

How To Identify Metal Stamping Optimized To Manufacture Complex Precision Micro Components

6 Critical Factors In Precision Micro Stamping – Down to the μ m Level

As products become smaller, there are new challenges in designing and manufacturing components for full functionality. Micro and micro-miniature parts involve micro and micro-miniature features. Increasingly miniature parts demand increasingly tighter tolerances. But you can be optimistic about precision stamping as the solution to component micromanufacturing. In fact, you can pursue miniaturization, complexity and the benefits that are unique to precision metal stamping. *All the way down to the μ m level.*



Technology miniaturized to shrink product footprints sets challenging standards for manufacturing micro and micro-miniature metal parts with complex features and ultra-tight tolerances. Medical device and electronics manufacturers, in particular, are developing unique, ever-changing products featuring aggressive miniaturization that challenges the best methods of conventional metal working.

High-end tool engineering and stamping achievable today wasn't imagined as recently as five years ago.

As dimensions decrease and complexity increases, what is the best metalworking approach for achieving precision measured in thousandths of a millimeter?

Metal stamping is up to the task. But it's critical to distinguish the relatively new precision **micro stamping** specialty from its old-school heritage and reputation for non-complicated, flat-profile and standard-precision parts.

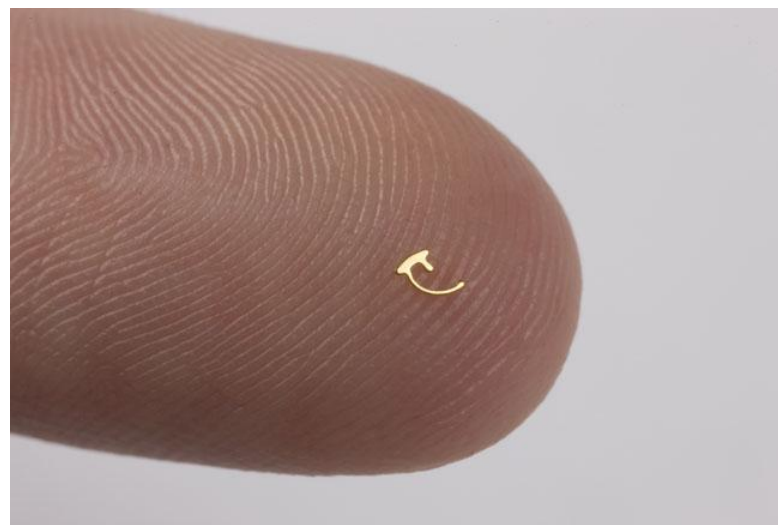
Much of what's possible at the high-end of tool engineering and stamping today wasn't imagined as recently as five years ago. A specialized stamping supplier dedicated to finely tuned micromanufacturing can deliver sophisticated – even breakthrough – parts solutions. Down to the μm level. With

advanced characteristics like multiple forms, tolerances thinner-than-paper, and ultra-thin exotic materials.

Premium tooling and advanced press operations accomplish features – formed, coined, drawn or tapped – sometimes visible only under magnification. It's possible to store 5,000 micro-miniature parts in one half of a prescription medication bottle. And then pour the inventory like fine-grained sand. Or gold dust and platinum flakes, in the case of precious-metal components.

But all micro stamping is not the same. What are the critical supplier characteristics that predict the aptitude to build tools and manufacture complex precision components specified in millimeters and microns?

Convergent Micro Stamping™ (CMS) is an inventory of six critical-to-success factors that form a 360-degree view of integrated systems, processes, technology, philosophy and experience important to high-end micro



component tool making and stamping.¹ The six factors – executed at a “best practices” level – converge on the optimized approach to stamp a complex precision micro component.

4. Advanced, Progressive Techniques and Tactics
5. Specialized, Fine-Tuned Infrastructure
6. Dynamic Supply Chain Management

What is *Micro*?

A technology example supports the importance of micromanufacturing customers aligning with a precision stamping resource that defines “micro” and “complexity” aggressively. The Swiss-made AgieCharmilles wire EDM center at Top Tool Company, one of only four such systems online in the United States, erodes metal today using a .0008in wire. (Compared to micromanufacturers who forecast they will achieve .004in cutting by the year 2015.)

The diameter is less than one-quarter the size of a human hair. And it enables precision metal stamping – the high-end version – empowered to design, engineer and build tools that can incorporate a work piece radius as small as .0007in.

