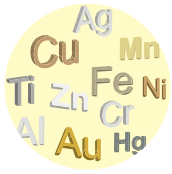
# The Uniqueness of Miniature Fasteners

by Laurence Claus

Almost a year ago now one of my sons undertook a project to help his good friend rebuild his dad's shattered screen Apple iPhone. He went online and found a screen replacement kit and ordered it. When they received the kit, they did what any other resourceful youth would do today, they brought up an instructional video on YouTube and got to work. I was quietly watching the process and became very intrigued when they started to extract one micro screw after another. I did not keep count but I believe the process involved taking out about twenty or more different screws.

As the project progressed I noted that my son and his friend had no problem removing the existing fasteners but reassembling them was more of a challenge. In fact, they had to ask me to assist them with about five or six of the screws that they were really struggling to get restarted.

This exercise was a valuable illustration to me of the challenges of working with micro hardware. In fact, it is challenging every step of the way from producing the raw material, forming the part, to its final installation in the end product. This article will explore the journey that a micro screw makes from beginning to end.




## Raw Material

The finished wire used for cold forming screws normally starts out with a large continuously cast billet. These billets are usually square or rectangular in cross section and in the neighborhood of 125 to 175mm per side and perhaps 10 to 15 meters in length. These are then broken down in the hot rolling mill to a round rod that generally is anywhere between about 13mm to 38mm in diameter. Final wire size requires taking this "intermediate" rod and cold drawing it to a near-final or final size. This is not that complicated when drawing rod to size for fasteners in the standard size range, say 6mm to 10mm, as it usually only takes one or two drawing passes. The process, however, is a little more complicated when the wire diameter becomes very small, as would be required, for example, for a 1.2mm screw. To achieve the necessary diameter the wire must undergo multiple drawing passes. This requires what they call a "multi-hole" wire drawer, meaning that the wire is passed through a series of draw dies, each progressively reducing the diameter down in small to moderate steps. If the wire must be passed through many of these steps or if the material is subject to accelerated work hardening, the wire may have to undergo an intermediate annealing step between every couple of draws. This makes very small diameter wire more complicated and expensive to produce.

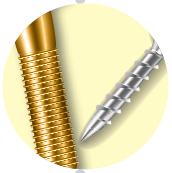
## Cold Heading

The tooling, process, and machines are no different from standard cold heading processes except for the size. The fully assembled cold heading dies and punches can easily fit in the palm of one's hand. Although this makes handling such a die compared to those from larger machines that may weigh many kilograms relatively easy, it poses problems with construction and measurement. The micro-features that have to be constructed into the dies or punches may take extreme precision to make and may be too small to be feasible for some in-house or vendor capabilities. Therefore, tooling which may often be standard to fabricate or order from trusted vendors, such as simple inserts and punches may not be available from regular vendors and require purchase from specialized tool sources. This limited supplier pool can raise issues related to procurement timing and costs.

The cold heading machines utilized to make miniature parts usually don't function any differently than larger machines. In other words, they perform the same duties as their larger counterparts and have mechanisms that operate in an equivalent manner. Again, the primary difference is size. Miniature headers resemble toys or salesman samples when situated near a large header.

In a similar vein to the raw material and tooling, there would seem to be advantages to the smallness in size, especially when it comes to handling. However, just the opposite is true. It does not take a large volume container to capture a high quantity of micro screws. Therefore, manufacturers that usually are making larger diameter products may be attempting to capture them in their standard size catch pans. It is very common to have significant inventory loss at this stage because of non-optimal collection practices and the very small size of the blanks. In-process quality checks can also be challenging and usually require some sort of lighted magnifying device be available.

## Thread Rolling

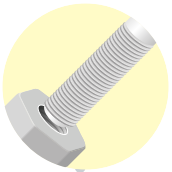


Thread rolling has many of the same challenges as the cold heading process. Two additional challenges arise, however. First is getting the blanks successfully fed into the roll die. This can be especially challenging when the part has a countersunk head configuration, is very short, or has a lot of oil on it. In these three scenarios it is difficult to get the parts fixtured or moving in the feed rails. The second challenge is validating the thread. The small size makes utilizing a System 21 thread gauging process difficult. Just like in the heading process, capturing and transporting the rolled threads can be challenging. I have actually heard and seen machine operators use items like coffee cups to collect and transport these micro screws in. Although the size is effective, coffee cups are really not an appropriate container for a fastener manufacturing environment.

## Outside Vendor Operations

If handling the parts seems like a challenge for the forming and thread rolling processes, it is minor compared to the challenges for heat treaters and platers. Commercial heat treating and electroplating operations for fasteners are designed to be completed in bulk. The equipment and processes utilized attempt to cover as broad a size range as possible, but are just not suited to the really small micro screws. In fact, the screws would likely get trapped in the heat treating furnace belt or fall through the holes of the plating barrel. Therefore, vendors for these types of parts either have to have equipment designed and dedicated to micro screws or have a way of containing these small fasteners so they can be used with normal equipment in the normal process. Once again, this may limit the number of sourcing choices available.

## Assembly



The challenge of using these types of fasteners does not end with the manufacturer. In fact, these small screws can be quite challenging for the assembler as well. They have to specify special screw driving equipment that is also small in size so that it limits the amount of torque being applied, easily engages and holds the drive feature (usually an internal recess), and can be easily loaded onto the tip of the driver. This last piece is often challenging because of the small size and associated length prevents parts from being automatically fed into drivers like larger standard parts may be. Often times assemblers depend on a magnetic bit to pick up a part from a common tray. This, however, is not always possible, especially if the screw is made of a non-magnetic stainless steel.

## Other Considerations

Interestingly, fastener pricing usually follows an inverted bell curve as a function of size. This means that the least costly fasteners are somewhere in the midsize range and begin to get more expensive as they get bigger or smaller. This makes sense as fasteners get larger because there is more material needed to make the fastener but may be counterintuitive to some with these smaller screws. However, the process and handling complexity at every production stage described above coupled with the limited vendors for materials and services serves to raise the cost on the smaller end. In fact, the smaller the part, the more costly one can expect it to be, even if it has virtually no material content.

As already introduced quality is also complicated with micro hardware. The size makes it much more difficult to see and to use gages. Some characteristics can only be validated if there is a tool that will sufficiently magnify the parts and make performing the check feasible.

## Wrap-up

In summary, micro hardware is a very interesting niche fastener market. Although micro screws would seem no more difficult to make than any other fastener, they are. This means that not every fastener manufacturer should try to make such product and those that do, must become experts through experience.