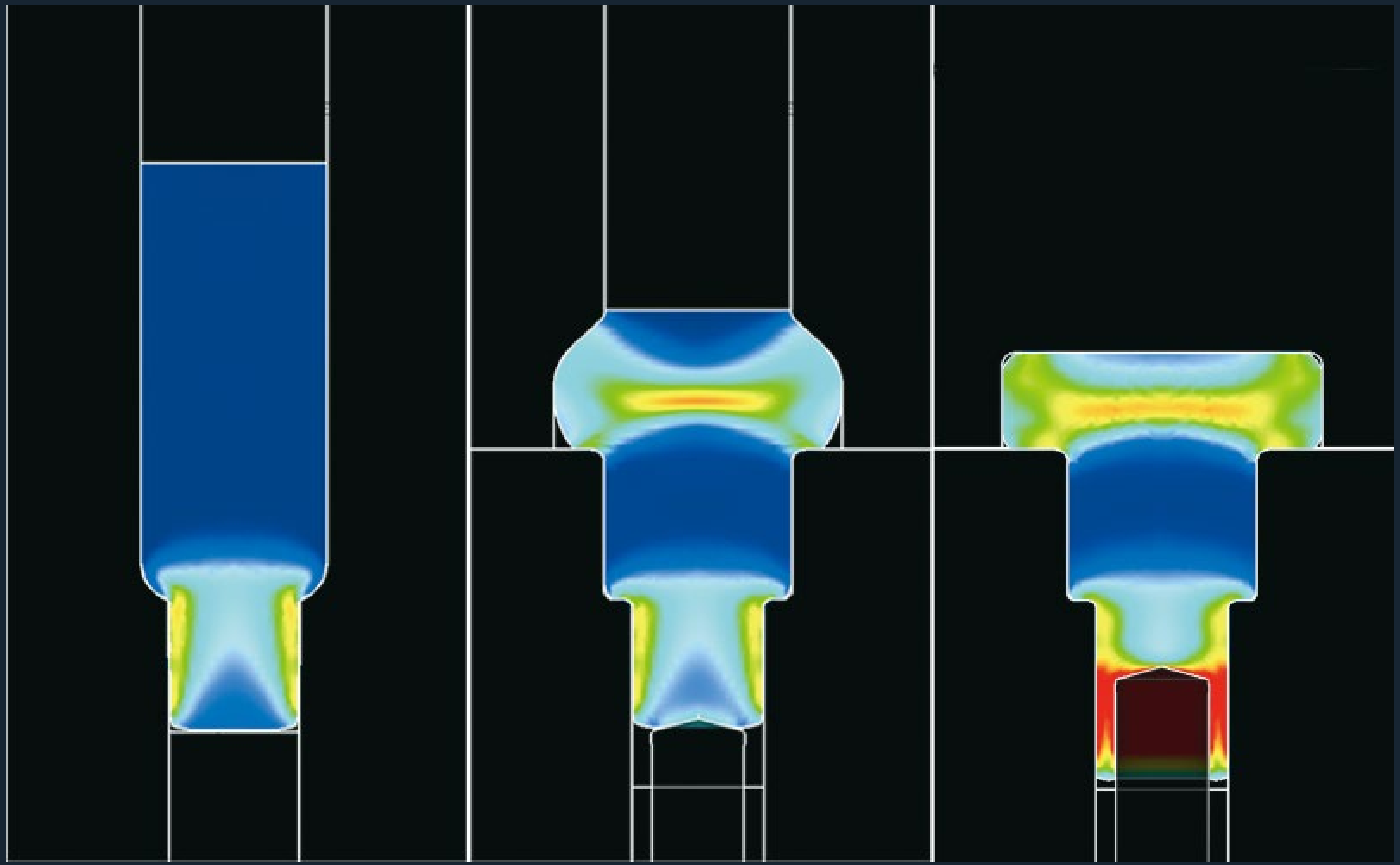
Advantages of Cold Forming



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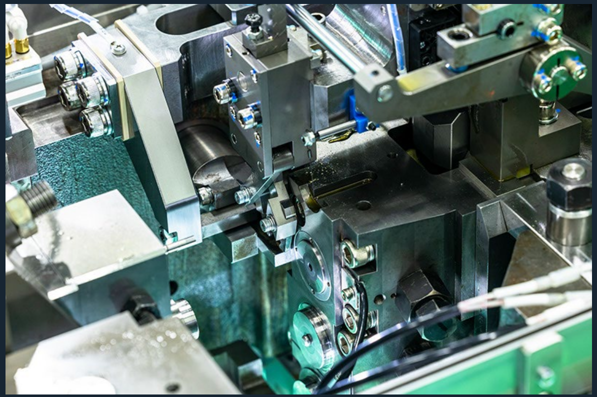
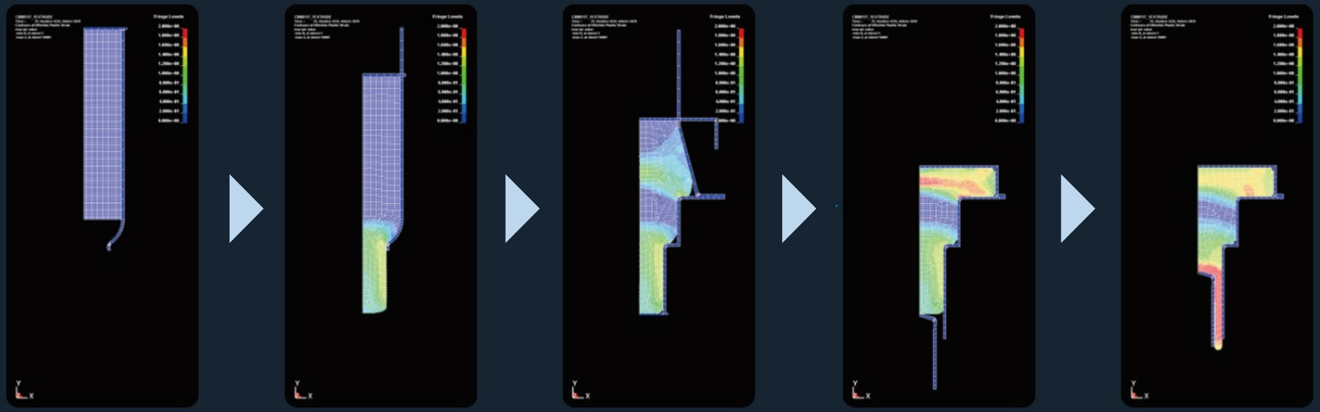
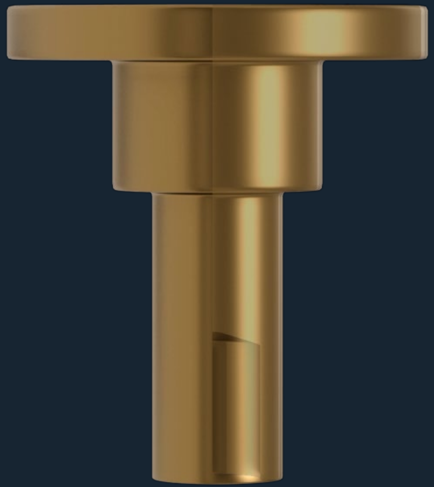
1. Cold Forming : Introduction



Cold forming is a manufacturing process that plastically deforms metal using dies. It allows for high speed production, little to no material waste compared to conventional machining, and creates a stronger end product due to work hardening of the material.



Material Cut-off → Forward Extrusion → Upset 1 → Upset 2 → Backward Extrusion



2. Advantages of Cold Forming

(1) High efficiency material utilization (high yield)

The high material utilization of cold forging allows for significant reductions in material waste (scrap) compared to machining for the same geometry.

Material Yield Rate (multi-step rivet example)

[Machining]

Scrap

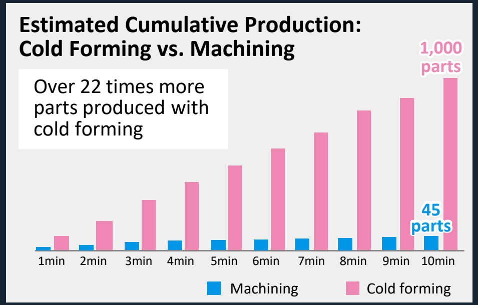
45%

[Cold Forming]

In principle, the weight of material used equals that of the finished product.

