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A Revolution in Tooling Qualifications

Sponsored by: Weiss-Aug Co., Inc.

Weiss-Aug provides custom insert molding, precision metal stamping, and assembly solutions. With over 45 years of experience serving the automotive, medical, electronics and semiconductor industries, our experts in design, engineering, tooling and manufacturing excel at providing precision manufacturing through innovative design.

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New equipment for improving capabilities

The requirement for computer numerical control (CNC) technology began in earnest when Weiss-Aug's engineering group decided to visit the 2010 International Manufacturing Technology Show (IMTS) in Chicago to find a single supplier of both electric discharge machining (EDM) and hard mills capable of a ±5μ (micron) accuracy based on our materials and hardness specifications. The idea was to service all our existing mold tools and expand the capability for producing complex stamped parts that require more than basic forming.

Up to this point, all the mold and die tools were serviced with spares. Electrodes were provided by outside suppliers. Our company was prepared to make a technological leap forward: complementary machining technology to go along with our wire electrical discharge machining (WEDM). We started by establishing a detailed benchmarking plan to evaluate manufacturers' equipment. This involved selecting components for mold and die applications of various materials and sizes to determine the specifics we needed. By 2012, our team had a supplier narrowed down and were planning to visit IMTS again.

Only the best equipment

This second visit to IMTS was to finalize a purchase agreement and investigate all the ancillary equipment, including work holding, tool holding, cutting tools and software. The engineering team was joined by the manufacturing team, who were looking to not only reduce component cycle times, but also improve quality, guarantee repeatability by eliminating hand work, and provide reverse engineering for components that were proven to produce effective parts.

This impetus changed the mindset and thus the capability requirements of the equipment. No longer was ±5μ good enough and no longer was it important to have a single supplier of all equipment. The new paradigm required ±3μ accuracy, grinding capability to complement the EDM and hard mill (to ensure any geometry and needed finish could be produced), a system to eliminate hand work and a means to place pre-qualified components directly into a tool by using metrology within the department to verify parts against the model. This change in direction forced the question of whether grinding was the better solution, at least as far as stamping components.

The planning stage

Over the next two years, engineering and manufacturing established a new plan to determine the parameters to test and evaluate equipment for each operation. This process included visits to indirect competitors, as well as visits to our existing tool supply base to see what equipment the best shops had in common, as well as the expectations from each manufacturers' highest quality machines.

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Component surface finish studies were conducted in retired stamping tools with purposefully harsh conditions to speed the evaluation process. Machine tool tests were selected from heavily used components of both mold and stamping applications. Items were selected and utilized to directly evaluate test cuts. The result was that we needed grinding to complement the hard mill and EDM capability.

Concurrently, a plan was put in place for long-term system use. This involved looking at potential scheduling systems, work holding to minimize setups and improve accuracy, as well as the provision of a method to inspect geometry without part removal and reduce overall machining times. We also had to determine whether it would be wise to bring in all the equipment at once or stage its implementation. Important questions were asked such as “what are the people requirements to operate this equipment?”, and “should we look to the outside for someone with experience to run it and bring it to speed more rapidly?” Where were we going to place this equipment? What special requirements would there be to ensure the desired results from finished parts?

Execution

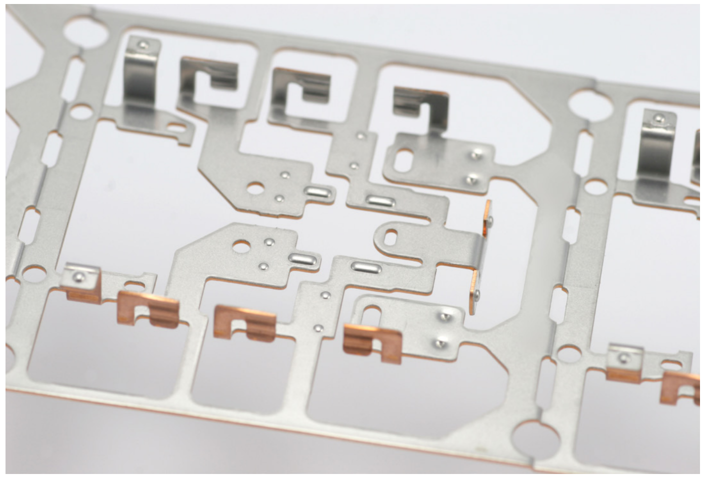
In the end, three machines were selected and proved to be the easiest decisions made. They were ultimately selected based on performance using accuracy and rigidity of construction as the final arbiter. Their ability to complement one another and integrate robotics was also considered. No expense was spared in their selection and setup as we knew that any sacrifice in support ancillaries would cause the completed item to suffer. This included the environment in which the machines would be placed (room and surroundings). We decided the best approach was to stage the implementation of equipment starting with the hard mill since we had sink EDM capability without a means of producing complicated electrodes. The desired CNC EDM and grinder were to follow, with the lead time factored in for high- end machines.

Optimizing the environment

We began working on the designated workspace setup. Using solid models for the room and its contents, we laid out the room and had a structural engineer evaluate the machine tool manufacturer’s requirements on site. We strived to meet or exceed the most stringent requirements for temperature control, vibration isolation and cleanliness while considering all three machines. To meet vibration isolation suggestions, there is more than a half-meter of concrete, over a third of a meter of stone, with two layers of vibration isolation between the slabs and remaining parts of the floor. The room is located such that it is away from an outside wall, has an insulated ceiling and diffused air under constant pressure, and a dedicated HVAC system that holds temperature to within $\pm 1^\circ$C.

