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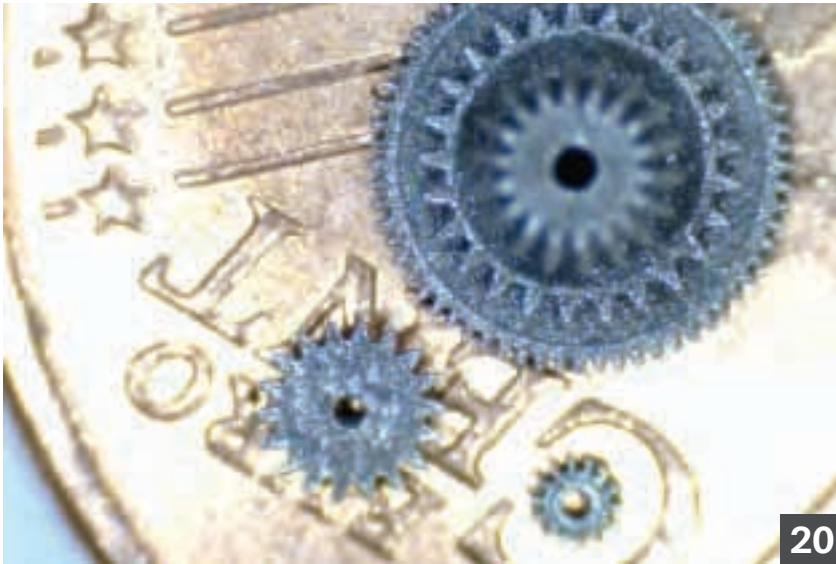
September/October 2011 Volume 4 Issue 5

A FABLESS IDEA

MEMS makers outsource fabbing processes



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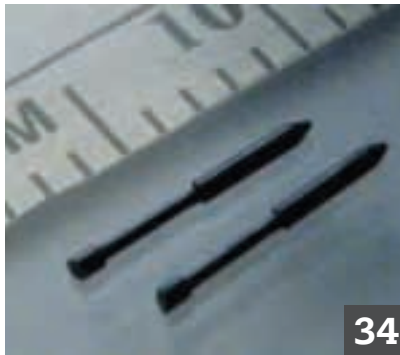
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Shown is a MEMS piezoresistive sensing die designed by All Sensors, Morgan Hill, Calif.

Cover design by Tom Wright.

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Stamp of Approval

'Success factors' to look for in a microstamper

By Duane Kari, Top Tool Co.



All Images: Top Tool

A stamped electrical connector used in a device that tests next-generation computer chips.

Standards for manufacturing metal microparts with complex features and ultratight tolerances are challenging, to say the least. Medical device and electronics manufacturers, in particular, are developing unique new products with aggressive miniaturization strategies that challenge the best conventional metalworking methods.

As feature dimensions decrease and complexity increases, metalworking methods must achieve precision measured in thousandths of a millimeter. Metal stamping is up to that task. But it's critical to distinguish the relatively new precision microstamping specialty from its old-school heritage and reputation for uncomplicated, flat-profile, standard-precision parts.

Much of what's currently possible in microstamping wasn't imaginable as recently as 5 years ago. Today, specialized operations involve stamping exotic, ultrathin work materials to deliver sophisticated—even breakthrough—part solutions with multiple forms and thinner-than-paper tolerances.

Premium tooling and advanced press operations yield features—formed, coined, drawn or tapped—that are visible only under magnification. It's possible to store 5,000 microparts in one-half of a prescription medicine bottle and then pour out the inventory like fine-grained sand.

All microstamping is not the same, though, because not all stampers are the same. There are critical characteristics that predict a supplier's ability to build tools and stamp complex micro components.

Top Tool Co. has identified six toolmaking and microstamping success factors that, collec-

It's critical to distinguish the relatively new precision microstamping specialty from its old-school heritage.

tively, we call "Convergent Microstamping*." Together, they represent an optimal approach to stamping microcomponents that purchasers of stamped parts can use to help select a supplier.