100%

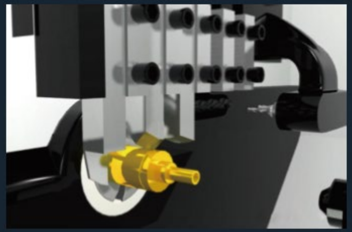
(2) Higher speed, more efficient production



Cold forming allows for high speed manufacturing (around 100 parts/minute) while still maintaining high precision and complex product geometries. No heating of the material is required.

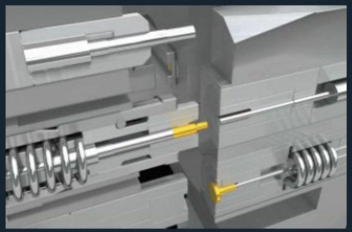
Production Speed (multi-step rivet example)

[Machining]



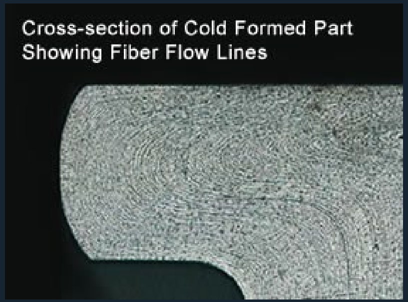
4.5 pieces /min

[Cold Forming]



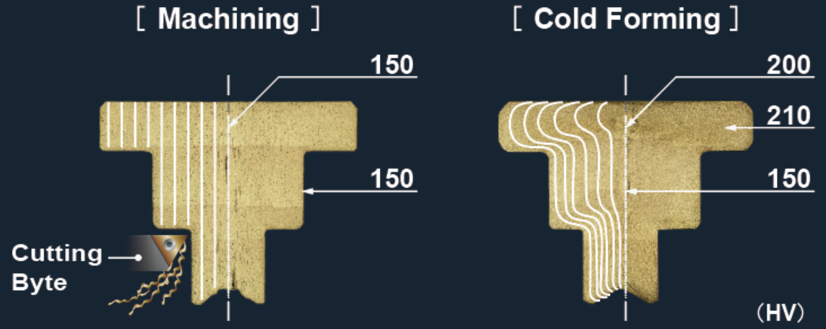
100 pieces /min

(3) Improved product strength by work hardening



Cold forming process design takes fiber flow lines (the crystal structure of metals) into account allowing for stronger more durable parts.

Fiber Flow Lines (multi-step rivet example)

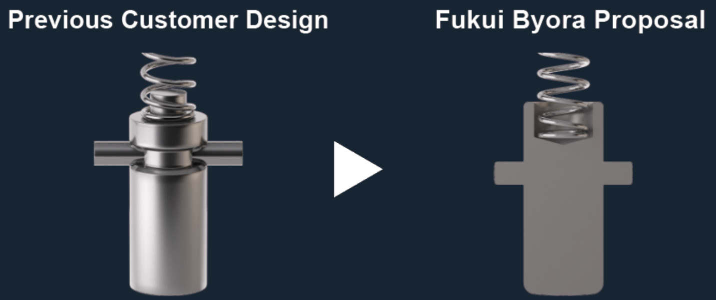


Cut	Fiber Flow Lines	Continuous
Weak	Product Strength	Strong

(4) Cost reductions through customized manufacturing processes

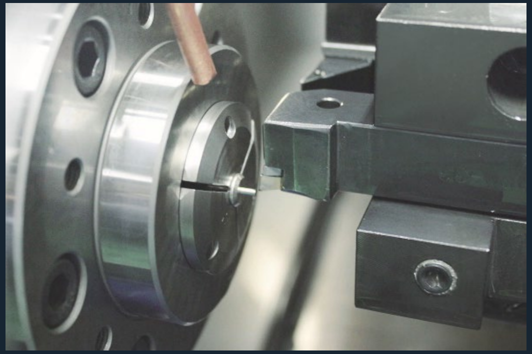
If a customer design(toleranc es, geometry, number of components required, etc) is practical using cold forming, significant improvements in part unit cost and reduced process complexity are possible.

