Converting Screw Machined Parts to Cold Formed Parts

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In this day and age where customers are expecting more suggestions and input from their suppliers, a recommendation to convert a part from screw machining to cold forming could provide advantages.

As more customers and OEMS reduce engineering and purchasing staffs, they are placing greater dependence and responsibility on their vendors and suppliers to generate both quality and cost improvement ideas. If your customer only purchases standard cold formed fasteners, providing ideas might prove to be a real challenge. However, if your customer's product is either complicated or its purchasing or engineering resources are not well educated in cold forming technology, there may be an opportunity to conduct a value engineering exercise and review the possibility of converting screw machined parts to cold formed parts.

It should be clearly understood that 80% to 90% of the opportunities one might look at are in fact not opportunities at all, as the engineers and designers have employed the correct process technology. However, in those remaining cases where opportunity resides, the advantages and results of conversion may be very compelling, and provide leverage to both develop a customer relationship and expand one's part portfolio.

This article is going to explore the three primary considerations one should review when attempting to convert a screw machined part to a cold formed part. Although absence of these three considerations does not equivocally exclude a part, it does dramatically reduce the possibility that it is a good candidate for conversion.

Will There Be Cost Savings?

The first, and in many customers' eyes, only consideration is cost savings. Unlike the cold forming process, which is designed for minimal or no material loss, screw machining involves material removal and often a significant amount. From a cost perspective, this handicaps the process in two ways. It generates material scrap, which with exotic alloys or red metals can have a significant impact on cost, and it produces long and costly cycle or process times.

How is Throughput or Yield Impacted?

The second consideration is throughput or yield. Although the screw machining process makes a great deal of sense for small lots and runs of parts with complicated geometries, the pendulum swiftly swings the other way as lot sizes increase. This is quickly understood when one compares screw machining run rates of maybe several parts a minute to cold forming run rates of up to several hundred parts a minute.

What About Mechanical Performance?

The third consideration involves mechanical performance. Because cold forming and thread rolling deform and reposition the material, the grain flow is realigned with the shape of the part. In other words, if a head or collar is formed, the axial grain of the material is "bent" around as those features are formed. This realignment can provide significant additional strength.

This can be illustrated with a simple example. Anyone who has ever split an oak log for firewood can appreciate this phenomenon. If the log being split is from the clear, center section of the tree, the log splits cleanly down its axis with minimal effort. However, if a similar log had a branch sprouting from the side, so that the grain was bent around the protuberance, one can attest that the effort to split the log through that bent grain portion is considerable.

Additional Specific Characteristics

Although the above three points represent the primary considerations in a general sense, there are a number of specific characteristics one should look for when reviewing whether a part is a good candidate for conversion. These specific characteristics include the following:

- ***Round Parts With Multiple Steps and Transitions:*** Multiple diameter reductions are common and well suited to the cold forming process. However, in screw machining, each reduction represents increasing metal removal time and scrap.
- ***Round Parts With Collar or Significant Diameter Differences:*** When the diameter differential is small, as one finds on many shafts or pins, there may be little advantage to cold forming. However, when that diameter difference is significant, once again the metal removal time and scrap can be substantial.
- ***Parts With Internal Recesses:*** The screw machine process is unable to form internal recesses. To achieve such internal drive features, costly secondary drilling and broaching operations are required.
- ***Parts With External Hexagonal Features:*** Although hexagonal bar stock is commonly utilized in screw machining, if the hexagonal feature is smaller than another feature on the part (such as a washer or flange feature below the hex), the process will require milling or some form of secondary operation. These would likely be time consuming and expensive compared to the trimming or forming processes employed in cold forming.
- ***Parts With Internal Bores:*** Long or stepped internal bores can be time-consuming metal removal processes and may be more efficiently created using a cold forming, back extrusion process.
- ***Parts Made of Expensive or Exotic Materials:*** Today, even steel is expensive, but this is quickly magnified when one is working with red metals, aluminum, nickel-based and other exotic materials. In cold forming, there is little or no waste of material, whereas a screw machining process may remove a significant portion of the pre-machined bar.