Some assembly required

As the room was being completed, we were scheduling delivery of our Yasda hard mill. We chose the three-axis Yasda YMC 430 because our part size and profile did not warrant a five-axis variant. The size range, coupled with its rigidity and built-in mechanical accuracy made the purchase decision easy. It can machine extra-hard materials such as carbide directly, which is a big part of our high-volume stamping tool component material matrix.



We had selected the Makino EDAF series of EDM to be delivered four months after the hard mill. We had also evaluated and selected our tool holding and work holding and had them scheduled to arrive ahead of the machine. We began the training for the computer-aided manufacturing (CAM) package that had been selected as well. The CAM software needed to be capable of processing native files without translation and also modeling, and it also had to be able to accept and process point cloud data (hence the modelling requirement). Our System 3R Matrix allows removal and repetition to within 1μ and 2 arc second (2μ in 200mm) accuracy for 90° rotation increments. Coupled with Macro, this system machines the largest mold component or the smallest electrode we typically use.

This system is in each machine, including metrology. It allows the parts to be produced with the least amount of downtime while also being evaluated without removal from the assigned pallet. With our benchmark visit complete, the selection of the grinder came next. For this, we decided on the Amada Winstar SP which, as with all the machines thus far described, was their best offering. This machine is built to order and fit into our time delay, with it not arriving until six months of EDM use.

Metrology is most important

Purposefully omitted from the account above is how to measure the created items. After all, you cannot truly make what you cannot measure. Having six coordinate measuring machines (CMM) and more than double the number of SmartScopes with all manner of options like line scan lasers and active touch scanning, we realized these systems only gave confirmation on selected cross sections. They did not convey that a whole area was correct to a model and could not provide the desired accuracy at the intersections where the surfaces changed direction rapidly.

We chose a vision-based system from Otto that allows the parts to be scanned and compared to a model in a 15-minute time frame. Depending on part size and lens assembly chosen, accuracies between ±2μ to ±5μ can be achieved. The training plateau is small and the software used to manipulate the scans is the only obstacle to faster throughput. This is also the vehicle needed for successful reverse engineering. This piece of equipment was the last item chosen and implemented. To be honest, it is not just used as a means of part verification, but also used in conjunction with — rather than in exception to — all the other more common pieces of metrology equipment.

Practice makes perfect

After two years of work and close to $2 million invested, we now have the foundation for servicing all facets of our business with tool components verified to meet the design requirements. It is revolutionary in that we qualify the tooling to produce parts that meet the customer's print dimensions and tolerances, rather than qualify the parts.

The automation eliminates the manual work, which improves repeatability. There is an open dialogue between the manufacturing and design teams so that process improvements and efficiencies can be communicated and implemented.

Below is an overview of the equipment and a description of the process using the stamping area in repair and maintenance (R&M) as an example, since it was the basis for the setup of the PCNC (P is for 'precision') area.

Equipment list

- Yasda YMC 430 hard mill
- Makino EDAF 2 CNC EDM
- Amada Winstar SP CNC surface grinder
- Delcam Powermill and Powershape CAM package
- Otto Vision camera-based metrology
- Geomagic ControlX software for scan processing and reverse engineering
- Starrett digital comparator
- System 3R Matrix based work holding for all equipment
- Vibration-isolated floor
- Diffused, positive-pressure, dedicated HVAC capable of ±1°C accuracy

Examples of the process benefit

Traditionally, stamping has relied on machines capable of generating ruled surfaces to produce parts (surface grinders and WEDM). This means that parts requiring surfaces made up of complex curved surfaces that do not meet these criteria must be "fudged." Today we use technology to circumvent the deficiencies.

If we take a part like disposable needle safety components, which runs into the hundreds of millions of parts, this tool started utilizing the aforementioned imperfect process. So much so the manufacturing group was reluctant to remove the tool until the components were so worn that a full replacement was needed. This could take weeks, cause delivery issues, and result in part shape changes that were noticeable even though the parts met the print. Today, through a collaborative process, the form components have been modeled to reflect the shape required from testing done between production runs. In short, the R&M group asks design for help in deciding what to adjust based on quality control (QC) provided data. The tool component may be modified by hand or machine and parts run and inspected. The component is scanned to see how close it is to the desired result or give direction for a future trial. Once the results are achieved, the print and model are revved to production status, and the work orders are issued to spare for the requirement. The PCNC area receives the work order, produces the part, verifies the tolerances, and delivers it to the R&M tool room for use.

The equipment was purposely selected to work in concert with each other to minimize setups and thus reduce tolerance stacking that may occur. We are continuing to develop our own system for grasping the work piece, but these fixtures sit atop of the Matrix system from 3R and allow positioning repeatability to 1μ or better. In fact, there are at least two mounting points in each machine allowing for multiple parts to be machined in any one setup. We can go from horizontal to vertical with the flick of a switch and still guarantee micron or better accuracy. Taken together it means that as many procedures as can be done in one setup are accomplished before removing the workpiece, including inspection.

Weiss-Aug is now in the position to better service our customers with less expensive tools as there are fewer components needed. These are less expensive to manufacture since the hand work and iterative setups are eliminated, and we are ultimately a more competitive machining service that completes projects faster than ever. We are more efficient since we utilize people for their intended function and can focus on minimizing tool problems.

WEISS-AUG CO., INC.

220 Merry Lane
East Hanover, NJ 07936
USA
Tel: (973) 887-7600
Fax: (973) 887-8109

ENGINEERING 360 MEDIA SOLUTIONS

201 Fuller Road, Suite 202
Albany, NY 12203-3621
Tel: +1 518 880 0200

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