Building a bridge or mounting a transmission is a job for the big guys- hefty bolts and nuts. Strength, endurance, toughness are what's needed. But how about the small stuff? When do you use a small screw and when is something else better? Small size screws have advantages and drawbacks. Often another type of fastening system may be better, more economical, faster, and/or more durable. However, sometimes something else is chosen because of the wrong reasons. A short review of the types of fastenings usually considered on smaller applications with the positives and negatives of each will assist the user in determining if a small screw is best for an attachment or if something else may offer other advantages.

SHOULD I USE A SCREW?

by Thomas Doppke

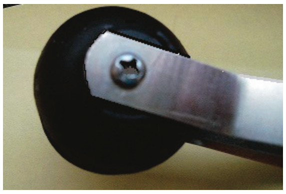
There are several ways that an attachment may be secured. Using a screw; a break mandrel rivet (often called a blind rivet or sometimes called a "pop" rivet although the name "pop" is actually a brand name); fastening with an upset, solid rivet; making use of a clip of some design; welding the various pieces together (plastics as well as metal are often fastened in this manner; adhesive bonding ("glue" to the novice); some sort of plastic fastener; or designing a snap in plastic feature to lock the parts together. Let's see what each method has to offer.

Screws: everyone is familiar with screws. Metallic, with spaced threads for tapping into pilot holes or soft materials or machine threads for insertion into pre-threaded holes or nuts. Screws are generally stronger than the base materials into which they are installed. Readily available in a variety of head shape, lengths and coatings. They are inexpensive, have had a long history in the industrial market and tooling is common and cheap. The choice to use a screw is often predicated upon what the plant already uses. The cost of initial new equipment and tooling may affect the decision to change the attachment method but it is probable that correct tooling already exists in the assembly plant.

Screws are little affected by environmental issues such as temperature, moisture (except for corrosion conditions which induce rust or chemical attack), and most encountered chemicals such as soaps and common cleaners. The use of a protective, corrosion resistant finish on a screw is common but care should be taken to comply with local regulations as to End-of-Life regulations and to avoid proscribed coatings (today mainly cadmium and hexavalent chromium based coatings). Screwed joints are easily repairable (often a larger diameter screw is used in stripped joints) and serviced with parts available everywhere provided that the selected screw is not unique in some manner (odd head size, recess, or thread). The introduction of the star drive screw recess years ago caused a major problem until the supply of bits and tools caught up with the demand. A joint attached with a screw requires little in the way of design modifications as do some of the other attachment methods discussed below. Screws are installed from one side and, as mentioned before, may tap into softer materials such as plastics or wood or a pre-located pilot hole. The use of a backside nut will, of course, require access to that side for a holding device.

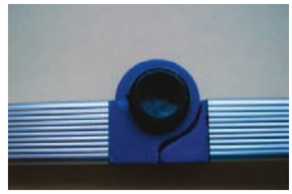
One of the few of the negatives of using a screw is that the fastener must be torqued correctly. Too loose and rattles will occur or if too tight the screw will strip, this makes the use of a torque control tool necessary. Very small screws are difficult for an operator to handle. Studies show that the smallest diameter screw that can be efficiently handled is 6mm, parts smaller than this will have a greatly

Screw



Rivet

Plastic Pivot



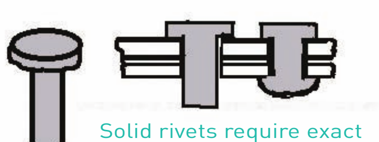
increased amount of spoilage (dropped and/or misapplied). The base material thickness must be thick enough to allow the tapping screw to engage and hold lest the joint loosen in service (the accepted minimum engagement is one full thread pitch). Fastening into plastics is a big problem as base material strippage is common at very low torques. The very fact that the screw is metallic may cause problems in electrical areas because of the possibility of small shards of metal being removed during installation which, when they fall into today's very small circuit boards will short out the electrical connections.

As these illustrations show, many types fastening are used, often more than one on a product. The round rubber cup is screwed for replacement ease, the handle is blind break mandrel riveted for security and rapid assembly, the center pivot is a plastic fastener for appearance sake.