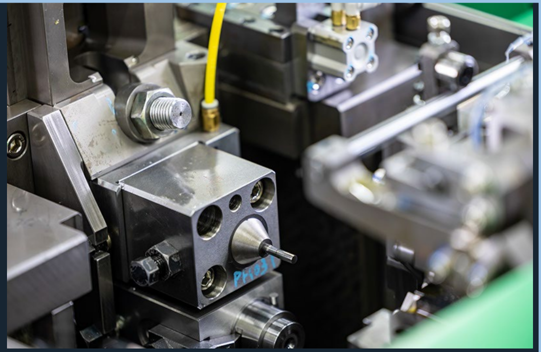
Example of our Value Added (VA) / Value Engineering (VE) through cold forming



2 pieces	Number of pieces	Single Piece
High Cost	Parts Cost	Lower Cost
Long	Lead Time	Shorter

3. Cold Forming vs Machining



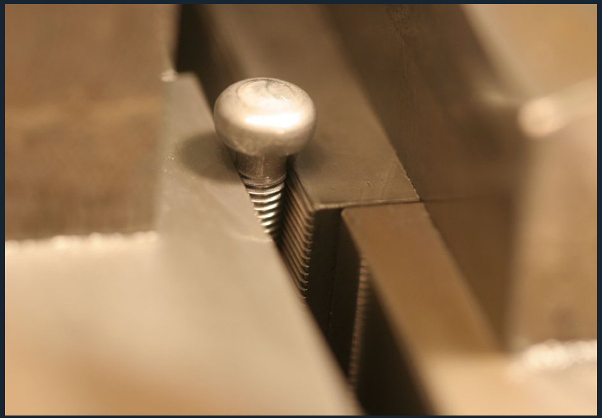


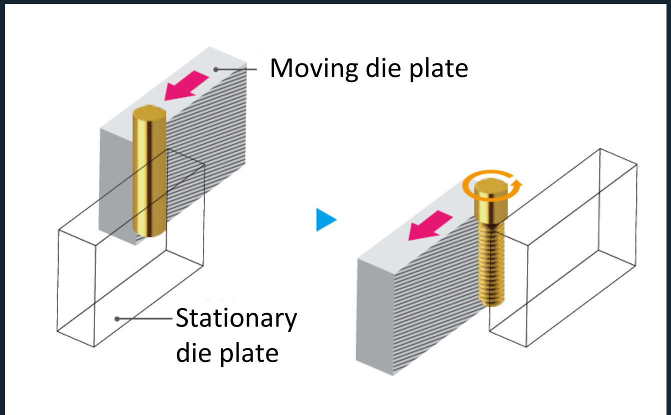
	Machining	Cold Forming
Dies	Not Neccesary	Neccesary
Material Yield	✘	✔✔
Processing Speed	✘	✔✔
Strength	✔	✔✔
Process Precision	✔✔	✔
Large Scale Production	✔✔	✔
Small Scale Production	✘	✔✔
Prototype Production	✔✔	✘
Mass Production	✔	✔✔

4. Comparison of cold, hot and warm forming

	Hot Forming	Warm Forming	Cold Forming
Characteristics	Forming with material heated above its recrystalization temperature.	Forming done at temperatures between those for hot and cold forming.	Forming done at/ near room temperature.
Forming Temperature	1100° C～1250° C (2012° F～2282° F)	300° C～850° C (572° F～1562° F)	Forming done at/near room temperature.
Required Loads	Low forming loads required	Medium loads required	Large loads required
Level of Precision	✘	✔	✔✔
Quality of Surface Finish	✘	✔	✔✔
Level of Geometry Complexity	✔✔	✔	✘
Ideal Production Quantity	Best for mid-to-small scale production	Best for medium scale production	Best for large scale production
Pros / Cons	Because material is heated to above its recrystallization temperature, smaller loads are required to form material. Greater deformation is also possible allowing for very large or highly complex geometries. However, surface finish is often poor for steel products compared to warm and cold forming because surface oxidation and decarbonation occurs above 900℃(1652° F). The level of precision achieveable is also poor due to the expansion /contraction of metal as it is heated and cooled.	Warm forming aims to combine the strong points of hot and cold forming. It allows for better surface finishes than hot forming, but temperature control is difficult. More complex geometries are possible than with cold forming, but precision is not as high.	Because no heat is added to material, cold forming allows for high precision, high quality surface finishes, and high speed production. However, compared to hot forming the loads required to deform material are high and material deformability is low, thus requiring a high degree of manufacturing experience to achieve complex geometries. Tooling life varies by product, but it is common for tooling to last into the 10,000 parts range and higher.

