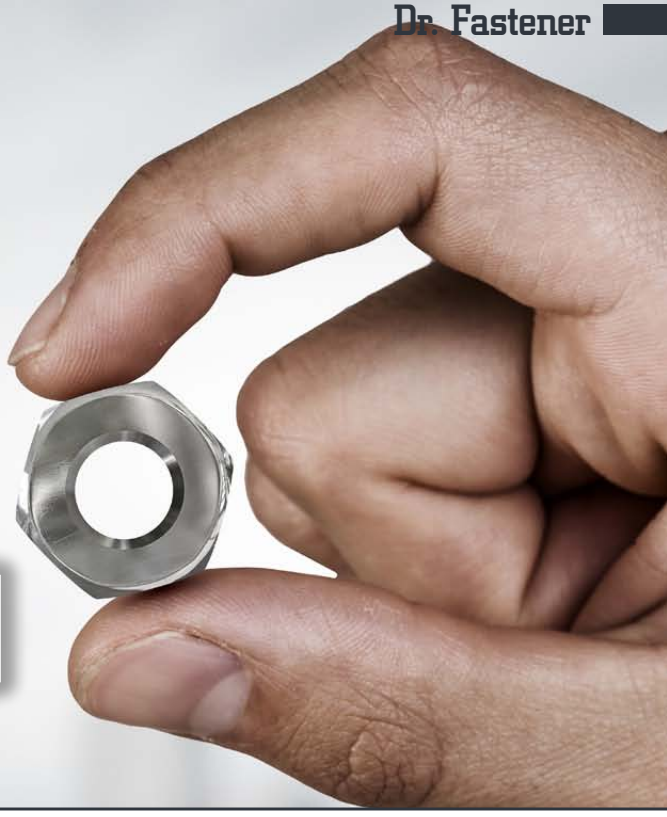

Common Problems Faced by Manufacturing in Nut Processing

by Laurence Claus

Nuts, bolts, and screws, are usually manufactured in high volumes, which necessitate high speed manufacturing processes. When these processes are working correctly everyone is happy, but they are complicated and subject to occasional problems and glitches. This month Dr. Fastener is going to answer some questions related to common manufacturing problems and concerns in nut processing.

What is unique or different about nut manufacturing?

Nuts, like screws and bolts, are, generally, a high volume commodity. As such, the most predominant method of manufacturing them starts with cold forming a blank. However, lower volume or large size nuts more often use hot forging or screw machining techniques. For the purposes of this article, we will limit our discussion to the cold forming manufacturing method.

Therefore, when comparing nut products to screw and bolt products, a couple of significant differences immediately present themselves. First, the Aspect Ratio (or relationship between height and thickness) of nuts is almost always very "short and squat". This geometry is uniquely different than the "long and skinny" geometry of screws and bolts, and means that we are unable to use the same cold forming machines. **Nut Formers are usually faster, more nimble, multi-station formers. They will almost always be designed with a short stroke, since they do not need to push long parts out of the dies.** Secondly, nuts have either hollow blind or through-hole features. Although nut designs may incorporate all of the cold heading capabilities; upsetting, forward extrusion, reverse extrusion, and shearing, **most standard nuts rely heavily or exclusively on reverse extrusion processes.** This results in a very different engineering and progression process than utilized in making screws and bolts. Thirdly, for ease of manufacturing, the reliance on reverse extrusion and hollow or through-hole features necessitate the ability to flip the part over to work each end from either the die or punch side of the machine. To facilitate this, **nut formers are usually equipped with Universal Transfer Mechanisms rather than a straight across Bolt Maker Transfer.** The Universal Transfer allows the part to be flipped between stations so that both ends can be alternatively presented to the punch and die. Lastly, with through-hole nuts a thin web of material must be pierced to achieve the through hole. Whereas with bolts that receive a trimmed head and pushed through the die, nut piercing involves shooting a pin through the part to pierce the web. The nut is carried back towards the punch on that pin, where it is stripped off and exits the machine.

Getting threads into nuts is also uniquely different than on screws and bolts. **Nut threads are tapped by either plunging a tool in and out of the nut blank or by through-feeding the nut blank across the tap.** Tapping can be either a cutting or forming process.

Nuts that are to function as "Lock Nuts" must have the locking feature incorporated. Most lock nuts utilize one of three different methods; Side Locking, Top Locking, or Top Locking Insert. Although there are some analogous locking mechanisms for externally threaded fasteners, they are fundamentally different than those used in nuts, making the manufacturing methods for nuts unique.

What are some common problems experienced in forming nuts?

Likely the number one problem experienced in forming by nut manufacturers is set-up. The Operator just can't seem to get the machine set-up correctly to successfully make the part. These problems can stem from a number of potential issues including engineering, operator error, tooling, and tool materials.

1. Engineering:

Nuts are made in multiple, incremental steps. When the process is "engineered" the Process Engineer must figure out what he/she wants to accomplish with each step. These are called the "Progressions". If the order isn't correct or he/she is trying to do more than the operation is capable of producing, problems may ensue. Normally these issues are discovered during the PPAP or ISIR run and fixed then. However, it is possible that progressions which initially work or have worked for many production runs suddenly do not work on a particular run because some other variable has changed, exposing that one or more of the progression steps has exceeded an important boundary because it was designed near a functional limit.