Factor 1: Has aggressive definitions of "micro" and "complex." There does not appear to be a consensus definition of "micro." A MICROmanufacturing survey in 2010 suggests that micro is defined by whoever is answering the question.

Micro becomes the smallest dimension at which a particular stamper can confidently

**Convergent Microstamping has been trademarked by Top Tool Co.*

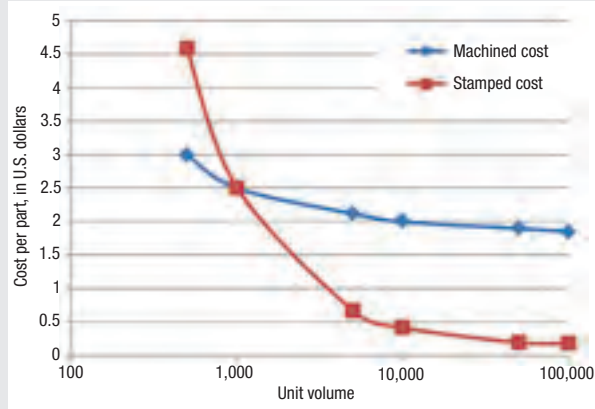
manipulate a part or part feature. The most aggressive and micro-proficient stampers set the definition at 2mm or smaller for parts, and down to 0.1mm for features. Less-accomplished stampers qualify an 8mm part as micro.

A stamping supplier's portfolio of work typically reveals how that supplier defines micro. Are toolmaking and manufacturing operations mostly engaged with part dimensions as large as 8mm? Or does the company regularly work with components 2mm and smaller?

How does the potential supplier define "complex?" The "flat profiles only" perception of stamping is compounded by the equally out-of-date perception that complex features and sophisticated geometries automatically reduce the applicability of microstamping.

Microstamped products incorporate cut and hole aspect ratios less than 1:1, small forms (bends, radii), and multiple forms and draw forms. Moreover, stamped products can be made from materials as thin as 0.0005".

Microstamping: cost-effective alternative



Microstamping compares favorably to the cost of machining, grinding, EDMing and other processing methods. Shown is a cost comparison of wire EDMing vs. microstamping a part for an electronic device.

Similarly, stamping supposedly means having to settle for relaxed tolerances. Not so. Microstamping can hold tolerances down to 0.001mm. Additionally, stamping can streamline and simplify manufacturing while reducing costs.

For example, in one case a \$3 machined micropart that required multiple machine setups was replaced by a precision-

stamped component costing less than 25 cents. While that example does not include the tooling investment, when producing 1,000 to 1 million parts, tooling costs can be rapidly recovered.

Factor 2: Has expertise in precious and exotic metals. The metal stamping industry is large and crowded. But the supplier population shrinks significantly

when limited to those specializing in stamping components 2mm and smaller.

That supplier group includes an even smaller subcategory: Stampers of microparts made from precious and exotic metals. These typically include gold, silver and platinum. Increasingly, however, more products are being stamped from materials such as Nitinol, titanium and MP-35N.

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 inventories of precious metals and exotic materials. The role—a specialty in its own right—is critical to delivering custom microstamping solutions.

About 50 percent of microstamping applications involve precious metals and exotic materials, and that percentage is even higher in the case of critical components for medical devices, such as the electrodes used in implantable pacemakers and pain-management neurostimulators.

Efficient material use is a key advantage when manufacturing microparts from these metals, particularly the gold and platinum specified for medical and electronics applications. Stamping is a lower-cost-per-part operation than machining because in-die forming operations—such as bending, coining, skiving and drawing—generate significantly less scrap than milling, grinding and other

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metal-removal operations. In fact, material usage during stamping can approach 100 percent. With some precious metal prices well over \$1,000 per ounce, this is a significant advantage.

Factor 3: Uses high-quality tooling. Every day, product designers and engineers specify more 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 tooling's influence on outcomes, ranging

A long-lasting, high-performing and highly reliable tool is a custom-built solution to project-specific micromanufacturing challenges.

from precision quality and piece-part cost to tool maintenance, reliability and longevity.