The **Convergent Metal Stamping** critical factors are:

1. Aggressive Definitions of *Micro* and *Complex*
2. Expertise in Precious and Exotic Metals
3. Leading With Premier-Class Tooling

¹ *Convergent Micro Stamping* is a Top Tool Company trademark

Critical Factor #1: Aggressive Definitions of *Micro* and *Complex*

What is *micro*? There is no consensus definition for *micro*. A *MICRO*manufacturing survey² in 2010 suggests that *micro* gets defined by whoever is answering the question. *Micro* becomes the smallest dimension at which a particular stamper can confidently manipulate a part or part feature. The most aggressive and micro-proficient stampers set the definition at 2mm or smaller for parts, and down to 0.1mm for features. Less accomplished stamping providers lobby to qualify an 8mm part as *micro*.

The portfolio of work reveals how a stamping supplier defines “micro.” Are tool making and manufacturing operations mostly engaged with part dimensions as large as 8mm? Or does the company’s book of business indicate it regularly works with components 2mm and smaller?

Fifty percent of survey respondents said they were already involved in micromanufacturing. Another 20 percent expect to be involved in the near future. In either case, the true answer depends on a supplier’s definition of *micro*. The survey found that 34 percent of manufacturers expect to use cutting tools with diameters of .004in or smaller *by 2015*. In the

² *MICRO*manufacturing.com, May/June 2010, p. 3

meantime, a different 20 percent – including the most capable micro component metal stampers – are already there. Consider the stamper employing wire EDM using a .0008in wire to build tools than can incorporate a work piece radius as small as .0007in.

What is *complex*? The “flat profiles only” impression of stamping shares space with the outdated perception that complex features and sophisticated geometries automatically reduce the plausibility of metal stamping. Similarly, stamping supposedly means having to settle for relaxed tolerances. Neither perspective is accurate at the high end of today’s micro stamping specialty.

Feature complexity points directly at today’s high-end micro stamping to streamline, simplify, reduce cost and enable the highest-possible quality. There’s precedent for replacing a \$3 machined part – involving multiple machining stations – with a precision-stamped complex component produced for less than 25 cents per piece, plus the tooling investment. And producing 1,000 to 1 million parts – at that level of cost reduction – recoups tooling cost rapidly.

Product engineers can be optimistic when it comes to designing complex-featured micro components for stamping manufacturability. Examples of micro stamping complexity include:

- Cut and hole aspect ratios less than 1-to-1
- Tolerances as low as 0.01mm
- Ultrathin materials, down to .0005” (0.013mm)

- Small forms (bends, radii)
- Multiple forms
- Draw forms
- Precision coining

Critical Factor #2: Precious and Exotic Metals Expertise

The overall metal stamping category is large and crowded. But the population shrinks significantly when it includes only suppliers specializing in complex precision micro and micro-miniature components 2mm and smaller.

Look For Materials Expertise

- Platinum
- Platinum Iridium
- Gold
- Niobium
- Stainless Steel
- Beryllium Copper
- Titanium
- MP35N
- Nitinol

That millimeter-sized slice contains an even smaller sub-specialty: Stamping complex precision micro parts from *precious* and *exotic* metals. Most frequently gold, silver and platinum. But also emerging, unique-property specialty metals like Nitinol, Titanium and MP35N. Materials cut, stamped and formed into complex-featured components. Like the electrodes critical to implantable, continually

shrinking pacemakers and pain management neurostimulators.

An accomplished stamping supplier protects its OEM customers from the financial risk and complexity involved in dealing with a volatile commodity like platinum. Previously, the OEM sourced its own precious metals. Today it's the metal stamper's responsibility to effectively manage and manipulate precious metals and exotic materials. The role – a specialty in its own right – is critical to delivering custom micro stamping solutions.

What does it look like when a supplier works at the intersection of complex micro stamping and precious or exotic metals? Expect at least 50 percent of micro component tool making and stamping to involve those materials. Especially in the case of suppliers making critical components for major medical device companies.

Efficient material use is a key advantage when manufacturing very *small* parts from very *expensive* precious metals. Particularly the gold and platinum specified in medical and electronic applications. Stamping is lower-cost (per piece part) than machining because high-precision, in-die forming operations – like bending, coining, skiving and drawing – generate significantly less scrap than removing material by milling or grinding. In fact, material use during stamping can approach 100 percent. At precious metal prices well over \$1,000 per ounce, the cost avoidance is significant.

