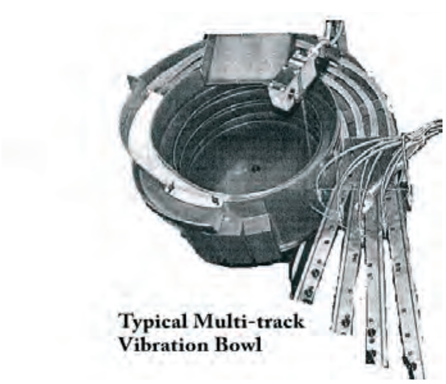
Fasteners for Automation

by Thomas Doppke

Fasteners come in familiar packages. Their dimensions and appearances are so common that no questions are ever raised about changing anything related to them. However, fasteners are used in many automated devices, from feeder bowls to assembly line robotic handlers, and problems occur. There are factors to using fasteners in such equipment that are seldom ever considered. The physical characteristics of the fasteners impact how well they can be adapted to automated assembly techniques.

The two main areas of automation in fastener installation assembly are automated feed with some human interaction and robotic handling. In many assembly lines and in sub-assembly work, fasteners are fed to the line by a feeder system rather than having the operator pick up one at a time from a box and install it. The systems vary from vibration bowl machines to complex tube distribution feeders.

Vibration bowl feeders are one of the oldest and most used options of parts feeding. The parts are placed in the feeder bowl and are moved, by vibration, up a spiral track that winds around the bowl. As they travel up the track they are orientated to slide up the feeder ramp by the vibration of the machine. Parts that are not correctly orientated fall back into the bowl to await another turn. Vibratory feeder bowls work best with small, lightweight parts and feed at a high rate approaching as much as 172 inches (4,350mm) per minute. They are available with single or multiple tracks.



Typical Multi-track Vibration Bowl

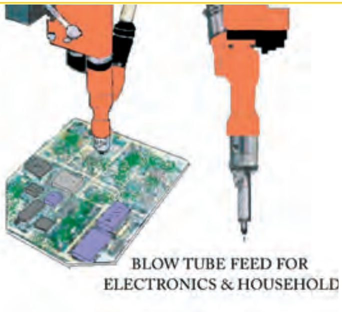
Where part damage may occur with vibration or where other concerns are present a centrifugal bowl feeder is used. This machine operates the same as a vibratory feeder except that the parts are not vibrated. Instead it uses an angled spinning disc to throw the parts to the outside edge of the bowl. There they are orientated and fed out to the feeder line. Misaligned parts are returned to the bowl. Parts that tangle or get jammed together are not especially suitable for bowl feeders due to their high feed rates. While this sounds simple enough, problems can occur. The fasteners must present one dimension of a greater width or length than the other one.

Nuts, unless of the non-directional type (plain nuts which may be assembled with either side down) need a directional marker for the feed sorter. This is usually a flanged side or some other feature, which will only allow the part to be fed in one direction. Most common locknuts used in many applications have a rounded top to allow the part, if bowl fed, to travel with the flat side down or fall back into the bowl. Only parts, which vibrate up the ramp with flange or flat side down, will travel the length of the feed track. Screw and washers need to have a length greater than their width to allow the screw assemblies to also track up the feed ramp. Screw and washer assemblies are notorious for having their length and width dimensions very close to each other, especially in smaller sizes.

Many times the operation uses a track feeder to move the parts from the bowl to the assembly station. The parts may be conveyed by vibratory feeder, hardened tracks, a magazine type drop tube, or a blow tube. Many of the problems mentioned above also apply to the track feeders. Common usages are blind riveting stations (often with multiple, simultaneous installation points), electronic circuit board assembly, roofing nail guns (magazine fed), and small household appliance operations.

Nuts for Automation Fed Operations Must Have a Feature Which Aligns Part in Feeder System.

