

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

6 Critical Factors In Precision Micro Stamping – Down to the μm 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 μm level.*



Metal Stamping In A Different League

Technology miniaturized to shrink product footprints also drives the manufacture of micro and micro-miniature component parts with complex features and ultra-tight tolerances. The challenge is how to achieve metal working precision measured in thousandths of a millimeter.

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

Have you looked at metal stamping recently – and objectively – to produce complex precision micro components? High-end tool engineering and stamping achievable today wasn't imagined as recently as five years ago.

Metal stamping regularly battles the mistaken impression that it is limited to non-complicated manufacturing applications. It's true *traditional* metal stamping is optimal for blanking out high-volume flat parts. Like a standard washer. Or a simple fuse link. But today's *micro stamping for complex components* is a distinct, dynamic and high-end specialty. An exclusive subset of stamping that offers impressive (often unexpected) upside for micromanufacturing.

A proven, specialized component supplier with operations dedicated to fine-tuned micro stamping can deliver sophisticated – even breakthrough – parts solutions. Down to the

µm level. With advanced characteristics like multiple forms, ultra-thin exotic materials, and 1.5-micron tolerances. Premier-class tooling and advanced 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.

Today's Micron-Level Precision *Plus* Proven Cost Efficiency, Productivity

The print for an intricate micro-stamped part – like a stainless steel coronary artery staple – might specify multiple, complex bends and forms across varying material thicknesses. All within a component that is just 5/100ths of an inch wide.

The value propositions that recommend metal stamping, in general, also apply to manufacturing that artery staple. In fact, the key advantages behind stamping become more relevant as part dimension shrinks, complexity increases, and precision is measured in microns.

One example: 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, the handling of demanding materials (with micro precision) is routine for a certain class of tooling and stamping. Even when stock is thinner than paper. Or a full-hard stainless steel alloy is almost as hard as tool steel.

The pro-stamping argument is similar when the goal is increased throughput and productivity. That's where a *progressive die* is the difference-maker. Toolmakers creatively engineer and automate precise material feeding through as many as 20 inline, simultaneous and sensor-monitored stamping and forming operations. To achieve ultra-high repeatability by avoiding variation-causing manual set-ups, fixture loading, and parts transferring between CNC operations.

Convergent Micro Stamping™ Leads to Best-Possible Solution

Every methodology exists on a continuum ranging from its low-end version to its high-end version. The metal stamping continuum – segmented into part sizes and related degree-of-difficulty – begins at the low-end ability. Producing large, relatively basic and standard-precision parts. As component dimensions decrease and complexity increases, it progresses toward the high-end expertise that is today's micro stamping. Where components and features are measured in millimeters. And precision, including tolerance, is quantified in microns.

Next, isolate the **micro stamping portion** as its own, separate continuum. Making it possible to distinguish between basic micro capability . . . and significantly higher, more sophisticated micro aptitude. In addition, to identify metal stamping **optimized to manufacture complex precision micro components**, rate a supplier against certain critical-to-success factors. An inventory of vital characteristics that signal the ability to build tools and stamp complex precision micro components at *“the high end of the high end.”*

Convergent Micro Stamping™ (CMS) is an inventory of critical-to-success factors that form a 360-degree view of integrated systems, processes, technology, philosophy and experience crucial to high-end micro component tool making and stamping.¹ The six critical factors – especially when executed at a “best practices” level – **converge on the best-possible approach** to stamp a complex precision micro component.

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 critical factors that comprise **Convergent Micro Stamping** are:

1. Aggressively Defining “Micro” and “Complex”
2. Expertise in Precious and Exotic Metals
3. Leading With Premier-Class Tooling
4. Advanced, Progressive Techniques and Tactics
5. Specialized, Fine-Tuned Infrastructure
6. Dynamic Supply Chain Management