Blind Break Mandrel Rivets: quick, cheap, available- that defines blind break mandrel rivets. Although head styles are limited to only domed or countersunk types and materials to aluminum, steel, stainless steel, and a few other metals for specialized applications such as beryllium copper for anti-spark areas, they are everywhere. Because they are meant to be deformed into a clamped joint when they are installed they are made of soft and malleable metal. The requisite strength needed for some joints will not be present. Rivets are not tension joints. They do not tighten by pulling together the separate part of a component (tensile motion). Rather they clamp together to retard sideways motion (shear). Rivet tooling is simple to maintain, easy to use-little operator training is necessary, and the joint is usually tight enough for most applications. Some backside clearance is required for the initial installation process of the rivet to be inserted and pulled up but the attachment is considered a "one-sided" joint (access required on one side only). The joints produced are not repairable or serviceable without a costly (time and labor as well as possible damage to the component) removal of the fastener. The usual method of replacement, if necessary, is drilling out the old part.

The broken off mandrel is often a problem in assembly plants, the short, wire-like pieces being littered on the assembly floor cause an operator safety hazard and the possibly of them falling into the balance of the component. While traditional blind rivets are metallic, rivets made of plastic have been tried but offer little holding power and their use is limited to cosmetic, no load applications.

Depending upon volume, blind rivets are approximately the same in cost as screws. They require some calculation as to the correct grip length when installed. Too long a rivet will not pull tightly enough and too short will give an inadequate pull up load. Fortunately today there are blind rivets with expanded grip ranges and varying grip ranges can usually be accommodated. Correct pilot hole size is also important. The rivet eyelet expands in the hole to fill out the internal area. Too sloppy a pilot hole will produce an insufficiently expanded river eyelet and a bad (loose) joint. Many of the same problems with environmental conditions affect rivets as well as screws. Very little has been done with cosmetically finishing rivets. Beyond the metallic silver color there is little except some yellow chromate parts available. Dyed or painted parts do not work well as the coating tends to interfere with the assembly of the parts (stem into eyelet) or the installation force. A corrosion problem often occurs when the broken stem of the mandrel rusts internally in the assembled rivet and bleeds out the eyelet. Not a problem with aluminum parts however aluminum’s lower strength precludes use in many applications.



Solid rivets require exact pilot hole size to expand to maximum diameter internally.

Solid Rivets: Are as simple a fastener as can be imagined. A small cylinder with an upset head on one end. The parts are assembled and the rivet/component assembly is placed in a machine which squeezes the rivet, upsetting the stem, to clamp the various sections together tightly. Like blind break mandrel rivets, exact lengths and pilot hole diameters are required when using solid rivets. Like break mandrel rivets, solid rivets are shear devices not tension ones, like screws. They should not be considered for joints that need to be tightened in tensile mode. The solid rivet, to work efficiently, needs to expand to entirely fill the pilot hole, with enough metal left to form the underside head. Too large a pilot hole will lead to insufficient fill and a weak or loose joint while too long a rivet body will not form the tight crimp or might produce too large an underside mushroom and, again, a loose joint. Therefore, the entire package grip thickness needs to be carefully calculated to derive the correct length of rivet.

While the process is very simple and the parts cheap, the equipment necessary for high volume production is a moderately costly investment. Low volume solid rivets require little beyond an arbor press to squeeze the joint together, however high speed assembly dictates an electric or pneumatic press with attendant bells and whistles.

Clipping: Many devices are held together with a cleverly designed clip attachment. Again, volume is the critical factor. Most simple fasteners like those discussed here will suffice but in many cases; cosmetic, functional, and so on, a clip is desired. The clip will probably be unique to the joint and component. High volumes justify the extra expense of designing a unique clip, the manufacture of the part, and any increase associated cost. Clipping may reduce assembly labor time and ease assembly effort, offsetting the initial cost increase. Many features of auto trim are held with clips, invisible to the outside, for a neat, uncluttered and pleasing appearance. Some fairly exact dimensions are usually needed to insure that the clip holds tightly enough. Some types of clips are standard and easily obtained (U-nuts and J-nuts for example) but a look at a clip company catalog will illustrate thousands of parts, making locating the desired clip a needle in a haystack item.

Welding: The quick solution to metal to metal joints. Not serviceable but few small appliances are repaired these days, replacement being the usual response to a service failure. The initial equipment setup cost is large and maintenance a cost daily item but there are no parts to be ordered (beyond weld rod tips), few line problems, and little space need be devoted to the assembly process. Correct weld schedules (the exact settings for a correctly performed weld) are necessary. Energy costs are an additional item to be considered.

