The Cold, Hard Facts of Cold-Heading

Photos by Charles Celander

BY GENE SIMPSON, TERRY MORRISSEY, MARK QUEBBEMAN AND THE SMW STAFF

The process of cold-heading rolled steel may be somewhat foreign to the precision-parts industry, but the actual operation is very basic. We manipulate force and the volume of the steel to craft a finished part. Depending on the type of shape we're trying to achieve, we mold the steel in such a way that, through the manipulation of the volume of the steel wire, we arrive at the final shape while maintaining control and quality. By doing this, it allows us to produce a final product that retains its strength and produces very little scrap, while preserving quality and consistency.

We have high production rates, we use high levels of force, we manipulate the starting and finishing volume of the steel wire, and we do it in an environment — we design our tooling in such a way that we control production at high rates and have a high level of repeatability. In addition to the high production rates that cold-heading can achieve, there is little, if any, material removal, and the strength of the metal improves. An additional benefit is the consolidation of components that is attainable through cold-heading. By forming a part that better fits the assembly process, perhaps by eliminating the need to add a washer or nut on a part, customers can complete the final assembly procedure more efficiently.

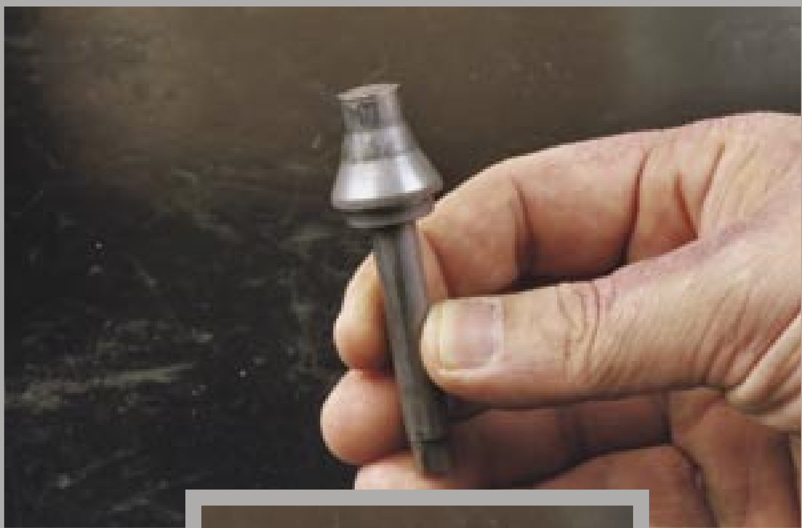
COLD-HEADING 101

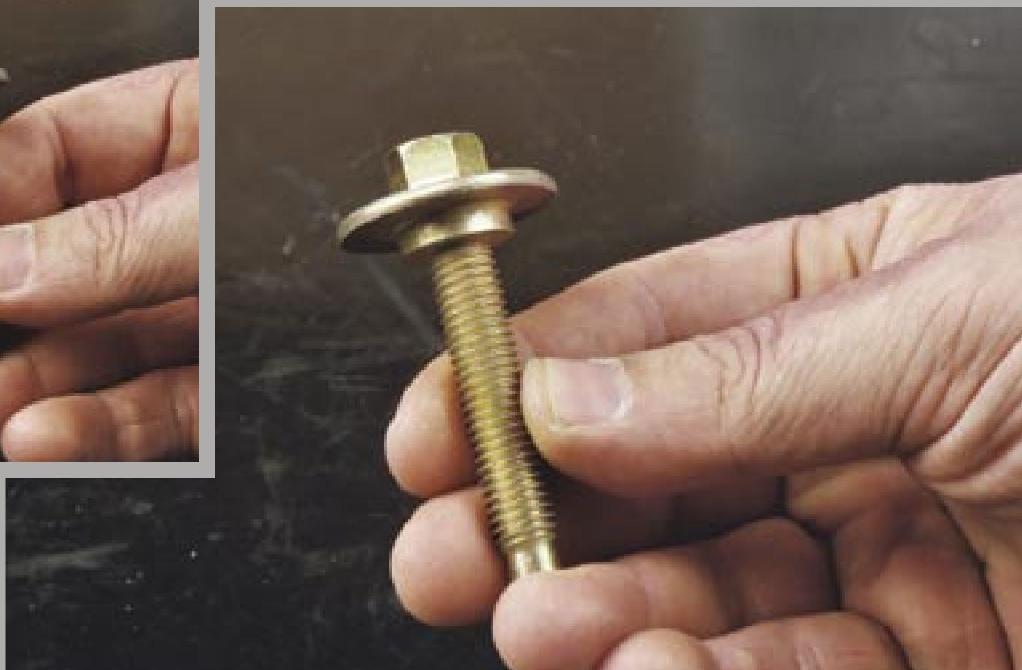
What we're doing is taking the steel through a series of operations. The key terms to remember in the process are the number of dies used in the process, as well as the number of blows. Dies are used to form the shank of the part. Conversely, blows are the number of "punches" that strike the part. Tooling lined up opposite the dies performs the punches. The cold-forming machine punches the metal in the die to mold the part. Once we have the dies and tooling set up, we're able to put material out at a rapid rate. The key is identifying how many dies or punches are needed to perform the operation. If you attempt to manipulate the material too much in any single die or punch, you can negatively affect the properties of the metal. So it really is a balance to achieve efficient manufacturing using the fewest steps, while also preserving the tensile strength of the metal.