Equally important, exotic materials or precious metals are more difficult to manipulate on a machining center. By comparison, handling demanding materials (with micro precision) is routine for Class A tools and a high-end press operation. Even when the material is thinner than paper. Or a full-hard stainless steel alloy is almost as hard as the tool steel itself.

Be aware, however, that a supplier in this category may not talk extensively about how they handle specialty materials. Vital elements in micro-stamping precious and exotic metals are closely held because a supplier can add value by innovating far upstream from the stamped part. This includes collaborating with suppliers – using unique systems, processes and methods – to create customized material specifications proprietary to the micro stamper's processes.

There is specialized art and science in creating premium tools that produce premium micro components.

Critical Factor #3: Leading With Premier-Class Tooling

Every day, it becomes more realistic for product designers and engineers to specify micron-level tolerances for advanced, complex part features. But tooling often is the least familiar, least visible contributor. As a result, it's tempting to underestimate the tool's



influence on outcomes ranging from precision quality and piece-part cost . . . to tool maintenance, reliability and longevity. A long-lasting, high-performing and high-reliability tool is a custom-built solution to project-specific micromanufacturing challenges. Superior tooling is intricately engineered mechanical art. And the investment will reflect it.

A close, objective look at tooling – especially premier-class micro component tooling – validates its status as a game changer. Tooling is not the area to reflexively cut corners because it's perceived as non-performing overhead. Particularly when it comes to protecting the cost, quality, repeatability and profit-contribution of micro-stamped parts. Commodity-priced tool engineering produces commodity tools, which are subpar for micromanufacturing. Producing premium micro components requires premium tools.

It's a fact: Top-performing tooling required for high-end micro stamping will not match the lower cost of under-engineered, commodity-type tooling. Quality does carry an initial cost.

But the tool investment is safe – and smart – because it dials up the caliber of outcomes, and dials down the risk. Forward-thinking capital investment in tooling optimizes quality, precision and cost control.

Finally, remember that a stamping manufacturer realizes most of its profit, if not all, from *stamping parts*. Not by developing and building a tool. The innovation, inventiveness and high standards that go into a tool solution – to protect the stamper's profitability plan – also drive best-possible outcomes for customers.

Critical Factor #4: Advanced, Progressive Techniques and Tactics

The potential in precision micro stamping is higher in the hands of a specialist that handles micro component projects other suppliers don't (or can't) design, engineer and manufacture. Delivering a turnkey solution for micron-level accuracy and precision involves orchestrating a high number of complex elements in constant motion. This includes best practices for techniques and tactics



ranging from the latest 3-D manufacturing software to automated vision inspection. The following two examples represent an advanced, progressive approach to precision micro stamping.

Rigorous Part Qualification. A high-end specialist in complex precision micro components consistently attracts projects that require breaking new precision-stamping ground. When that occurs, a supplier can respond in one of three ways.

Supplier A declines the bid, unable to tool and stamp with confidence.

Supplier B bids the project, hoping to figure things out along the way.

Supplier C is confident, but also seeks certainty – at the front end – that it can tool-up and stamp to meet customer requirements (and its own profitability goals).

Suppliers *B* and *C* are both optimists. But optimism doesn't guarantee producible parts.

Optimized manufacturability depends on how a supplier defines and applies the concept of *part qualification*.

Part qualification ranges from simple and limited . . . to rigorous and truly predictive. Micro precision and complexity demand the rigorous version. Passing a first article inspection (FAI) by making five parts to the print can be called a qualification process. But FAI is only one snapshot of a single element. It's not sufficient, by itself, to validate tooling and fully capable final production. In fact, it's possible to pass FAI, but also produce costly 15% scrap. Perhaps because the limited analysis can't predict extraordinary tool wear.

High-end part qualification involves broader and more comprehensive due diligence. The analysis and evaluation starts sooner and extends further. Qualification begins at concept and design, stays in place through all stages of the process, and finishes with a detailed follow-up in post-production. Even to the point, depending on complexity and the originality of a concept, that verification includes formalized risk management at every stage.

'Quick-turn, Low-Volume' Can Be Robust. A specialist can prove precision metal stamping is a micromanufacturing solution that combines quality, speed and price. Even in quick-turn prototyping or low- to mid-volume applications. And especially if the challenge involves complex features, precise geometries and micron-level tolerances.