Plastic are easily welded by a variety of methods, the most common being ultrasonic welding. High frequency pulses cause the plastic to soften and fuse. The plastic types must be weldable; thermoplastics for the most part however thermoset plastics are very difficult if not impossible to fuse. (Thermoplastics melt under heat/friction while thermosets are hardened in the mold by heat and pressure. Bakelite is a common thermoset plastic; it doesn't melt, it burns). Besides ultrasonic welding, plastics can be fused together by induction welding; spin welding (parts spin against each other under pressure, generating frictional heat to fuse); or orbital welding, to name a few methods. The equipment is expensive and initial setups very costly but high volume production of more costly appearance type parts makes this a good choice. No extra parts to handle, stock, purchase, and so on.

Adhesive: Glue is a choice where extra cost and labor to maintain parts inventory and assembly stations is not desired. Glue is inexpensive and easily applied. Metal glued joints are not recommended as thermal, loading, and service conditions may break the glue bond soon into the life of the part. Plastic gluing is a different story. If the plastics are compatible, a glued joint will live a long and successful life unless extreme conditions interfere. Thermal expansion and contraction causes shear failures as do prolonged loading above the plastics' yield point. Heat and cold can cause loosening of the joint and is a worry in service conditions in extreme temperatures. The main drawback to adhesive bonding is the fact that a specific amount of time is necessary for the glue to harden and bond. Joints glued together will take time to set, from several seconds to several minutes. Fast line rates are not compatible with glue joints although one auto company has been experimenting with fastening magnesium sections together with glue.

Plastic fasteners: Where metal parts may be a problem, the use of a plastic fastener is often the answer. Problems with electrical conductivity, interference with minute electrical currents in circuit boards, the possibility that small shards of metal may fall into the circuits (a major concern with all the electronic gadgets in use today), or the possibility of corrosion are common. Color matching is easy with plastic fasteners, assembly is usually a "hands only" labor issue, the finished component has a better appearance, and the fastener is inexpensive if a standard part can be found. Our same old problem, volume, is an issue unless a standard, available catalog part can be used. A specially designed part will be expensive unless volume justifies the initial investment. Cosmetic parts are often improved when the distracting metal screw or rivet is removed. Plastic fasteners are removable (generally) and reusable.

No fasteners at all: What? Yes, the use of a snap-in lever or tab or any of the several dozens of generic types of snap together designs are often an ideal way to attach two or more parts without any additional fastener. A look around your desk will probably illustrate a few examples of fastenerless attachments. Commonly the battery cover of cell phones use such joints. Easy to install, easy to service, and no additional parts to handle. The greatest initial cost is the effort to design such a feature into the component in the first place. Once done the resultant costs are almost zero. Not all products can be made with snap in attachments so the actual idea is limited by the parts configurations and usage. The great advantage is that there are no additional parts or assembly necessary beyond the snapping together of the two or more sections.

The Answer: As could be expected, the choice of using a screw or another fastening method depends upon many factors. Probably the screw will fit most applications, especially when the volume is less than millions. There are other alternative solutions, as discussed here, and many advantages possible but thought is required before selecting one. Before choosing one, it is hoped that these other ideas are at least considered. There may be a better way. A quick summary chart is attached below to clarify the various pluses and minuses.

Fastener Comparison of Properties Chart

	Strength[1]	Materials[2]	Economic[3]	Assembly[4]	Environment[5]	Repair/ Service[6]	Initial Cost[7]
Screw	Y	Y	M	H	Y*	E	L
Blind Rivet	Y	Y	M	H	Y*	D	L
Solid Rivet	Y	Y	M	H	Y*	D	M
Clipping	Y	Y	M	M-H	Y*	E	VH**
Weld	Y	N	L	H	Y	D	VH**
Glue	N	N	H (set up time)	M	N	Ltd	L
Plastic	Y-N	Y-N	L	L	N	E	H

Legend: Y = Yes, N = No, N/A = Not Applicable, H = High, L = Low, M = Moderate, Ltd = Limited, E = Easy, D = Difficult, Md = Moderate, VH=Very High

Notes: 1- Strength. Fastener attachment is as strong as or stronger than base material/joint.

2- Materials. Attachment capable of attaching all materials, compatible with all.

3- Economic. Part cost. Usage of part history. Cost to change to new part, need for stock inventory, line handling, time to install.

4- Assembly. Operator ease of installation and handling. Special tooling needed? Can it be installed from one side only? Ergonomic issues?

5- Environment. Works in all environments (heat, cold, chemicals, moisture) No effects on "End-of-Life" requirements. Safe to use.
*May be subject to corrosion in certain conditions.

6- Service/Repair. Can it be serviced, removed and re-installed. Ease of service. Are replacement parts readily available? Impact on warranty.

7- Initial Cost. Cost of investment in tools, design services, parts procurement and manufacture.
** Mostly due to design costs.