While we produce these pieces at high rates, we're also conscious to stick to what we're good at. We're familiar with cold-heading, so we focus on that. We do perform what we consider secondary operations here. After it's cold-headed, we may thread-roll the product. After that, the finished items are sent out to receive heat-treating. We don't perform that operation here because, again,

MANIPULATING STEEL'S VOLUME

Cold-heading revolves around the concept of altering an initial steel "blank" through force, using a series of tools and dies to change the blank into a finished product. The actual volume of steel remains unchanged, but the process maintains or improves its overall tensile strength.





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we focus on what we're good at. We partner with key suppliers who do our products for us after they undergo the cold-forming process. By outsourcing the other operations to the people we've built relationships with, we can remain centered on our core business.

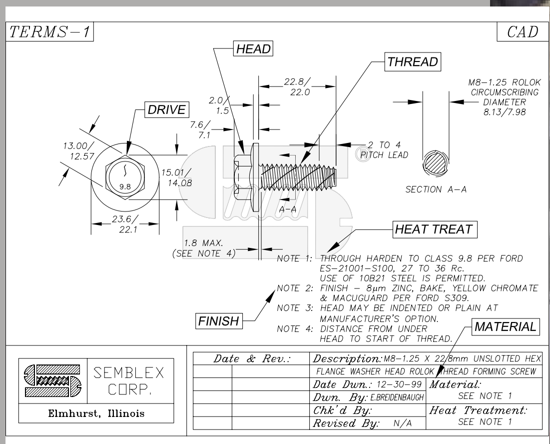
CREATING SOLUTIONS, NOT PRODUCTS

In cold-heading, the initial design process is important because the process revolves around the proper tooling to stay within your tolerances. While we manufacture fasteners for a variety of different applications, we've found that providing complete manufacturing solutions is a way to grow our business and satisfy our customers. To do that, we have to start from the ground up. We can make a part based on the customer's request, but what we'll try to do is, from an engineering standpoint, look at it from the big picture. Is there a better way to build this part? Is there a better overall design that we can create to incorporate its use? Is the assembly system that the customer is using antiquated? Can robotics or other changes in the assembly process save the client money on the back side?

As a cold-heading operation, customers come to us simply looking for a cost-reduction solution. Sometimes, a customer will come to us with a basic blueprint and ask us to make two million pieces. We have the ability to do that, but we want to look at how we can produce that part more profitably. We'll try to suggest to them why doing something different might work better in the long run, and if dialogue with the customer opens up, we can go with that. That's really where we can create a solution, because the customer works with us to solve an engineering or assembly problem. They give us the information and then we take it from there. We review the design or product that we're working on, checking to see if re-engineering the piece or the overall manufacturing process offers a much larger overall benefit to them in the long term.

ENGINEERING AN ANSWER

The engineering department analyzes the part to determine if it's possible to build a better part or assembly process before it presents options to the customer. Once client approves the part, blueprints are drawn up and sent out to the shop floor to ensure quality.



