	Yes	Yes	Yes	Yes	Yes
8	HCR OK?	No	Yes	No	Yes	Yes	No	Yes
9	Tooth Mods	No	Yes	Partial	Yes	Yes	No	Yes
10	Cm	Yes	Yes	Yes	Yes	Yes	No	Yes
11	Tooth Profiles?	Yes	Yes	No	Yes	Yes	Yes	Yes
12	Profile Export?	Yes	Yes	No	Yes	Yes	Yes	Yes
13	AGMA Tol?	No	Yes	Yes	No	Yes	Yes	Yes
14	Other Tol?	No	Yes	ISO, DIN	Partial	Yes	No	Yes
15	Span Measure?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
16	Ball or Pin?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Specify Pin Dia?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
17	PM Gears?	No	No	No	No	No	No	No
	Plastic Gears?	No	No	No	No	No	No	No
18	Geo Warnings?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
19	Warning Override?	Yes	Yes	Yes	Yes	Yes	No	Yes
20	Training Available?	No	Yes	Yes	Yes	Yes	Yes	Yes

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reduces processing time and insures consistent results.

Does your software calculate pin or ball measurements? Can pin or ball diameters be specified?

Some gears are not suitable for span measurements and pin or ball measurements are needed. Then there is the question of just how many sizes of pins or balls have to be on hand. Good software and simplify this situation.

Does your software have an option for powdered metal or plastic materials?

Not everyone makes cut metal gears.

Does your software provide warnings for questionable geometry?

Some gear designs violate the design rules found in various reference books. It is good to be advised when this occurs.

Can the warnings be overridden?

Not everyone agrees with the design rules which are not built into actual rating standards. Some designers are not troubled by a slight amount of undercutting or narrow top lands. The "override" option is also important for failure analysis and reverse engineering.

What training is available?

Not all programs are user-friendly, or easy to understand. Good instruction manuals or a training class can speed implementation and insure accurate results.

These questions were sent to the software vendors and their answers are tabulated in the attached chart. You may have additional concerns and questions which are best discussed directly with the vendor. Run a few problem sets through the trial version and make sure you understand the features and options available. If moving from another software system it is important to compare results between the old and new methods. Don't be surprised at slight differences in span or over pin measurements, as methodologies vary. On rating calculations certain factors — such as I and J geometry factors — are greatly influenced by specific cutting tool inputs. What's more, programs use different default tool geometry, so you must make sure your calculations match your production parts. A factor-by-factor comparison is a worth-

while exercise until you develop confidence in the results.

In the end, having confidence in your calculations is the primary requirement for gear analysis software. All the colorful renderings and impressive graphs are useless if you worry about the backlash matching up with the span measurements. The software reviewed here has a wide variety of features and price points. Some vendors offer outright sales, others prefer renewable leases. All of them want to help you design, analyze, and manufacture gears in the shortest possible time. ⚙️

For more information:

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