ßEYTA GEAR SERVICE
CHARLES SCHULTZ, PE [630] 209-1652 CHUCK@BEYTAGEAR.COM

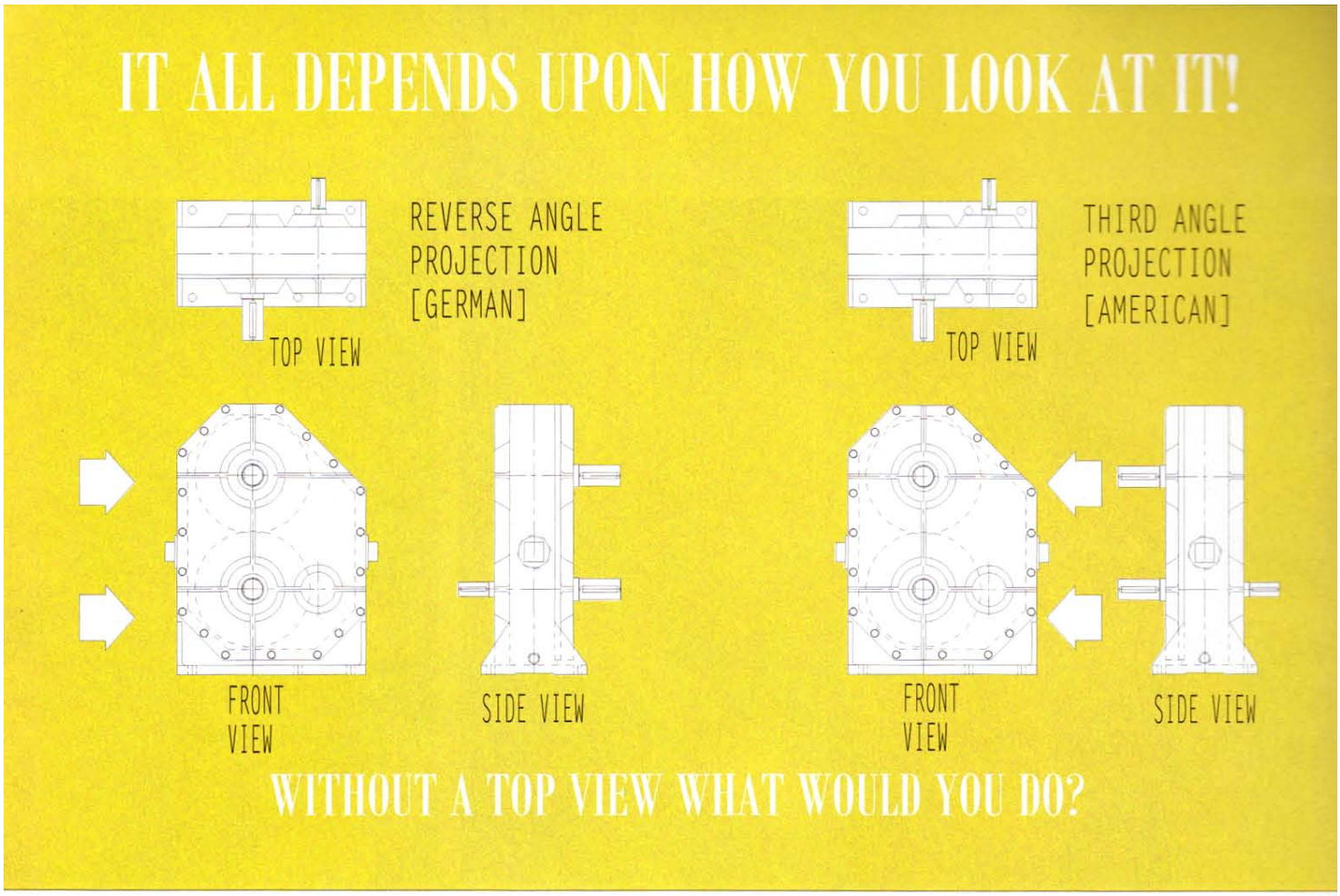
Successful Projects Depend on

One of my favorite sports stories concerns legendary UCLA basketball coach John Wooden. According to his players, he began fall training camp every year by instructing everyone on the proper way to pull on a pair of socks and to tie his shoelaces. We're also told he went over proper decorum during the national anthem! Why would the most successful coach in the history of his sport "waste" valuable practice time on something he could assume his players learned in kindergarten?

The coach knew that bunched-up socks could result in blisters or worse. An untied shoe could ruin a fast break, waste a critical time-out, or cause a serious injury. Poor conduct during "The Star-Spangled Banner" could bring dishonor upon the whole team and distract the Bruins from the important business of winning games and championships.

