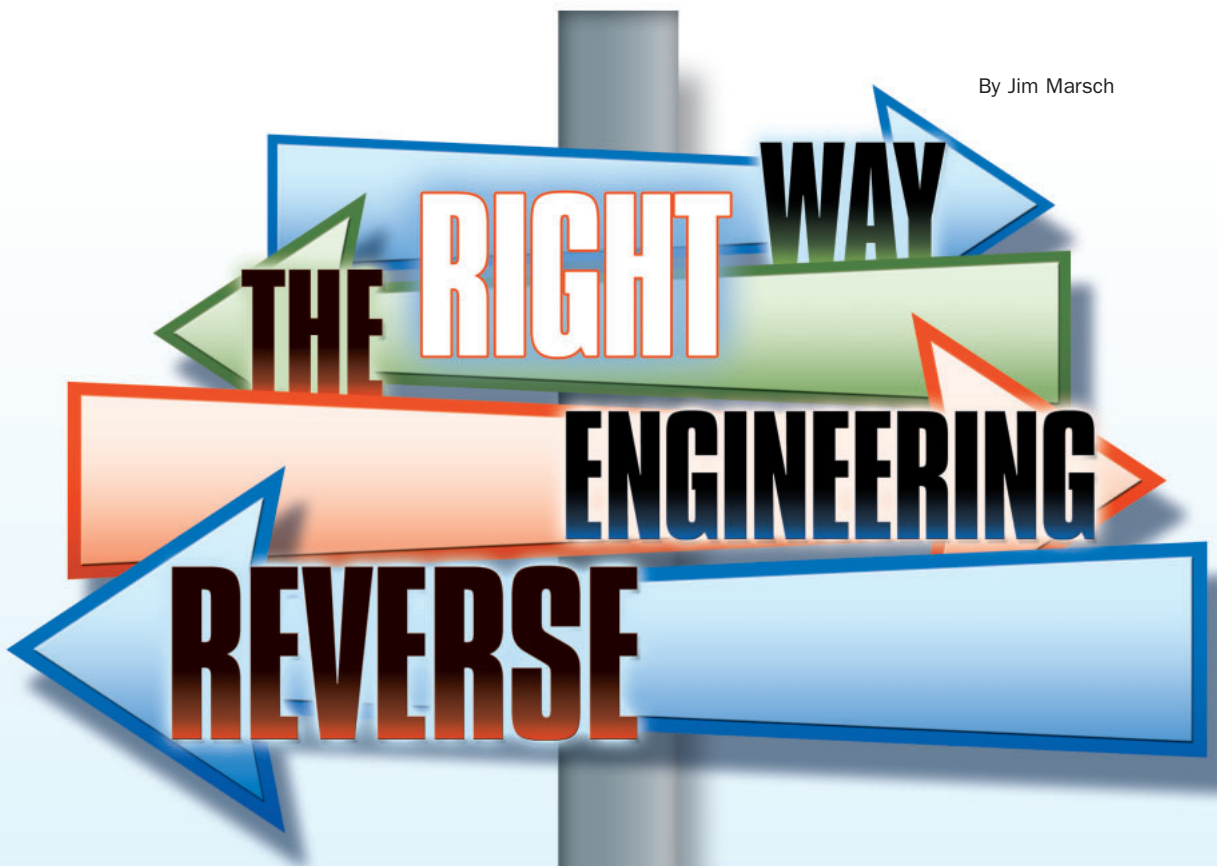


**IT'S AN OLD MACHINE,
BUT IT STILL WORKS...
UNTIL THAT **CRUCIAL PIECE BREAKS DOWN**
AND THE **ORIGINAL DRAWINGS HAVE BEEN LOST.**
HERE'S HOW TO OVERCOME THAT OBSTACLE.**

By Jim Marsch



Reverse engineering—the deconstruction and analysis of an object for the purpose of constructing a copy or replacement of the original component when the original design or drawing is unavailable—is especially helpful in making repairs or in improving old designs. For example, let’s say you need to manufacture a replacement for a broken gear, but you don’t have the original drawing. This is not an uncommon situation. The question is, what is the best way to reverse engineer a gear when you have the part in front of you, but do not have the part drawing? Most people will choose to approach this problem by guessing, and often-times will not be successful in duplicating the gear. However, this does not have to be the case. Reverse engineering of a gear is a science. I have outlined the procedure below in five simple steps (calculations are made using Integrated Gear Software™).