When material costs are four to five dollars a pound (or much more for the nickel and exotic alloys) the savings can add up very quickly.

- ***High-Volume Parts:*** It is difficult to say there is a specific rule of thumb here, as each case needs to be reviewed on its own merits. However, once a part begins to approach an annual usage of one hundred thousand or more pieces and possesses one or more of the other considerations for conversion, it would normally become a good potential candidate.
- ***Parts With Special, Extruded or Trimmed Features:*** Often parts require special flats or splines that allow them to lock something in place or transmit power. These features would normally require the screw machine version to be milled or broached, while it might be possible to form the same feature by extrusion in the cold forming operation.
- ***Parts Requiring Extra Strength or Fatigue Resistance:*** Cold formed and roll threaded parts, as previously described, provide mechanical performance benefits that increase strength or fatigue resistance.

These are all specific considerations that one might review when considering parts for conversion. The following case studies provide real examples of how these considerations were employed in order to convert a part that was screw machined to cold formed.

One of the significant advantages of screw machining is the tighter tolerances that can be achieved using this process. Therefore, it would be commonplace to include secondary operations on the cold formed blank to end up with an equivalent part to the screw machined version. Naturally, this may offset some of the savings that could be obtained by conversion, yet as these following examples illustrate, the improvements are often so compelling that even with the offset they make good sense.

Case Study 1: Aluminum Piston

Figure 1 illustrates an aluminum piston. This part was originally screw machined and then precision ground to obtain required dimensional tolerances on the shank.

Figure 2 shows the external view of the cold formed blank and the internal section. One immediately notices the significant reduction of material from the collar to shank diameter and the long internal bore. Although the outside of the cold formed blank required multiple secondary operations, the internal bore was back extruded complete.

In this case, the conversion to a cold formed part saved significant cost by reducing the amount of expensive aluminum scrap, by reducing the metal removal time on both the exterior and internal bore and by increasing the strength of the part's collar.

Fig. 2 — External view of the cold formed blank and the internal section.

Case Study 2: Spindle

Figure 3 shows a spindle, which was originally screw machined. On the right is the cold headed blank and on the left the finished part.

It should be noted that the cold headed blank pictured in **Figure 3** was an early prototype and does not include the extruded double flat on the end, which is seen on the finished part. The final version integrated these flats in the cold forming process.

Although there were secondary operations required on this spindle part, the cold formed version provided increased strength to the collar, threads and flats on the end as well as reduced the overall manufacturing time, reduced scrap and provided sufficient capacity to fulfill the high-volume requirements.

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Fig. 1 — Aluminum piston.

Fig. 3 — Spindle that was originally screw machined.

Case Study 3: Aluminum Piston

Figure 4 illustrates another aluminum piston. This aluminum piston is one of a family of similar parts that have been historically produced in a screw machining process. The right illustration shows the finished part. One can see the complex geometry and can envision the precise tolerances that go with these features.

Although at first blush this may look like it would be best screw machined, it is also an excellent example of a potential candidate for conversion.

Fig. 4 — Another aluminum piston.

Like the example in the first case study, there is a significant diameter differential, and being aluminum, cold forming significantly reduced the amount of expensive scrap and time-consuming metal removal. Additionally, the cold formed version of this aluminum piston required secondary operations to machine the top and to point the end. However, even with these operations the reduction in process time was noteworthy.

In an additional interesting development, this aluminum piston part was originally tempered to a T6 aged condition after forming. However, eventually a process was developed to use wire in the T6 condition, forming the part into a finished complete state and providing additional cost saving advantages.

In Conclusion...

There are usually compelling reasons that a part is screw machined, so that true candidates for conversion are in the minority. However, in those cases where parts possess some of the characteristics discussed in this article, the cost savings can be significant.

In this day and age where customers are expecting more suggestions and input from their suppliers, and suppliers are looking for ways to stand out from the crowd, this is one tool that may be worth pursuing.

For further discussion on converting screw machined parts to the cold forming process, contact the author by sending an email to *lsclaus@sbcglobal.net*. FTI