How many of our organizations could benefit from a regular review of the "minor details" of our day-to-day operations? Before you tell me how busy you are, consider the following examples:

1.) A certified drawing gets approved by a quick comparison to the previous German layout drawing. More than 40 units are built with the wrong hand of assembly because German drawings are made using "reverse angle projection" rather than the U.S. standard "third-angle projection."A costly, project-delaying rework had to be undertaken after a long and non-productive search for a villain.
2.) No one checks the notes on another approval drawing against the project specification and a dozen screw conveyors are built without the required anti-corrosion coating. A costly legal battle was barely avoided when coated replacement parts were rushed to the site at shared expense.
3.) A drop-in replacement gearbox for a crane is hoisted into place only for the millwrights to discover the



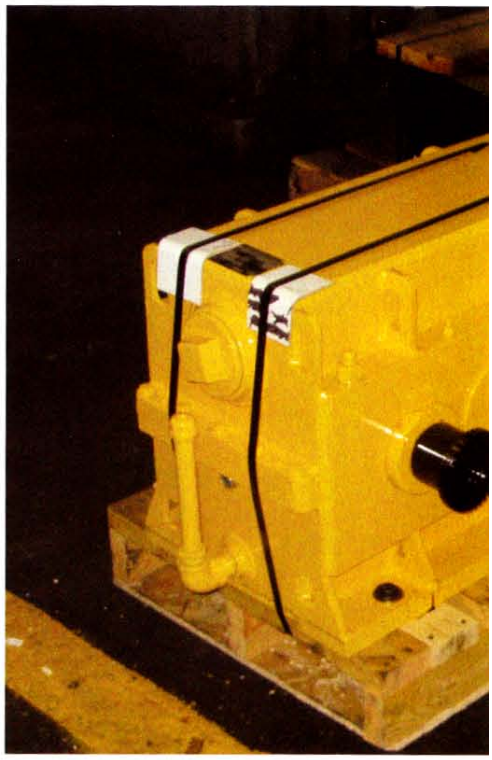
Careful Attention to Detail

foundation bolts don't line up. The approval drawing was checked against the barely legible "generic not-to-scale" print on file from the original construction. No one bothered to verify the smudged dimension against other prints from the project or to physically measure the original gearbox. The worn original had to be returned to service for a month at reduced capacity while the upgraded replacement was hurriedly modified.

If you attend trade association happy hours, you are likely to hear similar stories of minor errors that grow to major problems. Mistakes by brothers-in-law or competitors, of course. The sad truth is that we all are at risk of embarrassing lapses, and a regular review of "standard operating procedure" can be a great insurance policy. That is why pilots have pre-flight checklists and surgeons count sponges and scalpels before closing incisions.

Mistakes can be great teachers if you put aside the embarrassment and think about the root cause. Often, simple changes can be implemented with little cost in time or money. For example, once the "projection" problem cited above came to light, it dawned on the engineers involved that the "top view" of the gearbox was the same in either method. Making a "top view" mandatory on approval drawings positively prevents future misunderstandings. General arrangement drawings for process lines and architectural projects always include plan views for similar reasons.

Unfortunately, some of the situations described above can't be resolved so easily. Checking drawings against project specifications, catalog dimension sheets, general arrangement drawings, and connecting equipment requirements necessitates the cooperation of many different people, sometimes in different organizations, at different locations, and in different languages. The Internet holds great promise for speeding up this process if the inevitable file format conflicts can be resolved. We were just starting to get decent results with .dxf files from