Step 1: Calculate the Normal Base Pitch

The normal base pitch is the distance on a normal base helix between corresponding involutes of adjacent teeth. To calculate, make two measurements using a span micrometer. If the first is over four teeth then the second has to be over five teeth. Trial and error shows that we can measure across five teeth without contacting the OD and four teeth without contacting the root. The difference between four- and five-teeth readings is the normal base pitch of the gear. Better accuracy will be obtained if a number of readings are taken at four and at five teeth and then averaged. In this example the normal base pitch works out to be 0.949 in.

Step 2: Measure the Outside Diameter of the Gear

Measure the outside diameter of the gear in inches using a set of calipers.

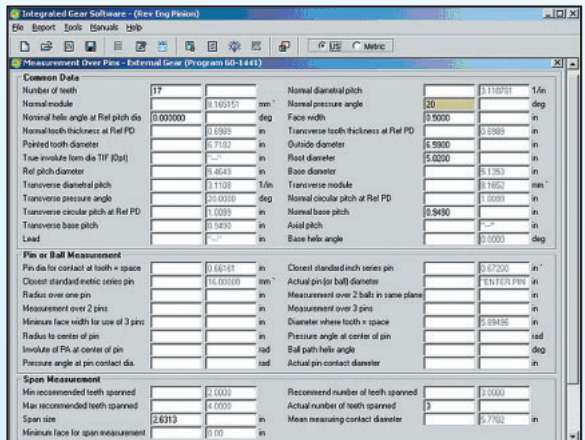
Step 3: Measure the Root Diameter of the Gear

Measure the root diameter, measured across the bottoms of opposite tooth spaces. You can also measure the root fillet radius if you have a radius gage or another method.

Step 4: Calculate the Diametral Pitch

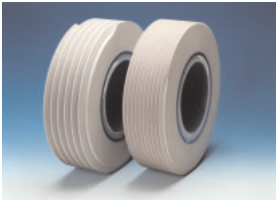
Do this by assuming the pressure angle, the angle between the tooth profile and a radial line at its pitch point (try 20 and 25 degrees as they are more commonly used). Typically the diametral pitch, the number of teeth per inch of pitch diameter, will be a whole number such as three, eight, 10, etc. The following example shows a sample calculation (note: different combinations of diametral pitch and pressure angle will yield the same normal base pitch). From the span measurement, we will calculate the normal tooth thickness at the reference pitch diameter.

FIGURE 1



Technical Solutions

Aerospace and Automotive Applications

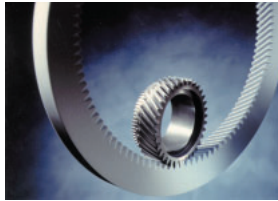


Multiple Start Gear Grinding Wheels

- Lower grinding forces
- New abrasive blends & bonds
- Lower grinding temperatures
- Increased porosity for higher stock removal

Gear Honing Benefits

- Flank correction
- Reduced operating noise
- Longer service life
- Correction for distortion from hardening process



Hermes Abrasives, Ltd.

524 Viking Drive • Virginia Beach, VA 23452 Toll free phone: 800.464.8314
PO Box 2389 • Virginia Beach, VA 23450 Toll free fax: 800.243.7637



The diametral pitch is 3.110781. Since it is not an integer number let us try a 25-degree pressure angle.

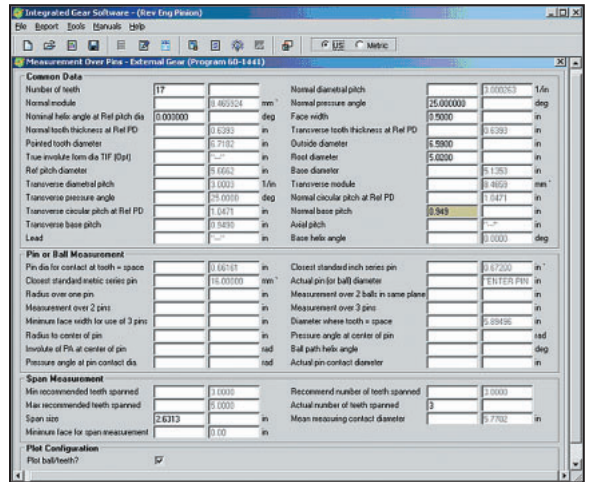


FIGURE 2

This time the diametral pitch comes out to be 3.000263. This can be rounded off to three. So, let us enter 3.00 as the diametral pitch and make another calculation, and calculate the normal base pitch. It comes out to be 0.9491 with normal tooth thickness calculated to be 0.6391.