In this manufacturing process, the front-end planning portion of it is really critical. That's why manufacturing and engineering work so closely together. It takes precise planning and understanding early on in the design process to make sure that in the end, the final product doesn't turn out to be junk. We want to be sure that we have everything right so that when we receive the tooling and materials we order, our operators can get the most out of the machine without putting unnecessary wear on the tooling or material. To many of the machine operators, this is an art, and we want to make sure they have everything they need to work with. Earning the customer's trust is critical, but once we've achieved this, we start off in our engineering lab. We'll begin here, analyzing the piece and determining what exactly we're working with. We'll also base our work on our conversations with the customer. How strong does the metal have to be? What type of application is this piece for? We focus in on the relationships where we can have the highest level of front-end dialogue or design impact, design influence. We refer to it as T.A.C. — total assembly cost. That factor is playing a bigger and bigger role in the market now. We can work with a customer and create some samples, test them in the lab, then send them back to the customer and ask, "Which one do you think works best for you?" We offer our recommendations as to what we think the best option is, and why. It's here that research and development play such a big role. And it really is the fun part of the job. We have the opportunity to solve a customer's problem; and because we're here in the United States, we can rapidly react to a customer's needs.

MOVING FORWARD

Once we get approval from the customer on a design, we move forward with the process. We have a series of company standards that are product specific, but we use them to create a blueprint of the part. The same requirements and tolerances get put on the parts. These drawings are found at every machine as the product is made. It gives the guys on the floor a reference point so that they know exactly what we're putting together. At Semblex, we're used to dealing in thousandths of an inch. Many times customers may need something in tens of thousandths. We know that's a tolerance we can't hold. That's why we need to work with screw machines or secondary machining. We know what our limitations are on the cold-forming end of it. Engineering and manufacturing work together, and by very aggressively marrying the two together, we've given the customer something extra.

On the front end, we ask ourselves "Here's how much volume we have to have. How do we get there?" There might be several different ways of doing

UNRAVELING THE FOUNDATION

Sourcing the proper steel wire is a top priority for cold-heading operations, because the coatings on the wire provide lubrication as the material is formed. The wire stock is dropped next to the machine, and then fed into the unit to allow for continuous fabrication.

it. We'll take the final product design, because we know the finished product's parameters, dimensions and volume, and work backwards with the help of manufacturing's insight to determine what's the best piece of equipment for that part to run on. We do tool design according to that to optimize tool life, and also to optimize consistency. We have operations that not only are forming that configuration, but also are trimming the shape. From there, we'll also secure material requirements, what size the starting material has to be, and also the outside sources, such as drilling or heat-treating. We do that by looking at the strength the end-user needs. Essentially, the customer will tell us what they need; we know what latitude we have for raw material, and then on the tool-design side, how much physical material is required to start with so that we can still manipulate the volume of the steel "blank" (the unformed steel piece used to create a part) when it enters the machine.

We also have a design team for manufacturing — engineering, quality and manufacturing — that does a "what if" scenario. They lay out all the drawings, all the requirements, and figure out the best way to attack the job. Maybe sourcing a particular material is tough, or the timeline may conflict with another job on the same machine. This team allows them to create solutions before a conflict ever starts up. At that point we create a bill of materials, procure the necessary raw materials and tooling, and get the job put on the schedule.

It's important to note here that the coatings on the steel are crucial to the production process. It's something we always have to be aware of. We definitely specify what coatings we want on the wire stock, because we can run into problems if we don't have the proper coatings on the raw material. Since we are forming steel, lubricity is crucial to moving the part through the machine. If we're going to use four dies to form a part, and in the first one or two dies the coating material is going to be pulled off, we're trying to get the larger reductions done in one of the first couple of dies. In the latter dies, the coating won't be present and, as a result, forming will be that much more difficult and tool life will be that much lower. Coatings are what are going to allow that material to flow, or not to flow. The goal is to have a material that flows well enough to undergo a reduction, without losing its tensile strength. We use everything from low-carbon steel, through an assortment of stainless steels.

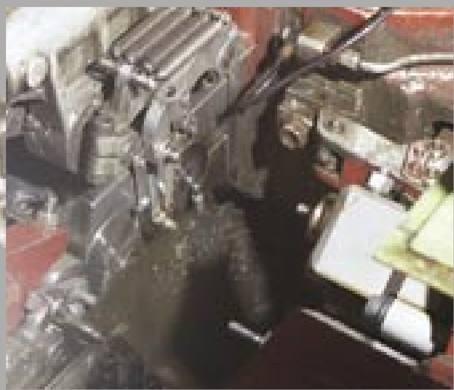
PUNCHING UP AND ROLLING OUT

The cold-heading operation itself is pretty straightforward. Once we've sourced the material and found the proper machine to produce the part, we move on to actually forming the part. In essence, we start off with a roll of wire steel, which is specific to the part we're making. We drop the steel onto a roller at the far end of the machine. The wire stock comes off the roll and is fed into the cold-heading machine, which is set up with the proper tooling as set forth in the bill of materials that we've created for the job.