A long-lasting, high-performing and highly reliable tool is a custom-built solution to project-specific micromanufacturing challenges. Superior tooling is an intricately engineered mechanical art—and the investment will reflect it.

Top-performing tooling required for high-end microstamping 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 greatly enhances outcomes and dials down the risk. Forward-thinking capital investment in tooling optimizes quality, precision and cost control.

Choose a supplier that designs and builds superior tooling.

Factor 4: Uses progressive techniques and tactics. The potential for microstamping success is higher when the supplier is used to handling projects other suppliers can't or won't.

When evaluating a project that requires new microstamping technology, a supplier can respond in one of three ways: decline the bid because it is unable to tool and stamp with confidence; bid the project, hoping to figure things out along the way; or seek certainty at the front end that it can tool-up and stamp to meet customer requirements.

The second and third approaches are both based on optimism, but optimism doesn't guarantee producible parts. Optimized manufacturability depends on how a supplier defines and applies the concept of part qualification.

The part-qualification process ranges from simple and limited to rigorous and predictive. Micro precision and complexity demand rigorous part qualification. Some consider passing a first-article inspection by making five parts to the print a qualification process. But FAI is only one snapshot of a single



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A die strip used to make electronic circuit connectors. In the manufacturing process, 0.002"-thick beryllium copper coil stock is fed into a progressive stamping die that pierces, cuts, shapes and bends the stock. Round holes on each side of the strip align the stock and facilitate moving it within the die during stamping. The parts standing on the strip have multiple S-shaped bends. They are blanked free from the strip and then gold-plated.

process element. It's not sufficient, by itself, to validate tooling and the capability of final production. In fact, it's possible to pass FAI but also produce 15 percent scrap, which is excessive, because limited analysis often can't predict extraordinary tool wear.

High-end part qualification involves broader and more comprehensive due diligence. The analysis and evaluation process starts sooner and extends further. Qualification begins at concept, through design, stays in place through all stages of the process, and finishes with detailed follow-up in post-production.

Depending on the complexity and the originality of a part concept, that verification can include formal risk management at every production stage. This applies no matter what size the job. Even quick-turn prototyping or low- to mid-volume jobs must be qualified.

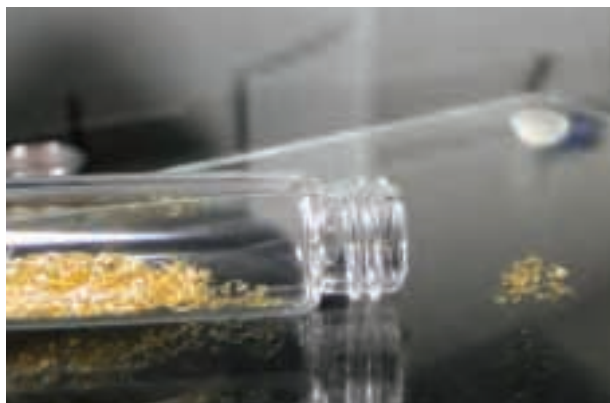
The Miniature Die Unit at Top Tool is an example of using precision stamping for prototype and low-volume production. We use standardized, in-stock die sets to deliver production-validated and customized hard tooling, typically in one week or less.

Factor 5: Has specialized, fine-tuned infrastructure. A race boat is built around an advanced-technology hull optimized for speed. Equipping a stamping operation to optimize micropart manufacturing is a similar process.

Since microstamping can require new or non-standard tooling technology, effective microstamping operations should have an effective R&D unit (with support from engineering and quality assurance), advanced prototyping capabilities and robust risk-management capabilities.