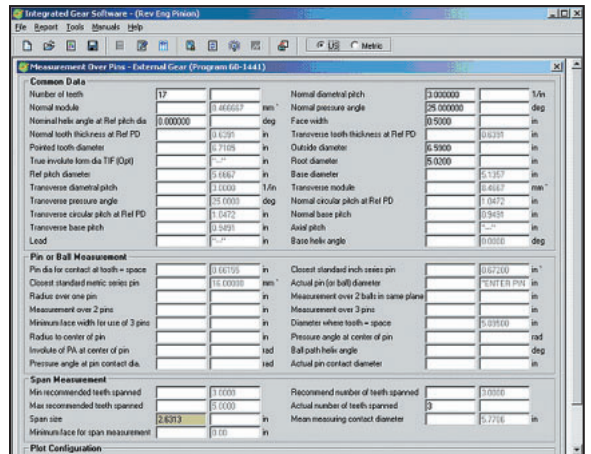


FIGURE 3

Step 5: Working with the Hob

Work with the chosen hob to determine the geometry of the gear that the hob will produce. You need to have the hob drawing or a way to measure the hob cutting edge geometry. A minimum of two dimensions will be required from the hob drawing: tooth thickness, and; tip to reference dimension. Also note the tip radius.

Figure 6 shows the data for the gear which will be cut using the chosen hob mentioned above.

THEM

US

With 8 Billion Encoder Solutions

Encoder.com

Has One Just Right for You!

Encoder Products Co.

"For World Class Performance"

© 2002 Encoder Products Co.

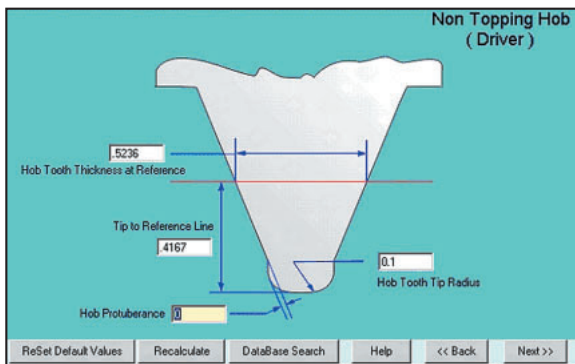


FIGURE 4

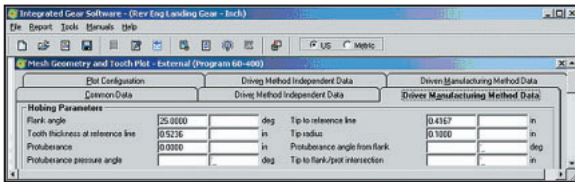


FIGURE 5

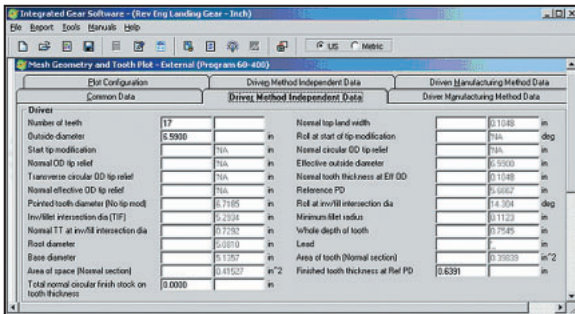


FIGURE 6

If the calculated root diameter is different from what was measured, input the measured root diameter and calculate the tip to reference line dimension for the hob.

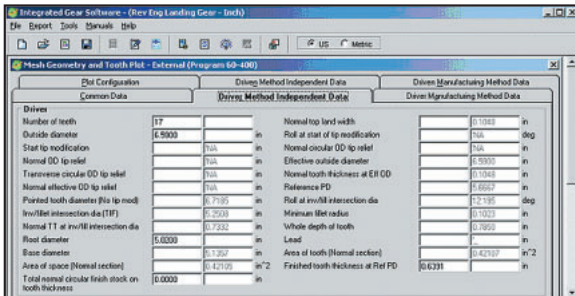


FIGURE 7

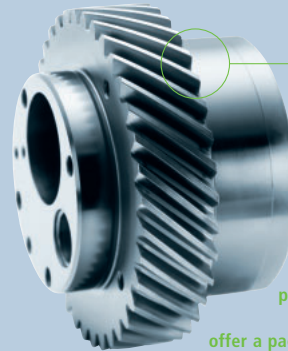
To assure that you have accurately reverse engineered the gear, get a scaled plot of the gear tooth on a transparency paper.