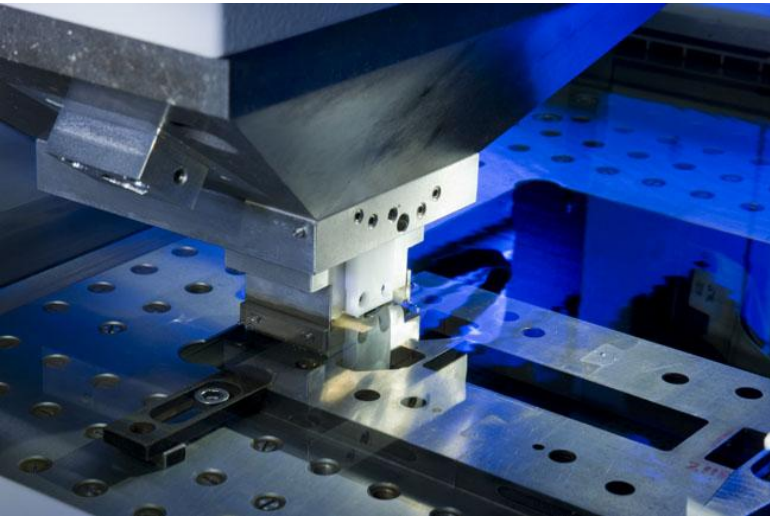
CMS™ Critical Factor #1: Aggressively Defining “Micro” and “Complex”

Micro Dimensions. To evaluate where a supplier’s capability ranks on the continuum from low-end to high-end micro stamping, look at the portfolio of work to determine how the stamper defines “micro.” Are tool making and manufacturing operations mostly working with part dimensions as large as 8mm? Or does the company’s book of business indicate it is dedicated to components 2mm and smaller?

There is no industry consensus or standard for defining *micro*. A *MICRO*manufacturing magazine survey² indicates that *micro* currently gets defined by whoever is answering the question. *Micro* means the smallest dimension at which the responding stamper can confidently manipulate a part or part feature. Stampers at the aggressive and most proficient end of the micro continuum set the definition at 2mm or smaller for parts, and down to 0.1mm for features. Less accomplished micro stamping providers, operating at the low end of the capability range, lobby for the 8mm part dimension.

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

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



Fifty percent of survey respondents say they are already involved in micromanufacturing. Another 20 percent expect to be involved in the near future. In either case, the real answer depends on someone's definition of *micro*. Clearly, more credit is due to OEM engineers – and their component supplier partners – already operating at the high end of micromanufacturing. The magazine survey found that 34 percent of manufacturers expect to use cutting tools with diameters of .004in or smaller *by 2015*. In the meantime, a different 20 percent – including the most capable micro component metal stampers – are already there.

Complex Features. The “flat profiles only” misperception shares time with the mistaken impression that complex features and sophisticated geometries automatically reduce the plausibility of metal stamping. Or that stamping means having to settle for relaxed tolerances.

That's not accurate. Not for a high-end micro stamping supplier.

Feature complexity actually can point directly at micro stamping to streamline, simplify, reduce cost and enable the highest-possible quality. In fact, there's a real possibility of 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 making 1,000 to 1 million parts – at that level of cost reduction – recoups tooling cost rapidly.

The bottom line? Product engineers can be optimistic when it comes to designing complex-featured micro components for stamping manufacturability.

Examples of feature complexity include:

- Cut and hole aspect ratios less than 1-to-1
- Tolerances as low as 0.010mm
- Ultra-thin materials, down to .0005” (0.013mm)
- Small forms (bends, radii)
- Multiple forms
- Draw forms
- Precision coining

CMS™ Critical Factor #2: Expertise in Precious and Exotic Metals

Metal stamping is a large, crowded category. But the population shrinks significantly when you single out *micro component* metal stampers. Including only suppliers that specialize in stamping complex precision micro and micro-miniature components. (In the 2mm and smaller range, keeping in mind that “micro” is a subjective term.)

This micro component “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.

What does it look like when a supplier works squarely at the intersection of complex micro stamping and precious or exotic metals? Expect at least 50 percent of the micro component tool making and manufacturing to involve those materials. Especially in the case of an experienced, proven and long-term supplier to major medical device companies.

A supplier may not be able to talk extensively about how the job gets done. Vital elements in stamping precious and exotic metals must be closely held because the specialty extends beyond the cutting, stamping and forming. Clearly, it’s about tool making optimized to minimize scrap. Or achieve complex features with incredible, thinner-than-paper tolerances. But a micro stamping specialist focuses equal creativity and innovation on materials management well upstream from the finished part. Often collaborating with material sub-suppliers on unique systems, processes and methods. Even to the point of creating custom material specifications proprietary to the micro stamper’s processes.