5. Rolling Process





In the rolling process, a blank is placed between two dies and rolled until the pattern on the dies is imprinted onto the blank. Typically used as a secondary process, rolling is used to create many different geometries including screw threads, grooves, diamond knurling and more. Rolling differs from cold forming with other types of machines, but because dies are used to plastically deform the workpiece, it is still considered a kind of cold forming.

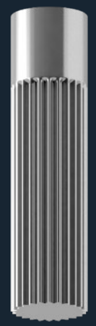
Some Geometries Possible with Rolling

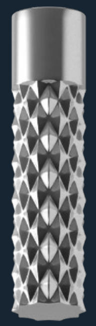

Screw Threads


Grooves

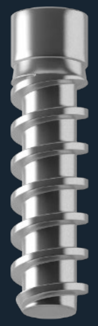

Pointed tips

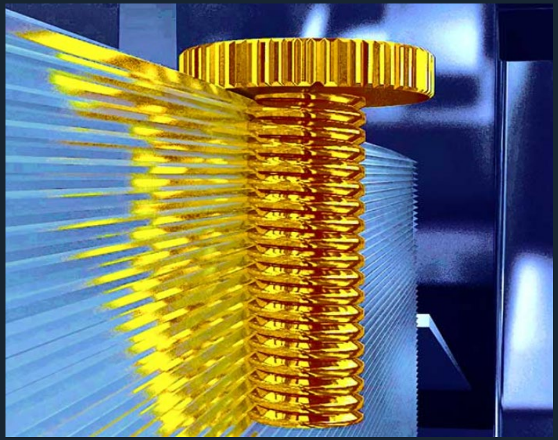

Rounded tips


Straight Knurling


Diamond Knurling

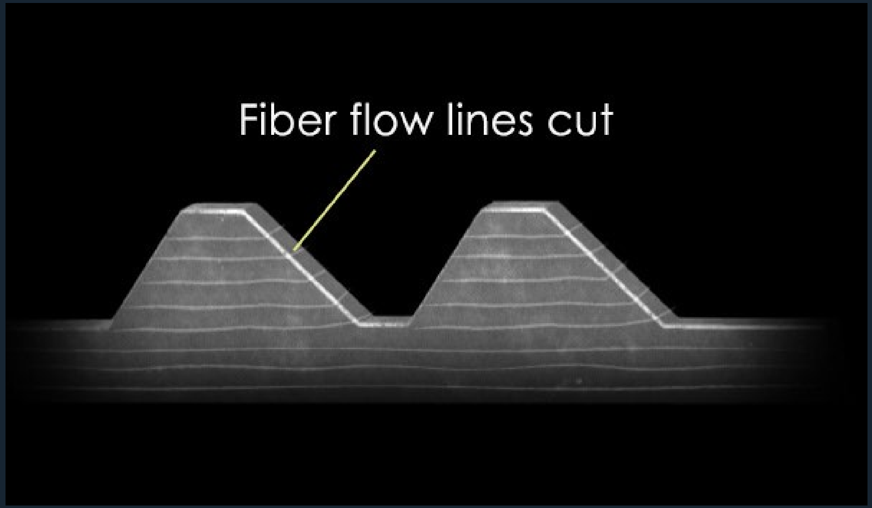

Spiral Knurling


Leadscrews

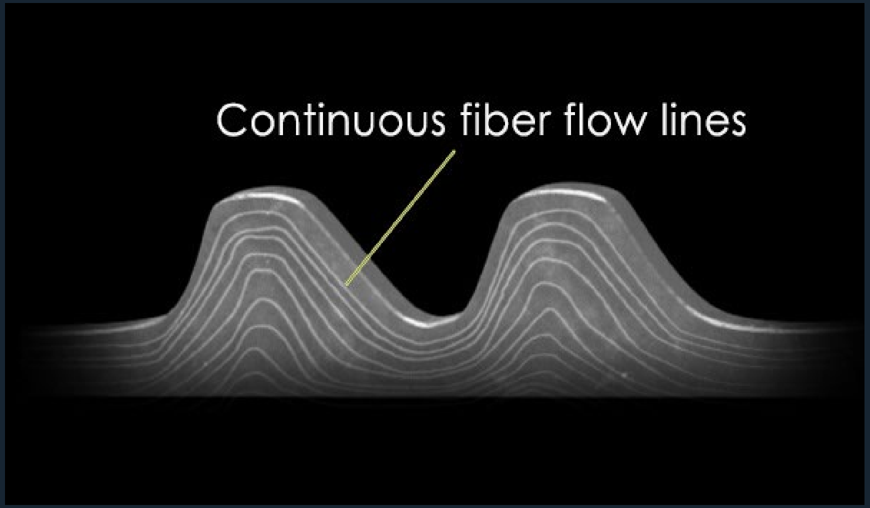