COMPLETE GEAR MANUFACTURING

- Gears complete to print up to 16 inches in diameter offering AGMA class 12 quality
- Gear grinding services up to 27.5 inches in diameter featuring Hofler Helix 400 and 700 CNC Gear Grinders with onboard gear analyzers
- Quantities of 1 to 100 pcs.
- Analytical Gear Charts to insure quality

Raycar
GEAR & MACHINE CO.
4884 STENSTROM ROAD • ROCKFORD, IL 61109
PHONE: 815-874-3948 • FAX: 815-874-3817
www.raycargear.com

How do you improve cutting efficiency, lower costs and increase tool life?



Ionbond offers gear makers engineered services for high value consumable cutting tools. All makes and brands of hobs, shapers and broaches can be coated to improve performance.

With global knowledge in providing innovative solutions, local Ionbond coating centers offer a package of services that include recoating, resharpening and tool management. Beginning with HP-TiN and the Maximize™ Aluminum Titanium Nitride family of coatings, Ionbond has the approach that is most suitable for your combination of machinery, material and gear geometry.

Ionbond: 1598 E. Lincoln, Madison Heights, MI 48071
Tel. 1-800-929-1794, E-Mail: info@ionbond.com.

IonBond

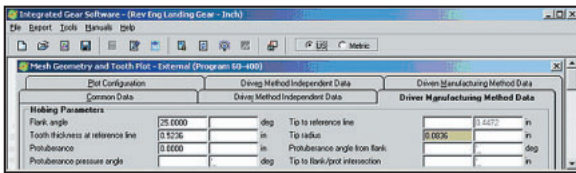


FIGURE 8

Compare that image with the image of the actual gear tooth seen on a shadow graph or other similar equipment. If the two match, great. If not, run the software again to get the required accuracy.

In the case of a helical gear you will need to measure the lead of the gear by using a lead checker or a more precise method of measurement, such as a computerized gear checker. All other steps for reverse engineering the gear will remain the same.

As I mentioned earlier, my objective is to lay out an easy to use procedure. If you found the article to be interesting, please contact me and let me know. Include other topics regarding the design and manufacturing of metal or plastic gears that interest you.

ABOUT THE AUTHOR:

Jim Marsch is gear product manager for Universal Technical Systems, Inc. He can be reached at jimm@uts.com. The company's Web site is www.uts.com.

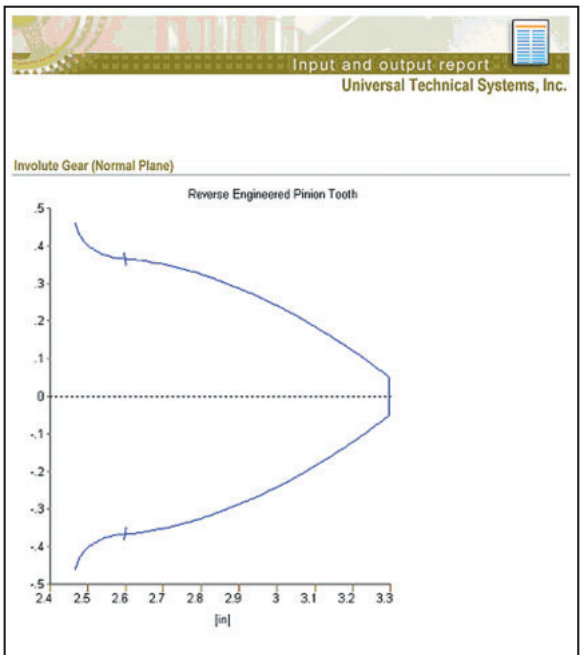


FIGURE 9

The finest quality

TRU-VOLUTE

A Leader in the Gear Tool Business for over 50 Years.

Master Gears

HOB Resharpener Service

Shaper Cutters

Gear Rolling Tester

HOBs

CNC HOB Sharpening Machine

Visit our website at: <http://www.tru-volute.com>

RUSSELL, HOLBROOK & HENDERSON, INC.

17-17 Route 208 North, Fair Lawn, New Jersey 07410
Telephone: 201-796-5445 Fax: 201-796-5664
A MEMBER OF OGASAWARA GROUP

Ultra Precise Hobs

Accuracy Class: AAA, AA, A
Materials: Carbide/Bridge/HSS
Technology: Dry/High Speed/
Hard Hobbing
Range: 10 ~ 500 Diametral Pitch

STOCK AVAILABLE

TRU-VOLUTE