The supplier’s objective is to protect OEM customers from the financial risk and complexity involved in dealing with a volatile commodity like platinum. Previously, an OEM sourced its own precious metals. Today it’s the metal stamper’s responsibility to effectively manage and manipulate precious metals and exotic materials. Because that role is a specialty in its own right. And because it’s critical to execute the specialty so it supports the customized micro stamping solutions.

Look For Materials Expertise

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

CMS™ Critical Factor #3: Leading With Premier-Class Tooling

High-end stamping for complex precision micro components rests on developing and building an elevated class of tooling. From a customer perspective, tooling often is the least familiar, least visible ingredient. As a result, it’s tempting to underestimate tooling’s influence on outcomes ranging from precision quality and piece-part cost, to tool maintenance,

reliability and longevity. A long-lasting, high-performance and high-reliability tool is a custom solution to a unique micromanufacturing challenge. It can be an intricately engineered work of precision mechanical art. And the tool investment will reflect it.



Getting to know tooling – especially premier-class micro component tooling – validates its status as a game changer. And not the area to reflexively cut back because it is non-critical 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. There is specialized art and science in creating premium tools that produce premium micro components.

That's especially true for tooling designed and built as the precision-stamped solution to component miniaturization. Every day, it becomes more realistic for product designers and engineers to specify micron-level tolerances for advanced, complex features. Not to mention succeeding with costly,

difficult-to-handle materials. But this is fact: The premium, top-performing class of tooling required for high-end micro stamping will not match the lesser cost of under-engineered, commodity-type tooling.

The image of advanced precision tooling is harmed when a toolmaker camouflages expense by amortizing a portion of the tool into a customer's piece-part cost. A precision micro-component specialist, especially with confidence from decades of designing and building tools, leads with the promise that end results absolutely reflect tool investment. 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.

Finally, keep in mind a stamping manufacturer realizes most of its profit, if not all, from *stamping parts*. Not by developing and

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

building a tool. The innovation, inventiveness and high standards that go into a tool solution – to protect and meet the stamper's profitability plan – also drive and ensure best-possible outcomes for customers.

CMS™ Critical Factor #4: Advanced, Progressive Techniques and Tactics

The potential inherent in precision stamping is worth even more in the hands of a micro component specialist that handles 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, moving pieces. Techniques and tactics involving best practices 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.

'Part Qualification' is Rigorous. A high-end specialist in complex precision micro components frequently gets projects that represent brand new stamping territory. When that occurs, there are varying supplier responses.

- A. *Can't tool and stamp with confidence. Declines the bid.*
- B. *Is optimistic, and bids the project. Expecting to figure it out along the way.*
- C. *Optimistic, but seeks certainty – at the front end – that it can tool-up and stamp to meet customer requirements (and its own profitability goals).*

A customer inquiring into suppliers' part qualification systems (to verify process) might get a positive response from both the B and C optimists. But optimism doesn't guarantee producible parts. Success depends on how a supplier *defines and applies* part qualification.

Once again, the versions range from simple and limited . . . to rigorous and truly predictive. Micro-level precision and complexity demand *rigorous*. Passing first article inspection (FAI) by making five parts to the print is a qualification process. But FAI alone – one snapshot of a single element – is not sufficient to validate tooling and confirm fully capable production. In other words, it's possible to pass FAI, but also produce costly 15% scrap. Perhaps because limited analysis couldn't predict extraordinary tool wear.



The high-end version of part qualification conducts broader, more comprehensive due diligence. 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 newness of a concept, that verification includes formalized risk management at every stage.

Even ‘Quick-turn, Low-Volume’ Can Be Robust. A micro specialist has to establish that precision metal stamping is the **quality, speed and price** solution for micro-miniature manufacturing. 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.

A supplier dedicated to micro stamping thrives on R&D challenges.

In 2000, Top Tool Company developed the proprietary miniature die unit (MDU). A standardized, in-stock die set for delivering production-validated and customized hard tooling in one week or less. The MDU packs all the potential of robust, high-end precision micro-stamping into a footprint for micro-miniature manufacturing.