Once the dimensions are set up, the wire stock is fed into the machine. The steel is pushed out to the required

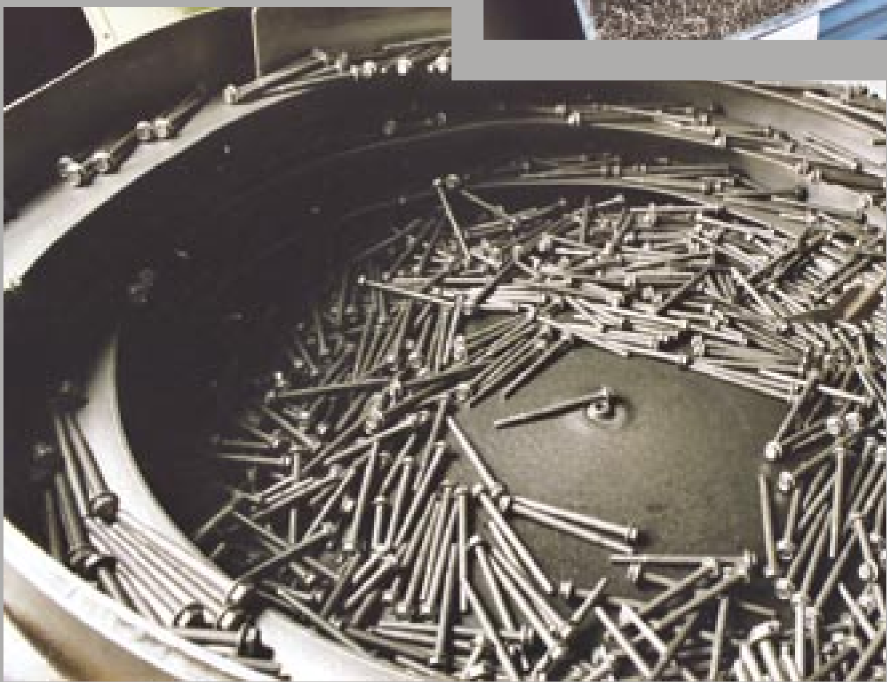
A MYRIAD OF OPERATIONS

Numerous operations occur simultaneously in the cold-heading process. When the steel is first cut, a punch also occurs on a different tool and die. The part then rotates through a series of punches, while other parts are cut, or dropped on a collection conveyor below.



QUALITY IS TOP PRIORITY

The force monitor notes when a disruption occurs, such as tool failure, and shuts down the machine, eliminating the possibility for contaminating the collection bin with unusable parts. The operator also checks parts for quality before they are sent on for secondary machining or heat treatment.



length. A knife then cuts the steel to the proper size, creating a blank with the necessary volume required to create the part. This blank is then inserted into a die, where it receives the first strike, or “blow.” It undergoes this process repeatedly until the final item is created. A one-die, three-blow item uses the same die, and is struck by three different punches from different tooling to form the finished item. If the part requires multiple dies, fingers in the machine will transfer the part from one die to the next, where it receives punches from the tooling to form the part.

The number of dies and blows is determined by the part’s requirements. It’s a balance between an excessive movement of material in one blow, which has detrimental effects on the part; and altering the steel just right, thereby enhancing the metal’s properties. Too much movement creates fissures and weaknesses in the part that even heat-treating can’t hide, while proper forming results in a part with improved characteristics compared to the original steel.

After the part is formed, it drops down into a collection conveyor underneath the machine. The part is then transferred via conveyor to a collection bin found at the back of the machine. A key quality-control feature is the force monitor, found on the top of each cold-forming unit by the operator’s control station. When there is a disruption in force (caused by tool failure or another machine problem), the conveyor shuts down, preventing the collection bin from becoming contaminated with irregular parts.

