Hobbing Large Gears with Custom Workholding Let ROI Blossom

While often overlooked, workholding can play a vital role for customers interested in maximizing production performance.

By Ann Pettiebone
SAVVY GEAR MANUFACTURERS NOT ONLY LOOK AT NEW MACHINES AND CUTTING TOOLS BUT ALSO FOCUS ON AND INVEST IN THEIR WORKHOLDING. UTILIZING APPLICATION-SPECIFIC WORKHOLDING FOR LARGE GEARS, LIKE THE MODULAR PEDESTAL TYPE FIXTURE DESCRIBED IN THIS ARTICLE, CAN MULTIPLY THEIR TOTAL PROJECT RETURN ON INVESTMENT SIGNIFICANTLY.

When changing from a traditional style of fixture to this innovative fixture, customers experience a reduced set up time of 40–50% and an improved in-process run time of over 50%. Designing and building this type of fixture requires an effective design protocol and, sometimes, a little help from nature.

Workholding in the world of large gear manufacturing has several challenges, and these challenges are present whether a company is working with new or existing machines. In general those include:

- Managing the weight and size of the gears
- The need for and ease of indicating in the part
- The skill of the operators
- Floor space conservation.

If you are an OEM or a gear manufacturer that needs to run a wide range of part sizes with short run volumes, there are additional variables to manage. The challenges go one step further if you add multiple families of part sizes to the manufacturing mix and those part sizes present a considerable range of face widths, bore sizes, and root diameters. By using a modular pedestal design concept that takes on the look of a flower bud growing to a full blossom as it accommodates larger gears, significant results are produced, similar to a successful concept we have used for gear grinding applications (Figure 1).

Recently, a customer came to us with a complex challenge where, together, we determined that a new evolution of the pedestal fixture might meet their requirements. The customer had
purchased a new Hoefler HF 900 gear hobbing machine and was committed to fully utilizing this new investment. They asked Drewco to design fixtures to maximize their production capability and equipment investment. This customer requested workholding fixtures that could hold 400+ different parts with a bore grip range from 2.5” to 15.5”, root diameters of 10” to 37”, and face widths from 1.5” to 12”. The gears in the group weighed up to 2800 lbs.

THE DESIGN PROCESS
A successful design and build outcome with this type of project requires a several step process, including: considerable data collection, ongoing communications with the customer, a review of the customer’s current methods, and an options analysis process.

DATA COLLECTION
When customers have multiple desired outcomes for their new workholding, the design process must always begin by looking at data, such as:
- Number of families and parts to be manufactured
- Size of the parts
- Volume of parts needed per size
- Frequency of parts needed per size
- Size variability of the parts

In the data collection phase, we also review the machine capabilities, the available skill...
level of the operators, and any other priorities the customer may have. Throughout the data collection stages and continuing through the whole project, communication between design staff and the customer is paramount.

COMMUNICATION
The focus of multiple conversations with the customer is to listen and learn as much as possible about the customer’s needs, process, and expectations. At Drewco, for example, we have been designing workholding for over 66 years and offer an experienced perspective that the customer may not have. Our customers are very busy managing their production and manufacturing tasks (plus probably fight a few operational fires daily). On the other hand, often the customer knows aspects about their product, production, other equipment and processes that we do not; thus, the importance of collaboration between workholding design firms and customer end users.

I believe part of that collaboration is having a “no assumption” policy: Important results and cost savings can be overlooked if the workholding design firm or the customer assumes the other knows what they do. Including a variety of people in these conversations—from operators to senior managers—produces the best results.

Choosing between a conventional design approach and a more innovative solution involves aligning the customer’s needs with the variables present, identifying any constraints, and looking at the workholding and production methods currently in use—it is often possible to produce cost savings by utilizing some of a customer’s existing components.

LOOKING AT THE CUSTOMER’S CURRENT METHODS
One common option historically used for hobbing large gears involves the use of multiple rough locators—one for each gear bore size. Like the customer in this example, many firms use (or have used) this method of having a simple ring- or plug-type rough locator and gear specific part stops. This type of fixture usually also includes part specific threaded rods and clamp plates to face clamp and secure the part, and with a skilled operator, tight tolerances with minimal TIR can be achieved.

Fig. 6: Pedestal fixture positioned for largest root diameter and largest face width.

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The downside is that it is hard to indicate, time consuming, labor intensive, and requires skilled operators for both set up and cycle time. It also requires a large library of components. This means considerable extra cost in multiple components, their maintenance, and floor and/or storage space required.

ANALYZING AND WEIGHING OPTIONS
The best designs evolve out of the review of the customer’s data and pinpoint the most cost effective way to improve production. It is important to ascertain what is most important to the customer’s bottom line. In general, when you have a family of gears to produce and each part size has high...
volume runs, improving set up time is less important than improving run time. Inversely, when you have a large number of parts with primarily short production run requirements, improving the set up time often trumps the production time improvement (Fig. 1).

In this example, our customer requests included set up reduction. Set up reduction can be accomplished in different ways. We considered the popular set up reduction option of a quick-change base system; this can be an effective tool. Drewco produces several types of quick-change fixture bases and top tooling, including fixtures that match up with the quick-change bases that are also provided by machine tool builders like Liebherr and Gleason (Fig. 2).

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These systems can allow for set-ups to be done outside of the machine and work well with longer runs. Because of the number of gears sizes and their shorter production runs, we took some aspects of the quick-change base concept to address part size families and combined it with features that added more flexibility.

