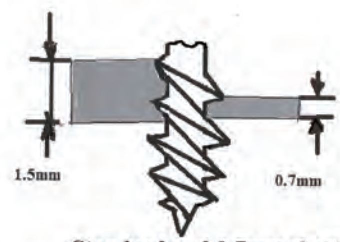
Clips, an Alternative Fastener System

by Thomas Doppke

There are times when a screw or threaded product just won't fit the attachment requirements. Not enough space, backside clearance, not reachable with the attachment tool, has to be installed prior to other sub-assemblies, and a whole set of other problems that preclude the use of the familiar bolt, nut and screw attachment method. Then the use of a clip type fastener makes sense. Although the clip may seem more costly at first glance, an examination of their features and usage may surprise you.

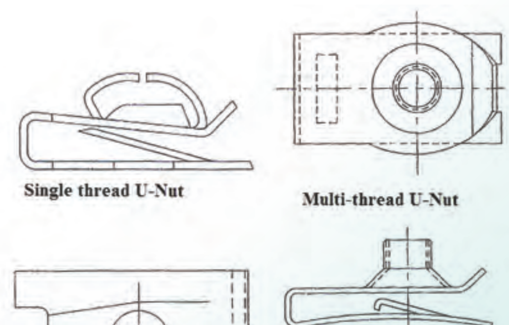
Among the problems of modern metal assembly is the fact the metal today has been thinned down to save weight and cost. Whereas in previous times the sheet stock was of sufficient thickness to allow a standard sheet metal tapping screw to gain a purchase (one thread pitch minimum needed), now the thickness used in many products is less than a half of a thread in depth.



Standard and 0.7mm sheet.
1 pitch vs 1/2 pitch engagement

The standard #8 tapping screw has a pitch of 1.41mm; today most automotive sheet metal is 0.7mm gage. How then can it be attached? Of the many possible solutions the use of a clip is ideal. Most clips are made of high carbon steel which allows for strength without strippage and their design allows them to easily slip over the metal without gouging or jamming. Negatives are the facts that a hole must be formed (drilled or punched in the die forming step of the metal) and the clip located at an edge for installation. Also, there is an extra labor step to install and the added cost of another part increases assembly cost. One often overlooked advantage is the fact that the attachment can be accurately located whereas a screw could possibility be mis-located by an inexperienced operator.

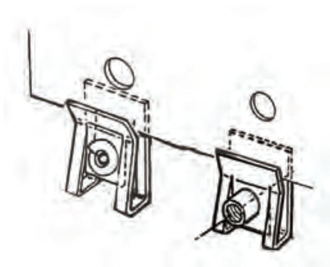
Clips have effectively solved the thin metal problem in a lot of areas. Easy to install (just push on), operator friendly (hand installed), and easy to fasten with the required screw. They come in a variety of shapes to fit specific requirements. The most common type is the "J-U" single impression clip used in many locations in automotive sheet metal attachments. It was estimated several years ago that the daily usage of this part type in the automotive industry was over one million pieces per day.



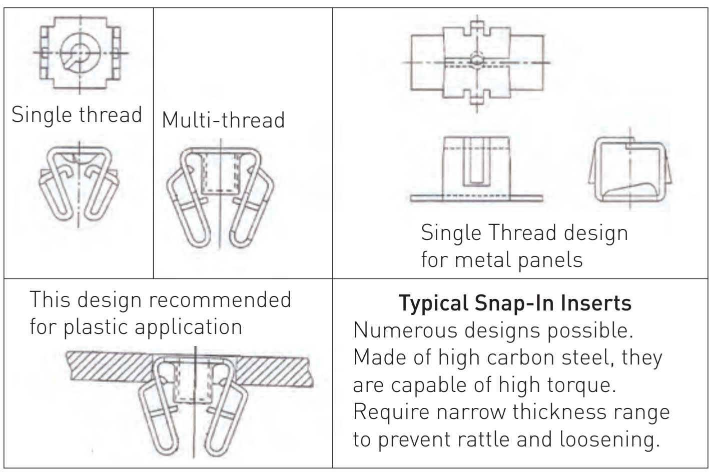
TYPICAL U-NUT DESIGNS
Many variations possible. All require installation from edge of plate or through a large adjacent installation hole.

The "J" and "U" designations refer to the parts shape, with the J shape being used to allow backside clearance where the bottom side of the clip may interfere with another component. With an increased demand for tighter clamp loads a multithread type was manufactured which allows greater fastening torque (more threads to engage) and, in machine thread dimensions, can allow the use of a bolt in place of a tapping screw for increased strength of engagement.

One of the early drawbacks to U-nuts was the fact that they had to be installed on an edge of the sheet or into a large hole where the clip could be inserted. The need for a clip to be used away from these limiting conditions led to the development of the push in clip nut.