2. Operator Error:

There are many different possibilities for operator error. An operator may be inexperienced or simply having a bad day. One method that is helpful to address this, and often required by many customers, is to have a Process Control Plan for each operation. If these, and perhaps augmenting Work Instructions, are detailed enough, they can provide a powerful tool for operators to use to help get set-up right the first time.

3. Tooling:

Tools are not always made correctly or operators have "tweaked" them to a point where they are no longer capable of producing the part to specification. For new tools, having some system of incoming certification or developing suppliers can often prove helpful in solving chronic problems. Everyone likes to get a bargain, but working with a tool supplier that chronically supplies substandard tooling is no bargain at all. Therefore, developing and maintaining good tool suppliers is critical to problem free manufacturing. Additionally, tools are often "tweaked" to get them to work the way an operators wants them to. That "tweaked" tool which worked with one coil of wire may not work for the next one. Operators or Tool Room personnel should have some way to record changes that have been made to tooling, so that these they can be easily and quickly ruled out during troubleshooting.

4. Materials:

Manufacturers find that different tool materials work better for some parts or in specific progressions than other materials. When the optimal material is performing sub standardly or is substituted with a different material, problems often occur. With shortages due to the COVID pandemic, some manufacturers have been forced to substitute optimal tool materials with the next best alternative. This has created some industry problems.

The Universal Transfer sounds complicated, does it exhibit unique problems?

Transfer Mechanisms on all cold heading machines preform a critical but intricate function. Universal Transfers are not any more prone to problems than other styles of transfer mechanisms. Once the mechanism is properly "dialed in" and working correctly, they are pretty problem free. This is not to suggest that an operator can get it working and just walk away from the machine, like all the moving parts of the machine, they must always be vigilant for brewing problems.

Like any transfer, the operator must get the Universal Transfer properly timed. The transfer mechanism must grab and hold the part at just the right moment, transfer without dropping the part, and release it at just the right moment. That can be an intricate "dance" and requires some experience by the operator or set-up person to get right. However, once all of these variables are properly set, the transfer mechanism should run without many problems or glitches.

Does having a wide selection of machine brands cause problems?

The best answer here is probably yes and no. There is no doubt that having multiple different equipment brands may mean having separate tooling and spare maintenance parts. It also requires more rigorous education needs as engineers, operators, and maintenance personnel all have to be trained and skilled in multiple machine formats and operation.

Therefore, the answer to this question strikes at the heart of a manufacturer's personal philosophy or need. In other words, the manufacturer may adopt a philosophy that having all one brand of equipment is advantageous. Perhaps one of the best examples of this philosophy in practice is the U.S. regional air carrier Southwest Airlines. Not only do they only purchase aircraft from Boeing, but all aircraft are the same model, the Boeing 737. In setting up their operation this way, they significantly simplify training of personnel and maintenance of their fleet. However, a similar strategy may not prove feasible for all nut manufacturers, as they may need a machine to provide a specific capability that is not available with their preferred brand or model of machine. Therefore, it is probably fair to say that having a wide selection of machine brands complicates the overall manufacturing operation, but, when properly managed is not a problem.

What are some of the common problems experienced in tapping?

Perhaps the four most common tapping problems are:

1. Slivers and Debris in the threads
2. Broken Taps (Especially in blind hole nuts)
3. Worn-out Taps which result in rounded, chipped out, and undersized threads
4. Improper Feeding

Like all manufacturing problems, these all have solutions. If any of these are chronic problems to a manufacturer, they should engage in continuous improvement and problem solving activities to determine ways to reduce or entirely eliminate the problem.

What are some common problems associated with Lock Nuts?

It should first be understood that these products which we refer to as "Lock Nuts" usually do not actually permanently "Lock" the nut in-place on the screw or bolt. These products are more appropriately categorized as Prevailing Torque nuts. This means that they generate some additional interference or friction which places an added torque in the system that makes it more difficult for the nut to spin off. There are three primary styles of these types of nuts: Side Locking, Top Locking, and Top Locking Insert. All three categories depend on a mechanical feature or component to provide the desired added interference. Most problems arise from variation in this desired interference spanning a range of little or no added prevailing torque, making it difficult to distinguish between a plain nut and a locking nut, and too much prevailing torque, making it difficult or sometimes even impossible to assemble.

These application problems and variability stem from the manufacturing process. In both the side locking and top locking variants, if the impressions made in the nut are over or under deformed or located in the wrong place (such as near the corner of the nut rather than the center of the flat) they will either generate a lot of application variation or simply not work correctly. These errors usually are a result of improper feeding, insufficient air or mechanical pressure, or broken and worn tooling. In top locking insert nuts, problems can stem from the insert component not being properly produced to the insert retention feature in the nut not being formed or pressed down correctly, allowing the insert to fall out. Additionally, most of these insert nuts use a Nylon insert. Nylon is hygroscopic, meaning that it absorbs or releases moisture depending on the moisture content in the surrounding atmosphere. The resulting swelling or contraction can dramatically impact the manufacturing results.