This customer was fully committed to maximizing their machine investment and did not want to leave any potential production advantage on the table. Their wish list was comprehensive. Specifically, they were looking to reduce set up time, to improve run time, and to accommodate multiple part families and part sizes. They also wanted to minimize and standardize the number of needed components and make changeovers easier for the operator. Strange as it may seem, this is just the type of project Drewco enjoys both designing and building.

USING DESIGN PROTOCOL
Drewco followed our design process protocol for this project beginning with data collection. We started with spreadsheets for more than 400 gears from three separate product lines. We looked at the face widths, bore diameters and root diameters of each. The next steps included populating new spreadsheets for the 400+ gears based on volume, frequency and size; creating new family groups with similar part characteristics.

We went on to have multiple customer communication sessions—information gathering conversations to verify things like usage, average run lengths, machine envelopes, etc. In addition, we talked with people from the shop floor to get their input on the current process and ascertain their requests regarding the new fixtures. We heard any potential concerns about new fixturing. Ease of indicating, part handling, chip build up and means of lifting all got discussed fully in these sessions. Conversations also included both exploratory and design proposals, onsite meetings with engineers, production managers, and operators together.

THE BLOOMING OUTCOME
Like all good design processes, this design evolved through the input from all involved. The outcome was a fixture design that includes movable and re-positionable pedestals that give it the appearance of a flower blooming. It appears in a “bud” stage (Fig. 3 and Fig. 4) when it is set up to
hold gears with the smallest root diameters, progressively “blooms” to hold larger root diameter parts, and finally blossoms when it is fully extended to hold the largest root diameter gear (Fig. 5 and Fig. 6).

The movable pedestals slide on T-slot tracks and replace the size specific part stops of the older method. Collets replace multiple rough locators. Multipurpose clamp plates reduce the number of clamp plates required. The modular design’s drawbar post/extender activates the collets as well as face clamps the parts. This creates a situation where the machine now does the centering and the clamping, removing the need for the operator to manually clamp or indicate in the gear blank. The design also allows for the full utilization of the machine stroke.

**BLOOMING SET UP REDUCTION**

Richard Meyer, one of Drewco’s design engineers explained, “The old way to set up a wide range of parts with short runs was to use rough locators on the bore, part stops, and clamp plates for each root diameter and threaded rods for each gear face width. During set up, each new gear needs to be indicated into place to minimize TIR.”

Set up in this pedestal scenario is done through sliding the pedestals to the new needed root diameter. The collet is changed to the new bore size and depending on the difference from the former part size to the new part size the clamp plate may or may not need to be changed. Companies do not need a rough locator for each bore size and a set of part stops and threaded rods for each gear face width.

**RUN TIME EFFICIENCY ADDRESSED**

Increasing run time efficiency has multiple aspects. Shortening the in-process change over time and the actual run time maximizes the full potential of the machine.

Meyer went on to explain, “During in-process cycle time (change over within a run of same size parts), the older style fixture design requires that the operator remove the clamping nut and face clamp, replace the finished gear with a new gear blank, replace the clamp plate and nut over the gear, manually indicate the gear to within tolerance. After these steps the operator uses a wrench to manually clamp the part into place and there is often the need to re-indicate the gear making sure the clamping did not disturb the gear position. Indicating alone can take 30 to 40 minutes depending on gear size and operator expertise.”

**BLOOMING RESULTS**

Fulfilling commitments to the customer requires an important return on their investment. Review data, including before and after times for set up time, run time, and customer feedback. This type of fixture produces dramatic results. In this example, it replaced the old style multiple rough locator system.

**SET UP REDUCTION RESULTS**

With the fixture shown here, customers can improve their set up time by 40%.
With hundreds of gear sizes to set up, the 40% improvement in set up time compounds the benefits the customer receives. Incorporating operator feedback, the fixture includes one common sub table and one common riser to address ergonomics requirements. Sub assemblies (pedestals, collet activating nose, etc.) sit on the base plate (Fig. 7).

As we began this project, it was originally thought that three sub assemblies would be required to accommodate all of the gears sizes. Through the communication steps of the process and our customer’s willingness to work closely with us, Drewco was able to reduce the number of sub assemblies needed from three to two. This further reduced the changeover time and significantly reduced the project costs.

**RUN TIME IMPROVEMENT RESULTS**
The 57% improvement our customer now enjoys in improved run/cycle time is an equally important outcome. The pedestal design fixture provides this type of run time improvement not only through quicker changeovers from gear to gear as described, but also through the rigidity designed into the fixture, which allows the machine to run faster while producing quality parts.

**FUTURE EXPANDABILITY**
We feel strongly that good workholding should, whenever possible, have expandability built into it. The flexible nature of this fixture allows it to accommodate additional future part sizes; in this case our customer has already added 20 part sizes with only the addition of three new collets (Fig. 8).

**SAVING SPACE AND COSTS**
As requested, this fixture design increased available floor and storage space due to its flexible and compact nature. Instead of needing to handle and house multiple tooling components for each part size, now the customer stores only collets and the one sub assembly that is not in use.

**IN CONCLUSION**
A project like this requires an enlightened customer, a well-defined process, and plenty of calculations, listening, planning, and discussion with the customer. The end result: A nature-inspired, uncomplicated solution that met all of the customer’s requests. By growing projects with effective design protocol, this blossoming design now produces dramatic and important investment returns, and those returns will continue to grow.

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