Machined vs Rolled Threads

Rolled threads enable high-speed thread forming with no material lost as scrap and a stronger product overall because, unlike machined threads, the fiber flow lines of the material are left intact. Rolling also allows for lower costs and better turnaround time than machining.



Machined Threads



Cold Formed Threads

6. Primary Processes

Custom Precision Forming

Precision forming for custom parts with shaft diameters up to 25mm (approx.1 in).

Catering to Many Different Customer Requested Geometries

Noncircular Shafts and Holes

Medium to Large Diameters (up to 25mm or 0.98 in)

Non-coaxial geometries

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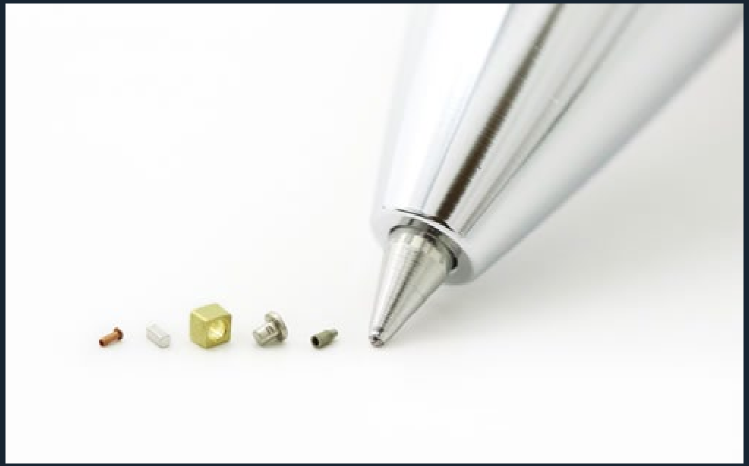
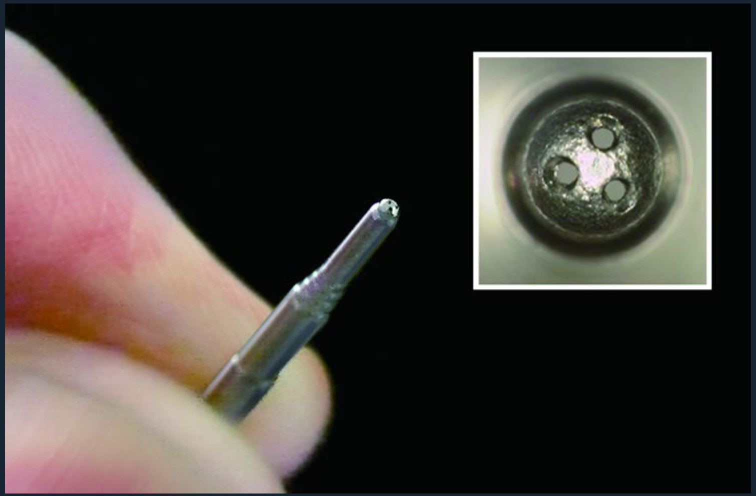
Micro-Precision Forming

Precision forming for micro parts with shaft diameters 1mm (0.04in) or less.