Usable whereever a hole can be punched, U-nuts are still limited by metal thickness. Too thin a metal thickness and the nut may fall out before it gets to the assembly station, too thick and it may pull out. However, it is generally usable where the stock is of a consistent thickness and the U-nut chosen to fit correctly. Advantages are that they can be used on plastic; always a difficult attachment material. Excellent torque values without relaxation of the plastic around it makes for good plastic component joints.



Typical Snap-In Inserts
Numerous designs possible. Made of high carbon steel, they are capable of high torque. Require narrow thickness range to prevent rattle and loosening.

Some negatives to the snap in type U-nuts are the facts that they require a greater amount of force to install (ergonomic issue), require narrow grip ranges (as mentioned above), tend to rattle and pull out easily on the "wide grip" varieties, and have fewer manufacturers.

Comparing some types of U-nut clips we find the following data. The tests are the averages of 6-10 samples per test from 3-6 lots of material for each size/type.

TORQUE FAILURE TESTS

Size	Impression	Failure (Nm)
M4.2 (#8)	Single	3.5-7.0*
M4.2	Multiple	5.5-6.75
M6.3 (1/4")	Single	10.0-15.8*
M6.3	Multiple	14.0-15.5

Note: * The range of values is due to increased metal thickness of the single impression U-nuts. Thicker parts increase failure values.

PROOF LOAD TESTS

Size	Impression	Proof Load (Kn)
M4.2	Single	3.01-4.562
M4.2	Multiple	7.9
M6.3	Single	8.1-9.0
M6.3	Multiple	18.2

Note: 1- Average load to fail for 0.7mm thick sheet metal.
2- Average load to fail for 1.2mm thick sheet metal

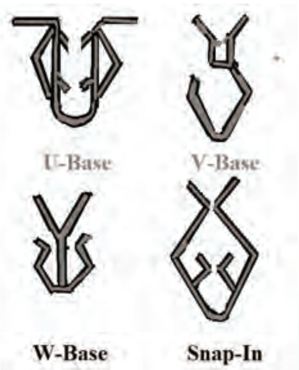
As the data shows, single impression U-nuts are as capable of being torqued to about the same values as the multiple thread variety. Real world applications show that the actual values used when employing these size screws do not exceed 2.6Nm for M4.2 screws and 6.5Nm for M6.3. Therefore the use of a multiple thread U-nut in most applications is over engineering. The one condition that occurs that gives the multiple an advantage is in cases where the plant does not take due care during installation of the screw. Quick, "push and shoot" assembly often causes cross threading of the screw as the part is not driven normal to the hole. The multiple thread offers greater alignment of the fastener. Another condition that single impression U-nuts cannot overcome is where an additional resistance to loosening is required. Multiple thread U-nuts can be "squeezed" in the cone section to produce a prevailing torque performance feature.

While the designs of the impression hole of the U-nut (the mating thread area for the screw) have been patented by various companies, they all operate pretty much the same and have so for more than 70 years. Over that time little change has occurred beyond a few minor improvements. A retainer ring was swaged from the inner hole to prevent the part from falling out too easily, variations in nut thickness to accommodate varying metal thickness and strippage properties, and various lengths to accommodate varying edge and locational requirements. The increase in thinner sheet metal meant that retention of the U-nuts to the metal dropped; power tool proliferation meant more cross threads, loosening, and stripped threads.

In summary about U-nuts, single impression parts are the most economical choice for most general applications. Torque values as good as or better than screws into thick metal values are obtainable, suppliers are plentiful, and a wide variety of shapes and sizes/types are available "off the shelf". Multiple thread parts are the only practical choice for machine thread bolts and high strength applications. Since they require additional backside clearance and longer screw lengths to accommodate the cone section, consideration should be given before choosing them. When there is not room for the installation of legged U-nuts, the push in style is the best choice. However, the exact design is dictated by each unique situation.

Besides U-nut type clips and threaded fasteners, clips are used in many other applications to replace other fasteners. They can tie together wiring bundles (the average vehicle has about 120 feet [36,57m] of wires), and they retain various components such as small boxes, miscellaneous devices, caps, hinge closures, and a whole variety of underhood and interior trim.

The modern design trend is not to have fasteners visible. The product lines are clean and visibly pleasing (at least to the designers this means no visible fasteners). Coming from an engineering background I like to see how to take things apart. The largest presence of clipping in vehicle interiors is in trim areas. The usual attachment uses a molding clip fastened to the backside of the trim strip (usually made of plastic) which is then installed by pressing it onto a slot in the sheet metal. The clip is retained to the plastic on a molded in rib-like section. This allows some adjustment capability during installation since sheet metal matchups are generally not extremely precise. Also the operator needs some "wiggle" room to place the part as he is installing the trim "blind". Depending upon the rib configuration and various factors in its placement on the backside of the trim several styles of ribs are available. The usual style is the V-base with adjustment made to the length, width, etc., as required by the conditions.