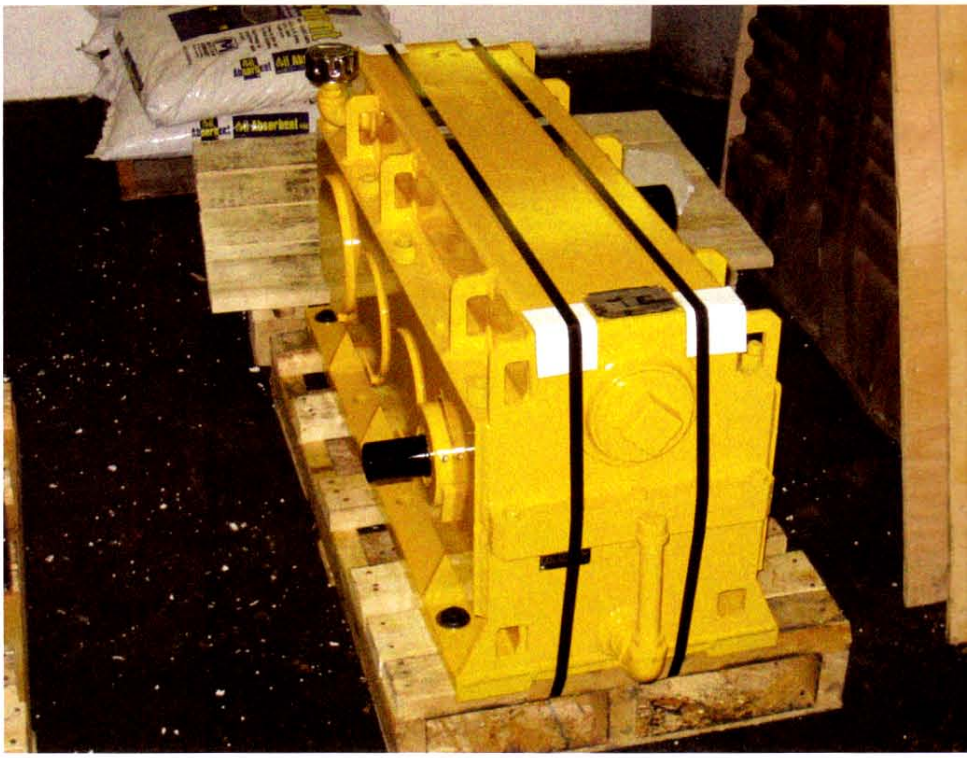


different 2-D CAD programs and had to start all over with 3-D. What would we do without .pdf and .tif files?

Language translation, of course, remains much more difficult. This places special emphasis on "getting the drawing right" because, other than the occasional projection quirk cited above, drawings are truly a universal language. Even the terse writing style of a drawing note lends itself to rapid translation. Those involved in multi-lingual projects quickly learn to construct "cheat sheets" with technical terms cross referenced into the languages needed.

Going back to our basketball analogy, drawings are the socks and shoelaces of the engineering game. We've worked with drawings so long, we take them for granted until a problem crops up. As manufacturing operations have become "leaner," separate job classifications for checkers have been eliminated, which reduces the number of different eyes looking over each document. It is also much less effective to check a drawing right on the computer screen than to print it out and literally check off each feature on the hard copy. Archived copies of "check prints" went out with the stinky ammonia-fueled blueprint copiers. None of these technological advances has eliminated the very logical reasons our predecessors invested so much effort into producing, checking and storing accurate drawings. Back in the Dark Ages before CAD, a veritable army of people were required to engineer, design, layout, draw, check, double-check, reproduce, fold and store the prints needed for a typical project. It took years for a detailer to work his or her way up the ladder to become a designer or checker. Lots of people, time and expense were needed to be sure, but also lots of experienced eyes looking for things that weren't right. We can't afford that kind of system now, but we can adapt some of the methodology used. That wonderful reference book for all things mechanical, *Machinery's Handbook,* still has a great section on checking drawings. If you don't have another qualified person to check your drawings and calculations, it is a good idea to develop your own checklist and to set aside a specific time to do quality control work.

Our third horror story was directly related to the poor quality of the print scanned into the user's electronic vault. During plant construction, it was recognized that storing hard copies of thousands of drawings for plant and equipment was an impossibly complex and expensive task. An independent contractor was hired to scan the bales of prints sent in by dozens of suppliers using the complex numbering system someone wisely imposed upon all those engineers. An operation of this sort doesn't slow down for smudges, coffee spills, or dog-



eared corners, and it was impractical to review each electronic file for quality before discarding the original. Five years later, our "problem drawing" could only be detected by someone going over every dimension on three individual prints during the redesign, and even then the significance of the issue wasn't apparent until the gearbox didn't fit.

Obviously, then, no quality control procedure is completely foolproof. In the case of approval drawings, it isn't simply a matter of introducing more people to the process. Each person in the system needs to be aware of his or her responsibilities and to diligently perform them. For the drawing preparer, this means carefully reviewing all specifications, calculations, ratings and dimensions for conflicts, inconsistencies and errors. There is no substitute for going over each dimension and each note with a highlighter or marker to ensure it is correct. If you spell poorly or are prone to transposition errors, you may need to go over them more than once.

After the document is completed, it needs to be verified against the purchase order or project specification before it is transmitted to the customer. Ignoring a special paint color or shipping instruction can be a major source of customer dissatisfaction. Once received by the customer, the document should be reviewed and approved by a knowledgeable person. This person may or may not be the purchasing authority. For questions that arise during the drawing approval process, technical and commercial contact persons should be clearly identified within each organization.

Performing these fundamental tasks can be time-consuming and tedious, but they could save you from a much worse, time-consuming problem. And, like the Bruin playing for coach Wooden, which would you prefer: checking that your shoelaces are properly tied or spraining your ankle because they weren't?

Charles D. Schultz, PE, is chief engineer at Brad Foote Gear Works Inc., located in Cicero, IL. In the gear industry since 1971, he currently designs gearboxes and modifies standard ones, both for industrial application. He's also overseen the repair and refurbishing of several hundred gearboxes from different manufacturers. Schultz authored *An Introduction to Gear Design* and the technical paper "Gearbox Field Performance from a Rebuilder's Perspective," which was presented at the 1999 AGMA Fall Technical Meeting.