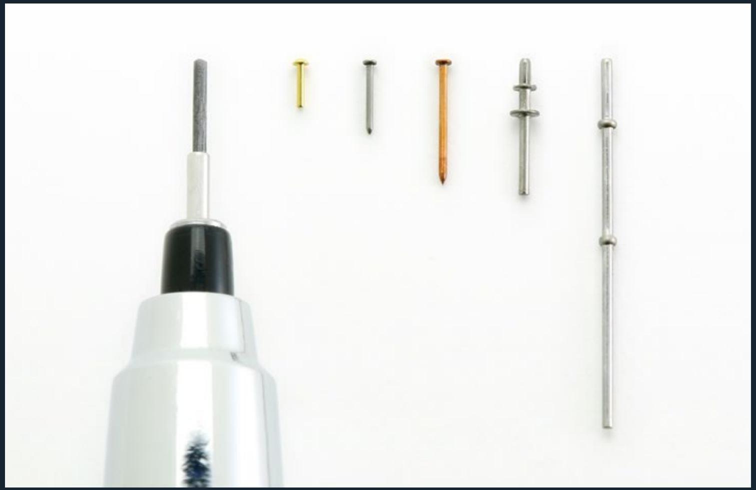


A Variety of Miniature Parts



0.14mm (0.0055in) Holes Formed at End of Shaft

Examples of (left to right) a Micro Double Flange, Micro-through Holes, Micro-flattening, and Micro-bending



Small Shaft Diameter Parts

Deep Drawing

Deep drawing for parts with thin walls or deep holes that would otherwise be difficult to form from round wire material.

Hollow Part with Thin Walls

Side Hole in Thin-walled Hollow Part

Part with Folded-In Tip

Examples of Parts Made with Press

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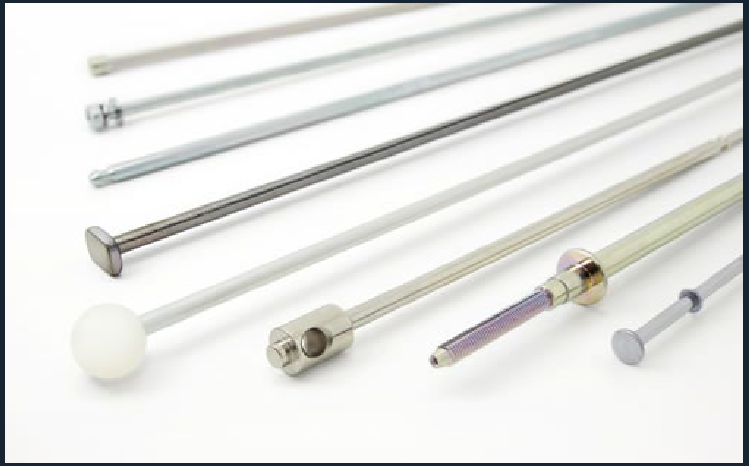
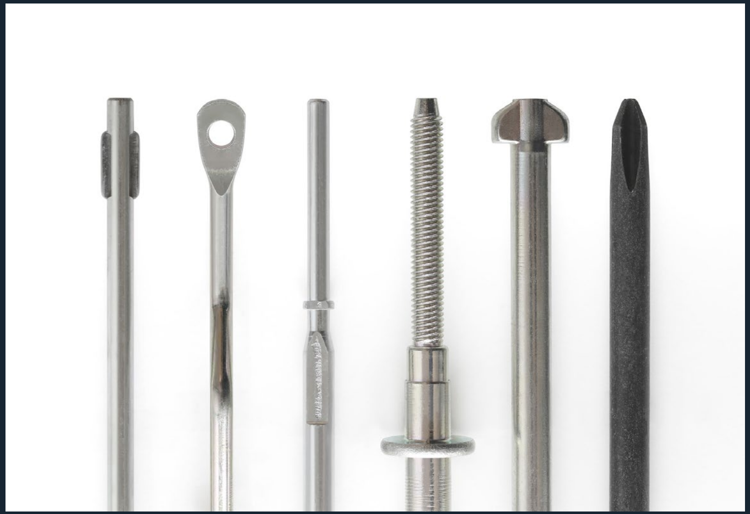
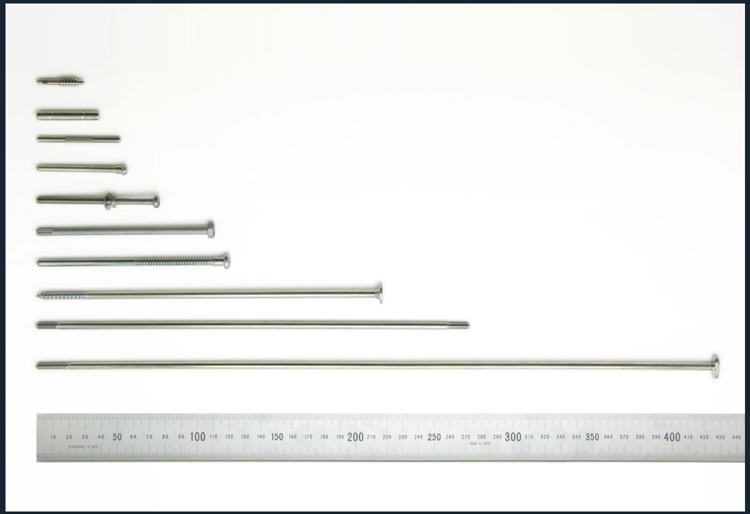
Forming for Long Parts