The last item—risk management—can help prevent costly rework. The objective is to reduce, avoid and prevent threats at each phase of manufacturing. Good risk-management strategies typically include:

- employing design for manufacturability;
- identifying, assessing and prioritizing risk exposure;
- measuring risks for probability and severity;
- analyzing potential risks to identify



Stamped, gold-plated microparts for an electronic device being inspected on a Brown & Sharpe Optivision system. Closeup of parts (left).

their cause and effect;

- grading existing controls on the capacity to detect weakness;
- studying solutions and the cost to remove or mitigate risk; and
- responding to problems and production issues.

Factor 6: Offers dynamic supply-chain management. A supplier's supply-chain management process is the key to generating value in microstamping applications long before production begins. Using capabilities such as the lean cost performance index (CPI), full-lot traceability, Web-based order management and effective sourcing of proprietary precious metals helps guarantee that unexpected problems will not derail a stamping project.

For example, consider the sourcing of a custom blend of nickel silver. This material—available through one European supplier—might have a 12-week lead

time. An electronics OEM can source the material, but will have to deal with daily price fluctuations. Typically, the material is too expensive to park in inventory or compile a safety stock.

However, a three-reusable-bin *Kanban* scheduling system managed by the OEM's metal stamper allows for just-in-time material replenishment scheduling, telling the supply chain what to produce, when to produce it and how much to produce. Bin 1, containing finished product, is at the OEM's factory. Bin 2, at the stamper's facility, is in the process of being filled with parts by the stamper. Bin 3 (the buffer bin) has already been filled with finished product and is in the stamper's warehouse. When an empty bin is returned from the OEM to the stamper, the stamper immediately sends the buffer bin to the OEM and begins filling the returned bin.

A supplier using this three-bin

Like grains of sand, made of pure gold

A COMPANY THAT PERFORMS BRAZING and other metal-joining processes required a microscale gold preform washer to braze components in one of its assemblies. The 99.5-percent-pure-gold washer was no larger than a grain of fine sand. With a hole diameter of 0.005", the washer was too small to machine or wire EDM economically. Order volume was 10,000 pieces.

The company asked Top Tool Co. to develop a microstamping solution. The part dimensions and material expense required Top Tool to create new processes, from initial tool design to custom material specs to QC. The hole diameter in the die and punch components required microscale toolmaking expertise to handle the microscopic clearances.

Avoiding scrap—valued at more than \$1,700 per ounce—was a major goal and required determining the exact amount of material needed in the die. Capturing, inspecting and packaging the washers was also critical, and included verifying that each completed part had been stripped from the die.

The die will be able to handle different jobs in the future, because Top Tool used an open, modular die design that enables stamping and punching different hole diameters with a single tool.

—D. Kari

material-management system can have parts on the customer's receiving dock within 3 days of receiving the empty bin.

The metal stamper sources the material, forecasting from hard production data, at locked-in, volume-purchase

A supplier using this three-bin material-management system can have parts on the customer's receiving dock within 3 days of receiving the empty bin.

prices, which may reduce the per-piece cost. At the very least, it makes pricing consistent and predictable. Sourcing the work material directly from the metal 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 parts fulfillment schedule—a necessity when part volumes reach the thousands and sourcing lead times are extended.

A microstamping supplier can leverage *Kanban* further by using a Web-based portal to view and integrate the customer's manufacturing operations

in real-time. This further streamlines the supply-chain response.

New stamping era

Every day, modern, high-end precision microstamping resembles old-school stamping less and less. In fact, today's tool engineering and press-floor innovations are transforming stamping into one of the more-effective processes for manufacturing multiple, intricate forms and geometrically complex features down to 0.1mm, while holding tolerances as tight as 1.5µm.

That should be welcome news for designers and engineers working on product miniaturization. Speed, precision, productivity and cost containment—the well-known characteristics of metal stamping—are making the process an important product engineering and design option for micropart manufacturing operations. ■

About the author:

Duane Kari is a technical sales support lead for Top Tool Co., Minneapolis. He has over 25 years of experience in tooling and precision metal stamping, including programming and applications for laser, CNC machining and wire EDMing. Telephone: (763) 786-0030. E-mail: dakari@toptool.com.



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