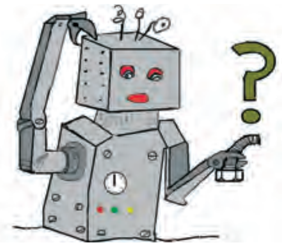
Another problem with smaller screws and parts in general is that the operator has difficulty in physically picking up and handling parts under 6mm (1/4 inch) in diameter. This problem involves not only automated systems, but also general assembly operations. Screws often have sharp points, necessary in tapping varieties, but these can injure operators in general assembly operations and can jam in feed machines with tube feeders as the sharp points stick in the tubes (The tubes are usually made of plastic). Pierce nuts and other fasteners, which employ a sharp edge to pierce the sheet metal, are another example of parts that get caught in plastic feed tubes. Since these pierce nuts are almost always used in multiple feed stamping dies to produce "in place" nuts, the problem of a jammed tube can be costly. Time to disassemble and clear the tubes stops the whole stamping process. Since the stamping process is



usually a timed operation in the entire manufacturing system, the loss of the stamping die is akin to the old adage about the "loss of a horse shoe nail, loss of horse, loss of battle, etc". A jammed nut may cost thousands in the operation expenses down the line. One solution that has had success is to insure that the feed tubes are placed with a minimum of bending in their location. Too sharp a turn will lead to the sharp edge either jamming or, sooner or later, cutting the tube. Replacement for most feed tubes in large stamping dies is a very time and labor-intensive operation.

To avoid fed bowl failure (usually jamming of feed mechanism or track) the finish on the parts being fed should be evaluated. Today the requirement for long life resistance against corrosion has led many fasteners users to specifying the new, thicker coatings. Many of these are metallic based paints, applied by various dip and spin methods. These finishes tend to flake off and produce a dust that settles in the bowl where it is vibrated into the moving parts of the feeder. Also, the vibration may chip off the coating at sharp corners and result in a part that corrodes (rusts) earlier than anticipated. Oil coatings, long a low cost favorite, also tend to clog up feed mechanisms. The oil residue in tubes and on tracks makes for a sticky situation.

Robots have lifted the boring burden of repetitious operations from the assembly line operator. While they can work tirelessly at the same installation over and over, without rest, they are also mindless. They do not "see" or "think" about what it is that they are doing. Many lines have experienced shutdowns when a robot picked up an unthreaded fastener and tried to install it.



Where a human operator would just toss it away, the robot will try its best to make it work. One of the innovations that I added to many prints that I oversaw, while working as a fastener engineer, was to add a note to the following effect: "If the parts are to be robotically fed and installed, 100% sorting certification is required. Robotically used parts should be noted as such on purchase agreement. Corollary with the warning that parts are to be 100% correct was the requirement that they also meet geometric dimensioning and tolerancing. Many parts are made in substandard manufacturing locations and "unless you ask for it" you may not get it. An example was a washer that came in from a low cost, third world manufacturer. The holes in the center were not concentric with the outside dimensions. Since there was no tolerance or other control dimensions, the purchaser got what the manufacturer made, as they made it. In this case, the internal diameter holes were drilled as a secondary operation.

Solutions are available for many types of fastener installations. The use of a bandolier type feed mechanism, like a machine gun belt, to feed screws continuously and in proper orientation, has been used in some operations (roofing installation tooling is a good example). This is a good solution where the assembly is a bench operation and the operator has to just install a single (or more) same screw in the same position. Often the installation gun is a suspended tool and the operator merely shoots the part.

Rivet tools have used self-feed mechanisms for several years with success. Tools are available which auto load and install the rivet with a single trigger pull. Spent mandrel recovery bags are often attached. Rivets are also available in strip-mounted form with 25 to 50 or more pieces in a row, which feeds into a tool for continuous usage installation.

In summary, fasteners, which are installed by any of the automated techniques should be reviewed early in the design process. This requires interaction between the designer and the plant-engineering representatives. If any automated process will be used, the designer must consider what type of installation process will be used. A simple feed with a human on the end doing the actual installation will require dimensional and coating review if a vibratory feed bowl is to be used. Proper length to width ratios is needed. A rule of thumb is that the length should be a minimum of at least one and one half times the width (longer is better). Nuts must also feed correctly. Tube feeders should follow the above guidelines plus care should be taken to insure sharp edges do not cut or poke into the tubing. Nuts are a greater problem but a human at the end quickly orientates the part as he places it in position.

Robotic installation is extremely dependent upon the parts being dimensionally correct and with all their features intact. Missing threads, wrong sizes, and/or mixed parts will all bring the robot to a complete standstill. To reduce cost, notation as to certification should be added to parts prints IF the parts are known to be robotically installed. The additional cost in purchasing them will be certainly saved if a malfunction occurs. Geometric dimensioning and tolerancing should be an included feature on all drawings, not just automatically fed parts.