R&D is a Stamping Role

Component miniaturization is tailor-made for customer-and-supplier R&D collaboration early in stamping projects. Two examples:

- Fast-changing circuit designs didn't allow the 2- or 3-week build time attached to traditional, fixed tooling. Brainstorming with the customer launched a modular, insert-driven solution to produce custom tools in 2 to 3 days. At half the per-tool cost, with improved quality and performance.
- Tool designers and medical device engineers collaborated to design a precision-stamped micro-miniature component for an implantable device. The early-stage partnering also drove design and engineering solutions related to manufacturability and cleanroom assembly.

The miniature die unit (MDU) proprietary to Top Tool Company is an example of using precision stamping for prototype and low-volume production. The standardized, in-stock die set delivers production-validated and customized hard tooling in one week or less. But it packs all the potential of robust, high-end precision stamping into a footprint for micromanufacturing parts.

Customers use the streamlined, fast-timeline MDU solution to make hard-tool micro stamping accessible at the "need it now" prototype stage of R&D. Previously, micro or micro-miniature parts might have been stacked up to be wire cut or laser cut at significantly higher per-piece costs. Medical device and electronics companies, in particular, leverage the MDU solution to

establish metal stamping as the validated method of manufacturing.

Critical Factor #5: Specialized, Fine-Tuned Infrastructure

A race boat is built around a high-tech hull optimized for speed. Equipping a stamping operation to optimize micro component production is similar. Core skillsets form an infrastructure that determines and enables performance. But the caliber of skills differs from supplier to supplier. The following three vital infrastructure examples signal an aptitude for fine-tuned, top-performing micro stamping.

Tested, Proven R&D Skills. A solution-seeking supplier dedicated to micro stamping thrives on R&D-stage micro component challenges. Even when there is OEM uncertainty or skepticism about stamping. High-end micro component suppliers seek out, accept – and even attract – challenges that less proficient stampers are forced to avoid. A forward-leaning supplier – with the engineering and quality assurance skills to back it up – is equipped to push the limits of micro component stamping.

Advanced Prototyping. The *time* and *cost* constraints inherent in prototyping act against achieving thorough, completely trustworthy verification. Corner-cutting won't necessarily prevent an outcome that's satisfactory. Or at least satisfactory *enough*. But less-than-optimized prototypes water down the data and cover up opportunities to refine. Using

temporary methods, quick-and-dirty tooling, and stand-in materials is a particularly bad fit with validating how to manufacture complex micro components.

It's not necessary – even when trying to minimize schedules and costs – to dumb down a prototype build by starting bare and making do with as little as possible. High-end micro stamping sets significantly higher prototyping expectations. It begins with a view of the optimized, perfect-world build. And then works to dilute that standard as little as possible.

Robust, Formalized Risk Management. Risk taking is fuel to achieve bigger, more valuable rewards by pushing boundaries to accomplish the best-possible micro stamping. Especially as ever-changing technology drives the development of unique and breakthrough products. The optimal solution for a component that is micro-miniature and complex can require new or non-standard tooling technology. The formal, expert management of risk dials back the related exposure without sacrificing the best-possible outcome. Typically, by taking early steps to “design the problem out.”

Risk management is the cost-avoidance antidote to fixing after the fact, or authorizing rework. The objective is to reduce, avoid and prevent threats. At every phase and as a daily operational practice. From design-for-manufacturability, to building the tool and sourcing the material. Identifying, assessing

High-Level Control

High-level control plans are not sophisticated – or used – across-the-board in precision micro stamping. Especially at the low end of the complexity and precision continuum. It's a different, more demanding story for a supplier that stamps precision micro components for implantable (highly regulated) medical devices.

Although FDA regulation related to medical device manufacturing does not mandate control planning, the major medical players require it. And they anticipate it will be FDA-mandated relatively soon. Likewise, as miniaturization-with-complexity gains momentum beyond medical devices, control plans are increasingly standard business practice for high-end stamping in electronics, defense and energy.

and prioritizing exposure. Measuring risks for probability and severity. Analyzing for cause and potential effect. Grading existing controls on the capacity to detect weakness. Studying solutions and the cost to remove or mitigate risk. And then responding to issues that could negatively impact the outcome.

Critical Factor #6: Dynamic Supply Chain Management

High-end micro stamping generates critical value long before the tool room and press operations go into action. Sophisticated, turnkey supply chain management is a key example. The critical skillsets range from

capabilities in Lean Cost Performance Index (CPI) and full lot traceability, to web-based order management and sourcing proprietary precious metals.