Forming for long parts (up to 1200mm (47in)).

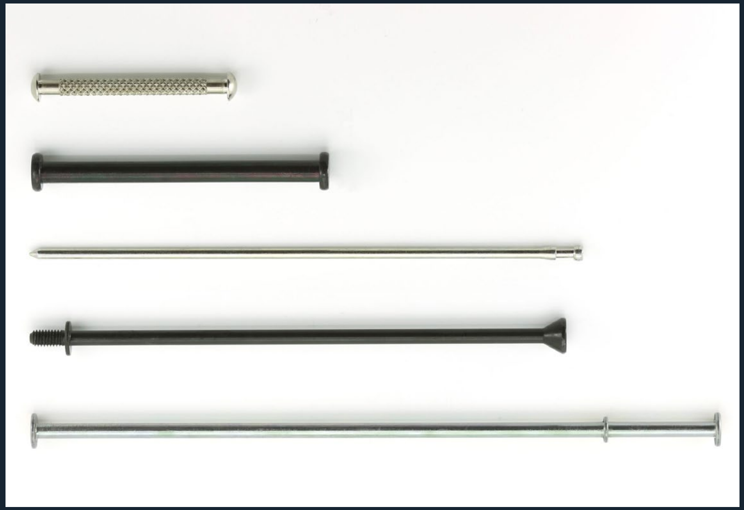




Examples of Long Shafts Formed with Multiple Steps, Flattened Sections, and/ or Flat Surfaces



Rolled Shafts in a Wide Variety of Lengths



Long Parts with Multiple Flanges

Long Shafts Formed with Bends and/or Flattened Sections

7. Secondary Processes

We offer a wide range of secondary processing services.

Machining

Bending

Flattening

Fastening / Press fitting

Plastic Molding

Tapping

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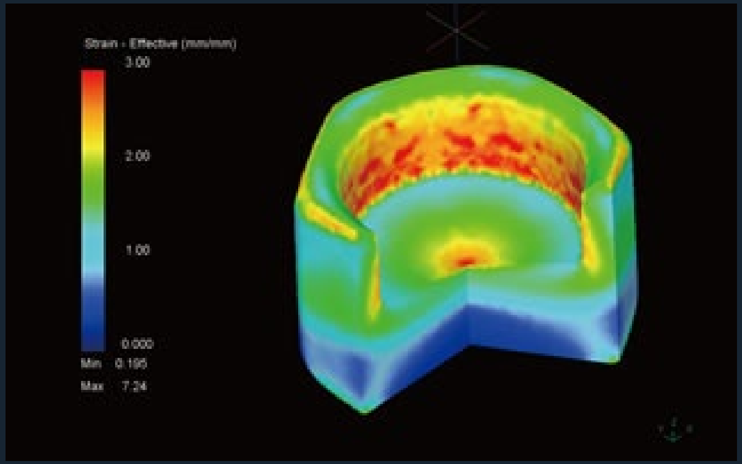
8. Processing Capabilities



Materials Possible with Cold Forming	Pure iron, carbon steel, stainless steel, copper, brass, aluminum, titanium, Kovar, and various alloys. Many other metals possible. Note: We are also able to perform tests to see if a material provided by the customer is forgeable.
Range of Base Material Sizes Possible	Base wire material diameters between 0.2mm and 23mm (0.008in to 0.90 in)
Possible Part Lengths	Part lengths between 1mm (0.04in) and 1,200 mm (47.2in) are possible. Note: Please consult with us if your part is particularly long.
Tolerances / Precision Possible	Tolerances in the μm (micrometer) range are possible. Note: What tolerances are possible depends greatly on part geometry and material.

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