When the parts arrive in the collection bin, they’re still heated to a temperature of around 140° F, so they

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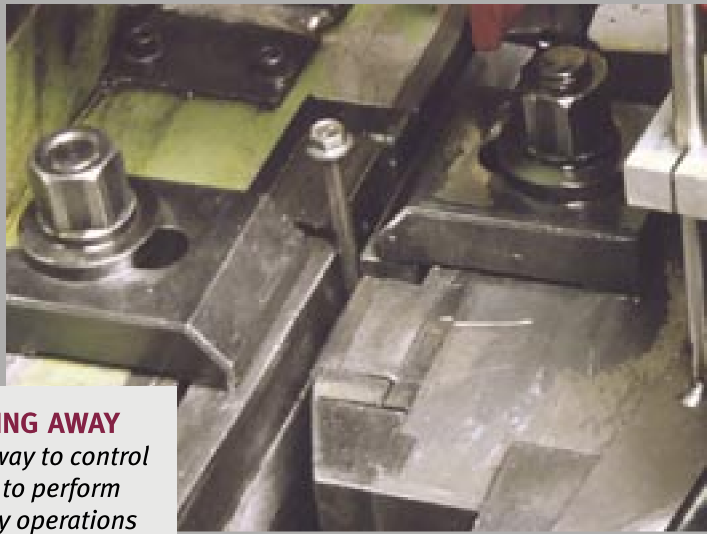
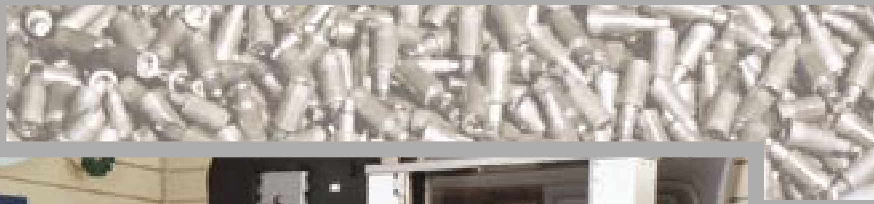
need time to cool. The operator then drops them down to a second collecting pan, where he can remove the parts and compare them to the specifications. The operator will review the product for consistency and quality. Once the product has met the criteria, it is dropped into a final collection bin. Here, it's held until it is either sent out for heat-treating or secondary machining, or for rolling on one of the thread rollers that we have in house. Subcontractors that have established relationships with us do all of our heat-treating and plating.

While most secondary machining is handled by outside sources, we do perform some secondary operations here, especially threading. If a product requires threading, once it's cooled and undergone inspection, it's transferred over to a thread-rolling station. The parts are transferred via a conveyor into a large hopper, where they are collected. The parts then move down a line toward a thread roller, which applies the proper thread size to the finished part. Detailed blueprints are found on the machine to insure that the proper thread sizes are added. Once the parts have been threaded, they are collected and prepared for shipment out to receive any other value-added machining, as well as heat-treatment.



THREADING AWAY

Another way to control quality is to perform secondary operations in house. Some cold-headed parts are sent to a thread-rolling machine, where they are transferred via conveyor and have the threads added to the part. The parts then get sent out for additional machining or heat treatment.



From left to right: Gene Simpson, director of engineering and technical services; Mark Quebbeman, vice-president of sales and marketing; and Terry Morrissey, plant manager.

Fastening a Solution with Cold-Heading and Secondary Ops

While the cold-heading process provides some advantages in manufacturing, Elmhurst, IL-based Semblex Corp. has found that marrying the process with secondary machining operations offers the chance to create value-added fastener products for a variety of markets. Mark Quebbeman, vice-president of sales and marketing; Gene Simpson, director of engineering and technical services; and Terry Morrissey, plant manager, see significant opportunities for secondary machining adding value to cold-headed parts. This optimism results from customers' efforts to avoid sourcing issues in the fastener industry. "Whether its concern about the quality of product sourced overseas, worries about an extremely distant supply chain or the inability to deal with someone on a local basis, companies are finding the benefits of staying at home and working with local suppliers," says Quebbeman. "Having key partners — not only on coatings and heat-treating processes — but secondary operations, really helps. A part might be cold-headed and rolled, but it still may require a drilling operation."

Simpson agrees, noting, "There are limitations in cold-heading. Certain tolerances can be met right off the cold-header, but we can improve accuracy if we can put additional secondary machining to it. We still achieve the benefits of cold heading — we eliminate material loss, and can produce the part rapidly and accurately — but, depending on certain tolerances and other features or dimensions on the part, we may need to touch something up to achieve the needed result. That's where secondary machining comes into play."

Quebbeman adds that, while the combination of the two procedures is a great fit, the industries haven't really melded together. "There are a lot of opportunities, and to be honest, not a lot of people are putting the two processes together."