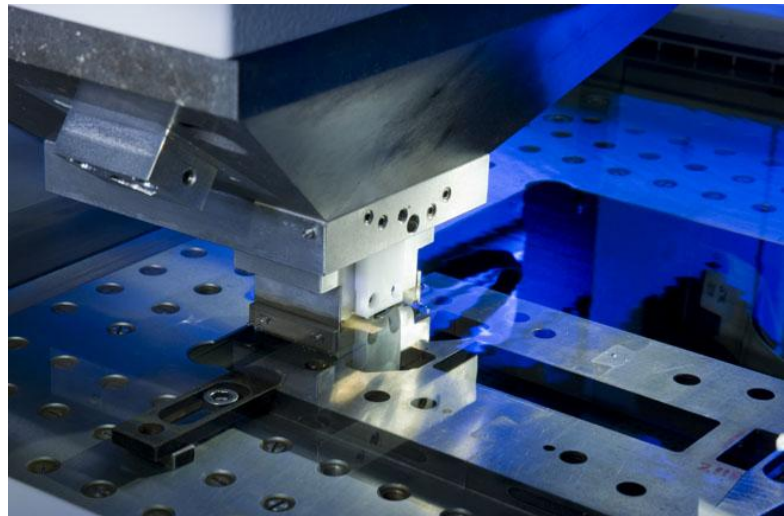
Consider the good news and bad news related to sourcing an uncommon, custom blend of nickel silver. Nickel silver – when available only through a European supplier – might have a 12-week lead time. An electronics OEM can source the material, but will wrestle with daily price fluctuations in order to manage price variation. And the material is too expensive – particularly at high volume – to park it in inventory or compile safety stock. That’s the bad news.

The good news is a *three bin Kanban* managed by the metal stamper. Just-in-time replenishment scheduling tells the supply chain what to produce, when to produce, and how much to produce. One bin supplying the OEM factory. One bin being filled during stamping production. And the buffer bin, in between stamping and the OEM, ready for the factory floor. A supplier using this three-bin material management system can put parts on the customer’s receiving dock within three days of getting the re-supply signal from OEM operations.

The metal stamper sources the material – forecasting from hard production data – at locked-in, volume-purchase prices. Which may reduce the per-piece cost. At the very least, it makes pricing consistent and predictable. Pulling the material from the supplier, according to the Kanban, reduces inventory

carry. And the work-in-progress reflects only what is needed to fill the next bin in the cycle. A Kanban fits the need especially well when there is a dedicated – at least monthly – parts fulfillment schedule. Particularly when volumes reach the thousands of parts, and sourcing lead times are extended.

A micro-stamping supplier can leverage Kanban further by using a web-based portal to view and integrate the customer’s manufacturing operations in real-time. Removing even more lag time to streamline supply chain response.



Summary

Every day, there are fewer and fewer resemblances between old-school metal stamping and today’s high-end precision micro stamping. In fact, the tool engineering and press floor innovations routinely occurring today are turning stamping into one of the *newest* technologies for manufacturing multiple, intricate forms and geometrically complex features at dimensions down to

0.1mm. With tolerances as tight as 1.5 microns.

Metal stamping, like any manufacturing methodology, is not the answer for every component application. But a high-end micro stamping specialist can accomplish results you might not expect. By applying leading-edge technology and experience handling the most complex micro and micro-miniature challenges.

That should be welcome news for designers and engineers working on product miniaturization. No one is making *bigger*. But speed, precision, productivity and cost containment – the well-known characteristics of metal stamping – are always in style when it comes to product engineering and design. Collaborating with a micro stamping component supplier at the high end of the specialty can lead your micromanufacturing in new, productive and breakthrough directions.

About Top Tool Company

Top Tool Company specializes in tooling and flawless precision-stamped components – down to the μm level – for world-class companies. Including the leading manufacturers in highly regulated industries. With more than 40 years of experience, Top Tool manufactures high-precision, micro and micro-miniature components – featuring complex geometries and tight tolerances – stamped from ultra-thin, exotic materials and precious metals.

An innovator in world-class tooling and design-for-manufacturing, the company develops inventive solutions for implantable medical devices, surgical instruments, electronics and more. Top Tool offers a full range of engineering services, in-house design and die construction, rapid prototyping, qualification runs and full-scale production. ISO 9001:2008 certified.

For more information on complex precision micro component stamping, visit www.toptool.com.



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