Customers use the streamlined, fast-timeline solution to make hard-tool micro-stamping accessible at the “need it now” prototype stage of R&D. Medical device and electronics companies, in particular, have leveraged the MDU solution to establish metal stamping as the validated method of manufacturing. Previously, the same micro or micro-miniature parts might have been stacked up for wire cutting or laser cutting. Generating significantly higher per-piece costs.

CMS™ Critical Factor #5: Specialized, Fine-Tuned Infrastructure

A race boat is built around a high-tech hull that’s optimized for speed. Equipping to optimize precision micro component stamping is similar. The infrastructure (or core) is the dominant force in shaping and guiding stamping’s ultimate performance. Once again, however, the caliber of this core structure differs from supplier to supplier along the low-end to high-end performance continuum.

These three examples of vital infrastructure – among several – signal a fine-tuned, top-performing micro stamping aptitude.

R&D Skills Are Tested, Proven. A solution-seeking supplier that is 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 wisely avoid. Being forward-leaning – with the engineering and quality assurance to back it up – signals a supplier operation equipped to push the perceived limits of micro component stamping.

The same forward-leaning specialist also troubleshoots *existing* tools and component designs to smooth out manufacturability problems. Which means getting the call – when the part is in production – to pinch-hit for some other machining approach. In that

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.

case, tool designers apply reverse engineering and component forensics to expose the root problem. And then develop the precision micro-stamping solution.

That said, there's no question about what ranks higher in a choice between working backward from a flaw already spiking non-conformance, or tackling an R&D-stage opportunity. The odds favor preferring to assume the R&D role in order to "design in" the potential and the possibilities that high-end micro stamping can contribute.

Prototyping is Advanced. The usual *time* and *cost* constraints in prototyping act against accomplishing 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.

Producing low-volume sample parts using temporary methods, quick-and-dirty tooling, and stand-in material sourcing is a particularly bad fit for validating how to manufacture complex micro and micro-miniature components. Especially when the substandard outcome is rationalized by predicting "it will get better at production."

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.

Risk Management is Robust, Formalized. Risk taking is fuel for achieving bigger, more valuable rewards . . . by pushing boundaries to accomplish the best possible micro stamping solution. Especially as ever-changing technology drives the development of unique products. Consider a component that is micro-miniature and complex. Perhaps the optimal solution lies in new or non-standard tooling technology. The formal, expert management of risk dials back the accompanying exposure. Without giving up on producing the best-possible outcome. By "designing the problem out" early.

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.

Don't fix after the fact, or accept defeat and re-do work. *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. Identify, assess and prioritize exposure. Measure risks for probability and severity. Analyze for cause and potential effect. Grade existing controls on the capacity to detect weakness. Study solutions and the cost to remove or mitigate risk. And then respond to issues that could negatively impact.

CMS™ Critical Factor #6: Dynamic Supply Chain Management

A high-end micro stamping specialist expects to generate critical value far upstream from

when the tool room and the press floor go into action. Sophisticated and turnkey supply chain management is a primary example. The critical supply chain skillsets range from capabilities in Lean Cost Performance Index (CPI) and full lot traceability, to web-based order management and proprietary precious metals sourcing.

As an example, consider the good news and bad news related to sourcing an uncommon, custom blend of nickel silver. First, the bad news. Nickel silver – when available only through a European supplier – might have a 12-week lead time. An electronics OEM buyer sourcing the material would 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.”

The good news? A stamping-managed “three bin” *Kanban*. 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 stamping 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 stamping supplier sources the material – forecasting from hard production data – at locked-in, volume-purchase prices. Which may reduce the per-piece cost. And at the very

least, 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 – shipment schedule. With volumes in the thousands of parts. And when sourcing lead times are extended.

Another supply chain-smoothing technique improves Kanban streamlining even further. The micro-stamping supplier can use a web-based portal to view and integrate the customer's manufacturing operations in real-time. Removing still more lag time in supply chain response.

Summary

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

It's wise to stay current on what is possible at the leading edge of precision micro stamping. Not to mention keeping up with where the specialty is headed from here. Collaborating with a micro-stamping component supplier operating at the high end of the specialty will 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.



Top Tool Company
3100 84th Lane NE
Minneapolis, MN 55449
Phone: 763-786-0030
e-mail: ttcsales@toptool.com

Copyright© 2011 Top Tool Company. All rights reserved. Convergent Micro Stamping is a Top Tool trademark.