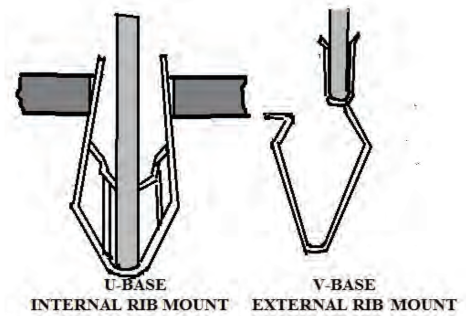


A few basic thoughts about designing molding clips to be considered are the facts that the thicker the clip stock thickness the more inflexible it will be. It will enter the receiving slot or hole with greater effort (higher installation force) and will also require more force to disassemble. Thinner clips, obviously, have lower installation efforts but may bend easily if they offset during assembly, have lower pullout values, and fall off the plastic trim rib easily. The general pull out to push in ratio is 2 or 3 to 1. Higher ratios are possible (as high as 5:1) but with greatly decreased assembly ease and are much more sensitive to operator handling. The common fault with these clips is that the designer wants them, for ergonomic reasons, to be finger pressure installed, which has been determined to be about 1Kg. But at the same time he wants them not to pullout at loads 5-10 times as great. Unfortunately, the Rule is "easy in, easy out!"

The four basic types shown are general in appearance. Almost every application seems to require a unique design or dimensional modification. Since they install upon a rib, flange or blade section molded into the part they are designed to accommodate the variation in, and so on. They are retained, as shown, by a formed barb to prevent any removal by accidental forces. Some types slide on and others snap onto the rib. Since their position is, as mentioned, dependent on the final appearance, location, etc., so the type of clip style chosen is a factor. The U-base type requires minimal packaging space and its usual application is to mate with panels 0.75 to out 2.0mm thick. Typical installation values are about 15Kg and pull out values can reach about 30Kg. While these values can be adjusted somewhat there is always a down side. Making the clip longer and/or with thinner metal would lower the installation effort but it could also produce an easily removal part ("easy in, easy out"). Also, a thinner clip may bend if it hits the edge of the slot or misses it partially, bending the clip or even breaking off the blade or rib. This is especially true of the long V-base types. Remember, these clips are on the backsides of trim strips and the operator cannot see where they go in and relies upon experience and a bit of luck to hit the slot.

Typical V-base values are about 13Kg to install and about 26Kg pull out. Panel thicknesses vary from 0.75 to over 3.0mm. V-bases also come in a variety of mountings; high, low and internal to fit the joint requirements.

W-base clips offer a more secure installation. They are difficult to pull out from the retaining slot/hole and come in a variety of blade mounting sides. Standard values average about 5Kg installation and about 19Kg pullout. The panel thickness is the most critical element and the sheet metal must match to the W-base design dimension within a 0.5mm range. Too thick a panel and a loose clip results, too thin and it may not engage at all.



Snap-on clips are a bit more flexible as the clip is installed when the rest of the trim is. Although they slide on easily they are not recommended for attachments that see excessive vibration or heavy axial loading. The previous types of clips almost always require that they be pre-installed. However, accidental removal, breakage during shipping and handling, and problems separating them on the assembly line are a few troubles associated with the pre-installed concept. On the other hand, the forces necessary to install a clip onto a trim piece are often greater than hand assembly can accommodate and will require an off line station and special tooling.

Some thoughts about what to consider if using a clip are:

1. What is the material of the trim part? Plastic, soft, hard (reinforced?) metal?
2. What is the panel material that the clip inserted into?
3. What is the rib/blade thickness? Usual standard is 1.5mm.
4. What is the panel slot/hole size? Is it oval or rectangular?
5. What is the panel thickness?
6. What are the performance values that are needed?
7. Can design be modified if necessary?
8. If panel gap is less than design specification can a standoff be added to the rib/blade?

Additional thought should be given to backside clearances, environmental conditions (wet, heat, salt and chemicals) material interactions (plastics creep at different rates), sharp edges, service repair and re-installation, and ergonomics.

We have looked at the two most common clips found in industry. The actual amount of clippings is astronomical, from small finger clips used for snap in covers, retainers for everything, to the device that keeps your ball point ink cartridge from pushing back into your pen. They replace screws; make components easy to remove vs. finding that tiny screwdriver and losing the screw in the floor when it does come off. The use of a clip also does help keep the price more affordable than many other methods.

While this article has been somewhat limited in its presentation of only the two basic types of clips, U-nuts and molding clips, many of the thoughts and suggestions apply to all clipping. Unless the designer has great familiarity with the type of clip he envisions, the best solution is to consult with one of the manufacturers that specialize in that type of product. They have the expertise and background in knowing what each facet of the part will do in the end design. Also, they probably have knowledge of what has been made before and what type of clip they have on hand. Sometimes a small design change will enable you to use what is already made. Clips are very expense to make if starting with a blank piece of paper. Volume dictate the feasibility of even considering a part, especially of the usage is slow.