



American
Gear Manufacturers
Association

Technical Resources

10FTM09

AGMA Technical Paper

Reverse Engineering

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[The statements and opinions contained herein are those of the author and should not be construed as an official action or opinion of the American Gear Manufacturers Association.]

Abstract

As Americas manufacturing base has contracted the need for reverse engineering has grown. Well established suppliers have disappeared, often leaving customers with no source of spare parts or technical support. Over time certain pieces of equipment require changes to output speeds or power levels and new parts have to be designed, built, and installed. And unfortunately, some pieces of equipment don't measure up to the demands they are subjected to and need redesign or improvement. In many ways, reverse engineering is just as demanding a discipline as original product development with many of the same challenges but plus the additional restrictions of fitting inside of an existing envelope.

The typical reverse engineering project begins with very limited information on the existing piece of equipment. This paper will describe a methodology for the reliable measurement, evaluation, re-design, and manufacture of replacement parts for gearboxes and industrial machinery. A step-by-step example will be provided.

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500 Montgomery Street, Suite 350
Alexandria, Virginia, 22314

October 2010

ISBN: 978-1-55589-984-4

Reverse Engineering

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Reverse engineering is a necessary activity in the modern industrial world. Rather than mount a defense against those who label it “copying”, the author would prefer to point out the long and honored history of the practice of studying a competitor’s product and using the knowledge gained to improve your own products. The largest, most well funded industrial organizations in the world spend millions of dollars each year on “competitive analysis”, despite what their intellectual property attorneys might want you to think. The entire automotive aftermarket sector exists because of reverse engineering. Where would car restorers be without reverse engineering?

As America’s manufacturing base has contracted, the need for reverse engineering has grown. Well established suppliers have disappeared, often leaving customers with no source of spare parts or technical support. Over time, certain pieces of equipment require changes to output speeds or power levels and new parts have to be designed, built, and installed. Unfortunately, some pieces of equipment don’t measure up to the demands they are subjected to and need redesign or improvement. In many ways, reverse engineering is just as demanding a discipline as original product development with many of the same challenges, plus the additional restrictions of fitting inside of an existing envelope.

As engineers, we have an obligation to behave in an ethical manner and to respect the intellectual property rights of others. It is recommended that any questions on possible infringement or conflict be discussed with your legal advisors before proceeding.

Reverse engineering process

The typical reverse engineering project begins with very limited information on the existing piece of equipment. Whether the need is a critical component for your own “down machine”, or a customer

with a broken gizmo in the back of his truck, people expect an engineer to develop a solution in a very short time. See Figure 1.

What is the part from?

If you know what the part is from, you can simplify your decision making later. Knowing what it is from helps you determine if replacement parts might be available from someone, somewhere. If parts are available you can often scrub the entire reverse engineering activity or get by with a temporary spare while the “good parts” are in transit. If parts aren’t available you can concentrate your efforts on making the best parts possible with a clear conscience.

Another benefit of knowing where the parts are from, is the insight it provides on the machine designer’s original intent and limitations. For example, a European or Asian machine will most certainly be “metric.” An older American machine will almost certainly be “customary units”. As you’ll see from our example, machines from the United Kingdom may be either system. The vintage of the machine will also tell you much about the materials and technology involved in its design; this is a big help in deciding the level of reverse engineering needed.

Why did it break?

There is little sense in making spare parts in a hurry if you are just going to break something else in the machine as soon as it starts up. Think “shear pins” – one can easily make stronger shear pins for an outboard motor propeller. The problem is you get stuck far from shore with an impossible to repair lower unit failure.

If the part “just wore out” you may want to ask why before making spares. Was preventive maintenance or lubrication lacking? Are related parts also in need of adjustment or replacement? Once a machine is down you might as well fix it right; the next failure might not be so easy to access.