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PROCESS INSIGHTS

MICROMACHINING BRINGS INFINITE POSSIBILITIES TO A FINITE WORLD

Market needs in micromachining (http://www.makino.com/industries/micromachining/) are becoming more demanding as applications shrink in size but increase in complexity. Mold builders are required to not only maintain micro-tolerances and build better surface finishes, but they also face the significant challenge of accurately measuring and inspecting their microcomponents to further enhance quality.

Manufacturers like Makino are offering ultra-precision micromachining technologies, like with the EDAC1 (http://www.makino.com/machines/EDAC1/), to address the need for increasingly miniaturized part production and mold development. And one company, EDM Department (http://edmdept.com/) of Bartlett, Ill., has even found a way to expand their micromachining capabilities in this unique industry. Uniting their highly stable Makino ultra-precision machining center with new metrology, they now have an even more successful and unprecedented inspection, measurement and micro-tolerance machining solution with which both their team and customers have been impressed.

ADVANCED DEVELOPMENT AND FLEXIBLE MANUFACTURING

Mark Raleigh, CEO of EDM Department, started out with the vision of creating a company that would place equal investments on its technology, resources and customers.

“By balancing our strengths, we have created a self-motivated environment, which is willing as well as ready to meet the challenges that tomorrow will bring,” says Raleigh.

Now finishing its 11th year of business, EDM Department has much success under its belt. A business with the mission to provide advanced development of flexible manufacturing, EDM Department has created the means to offer solutions in price, performance and lead-time. EDM Department’s goal is to help customers develop projects in a new way, offering as many options as possible and keeping resources and technology prepared for projects throughout their life cycle.

“We operate under the premise of three business models in one. We have a research and development facility, production facility, and a turnkey solutions facility,” says Raleigh. “With this approach, each division benefits from the other, providing the availability of equal energy and resources for our customers and ensuring a competitive stance in the global market.”

EDM Department serves multiple industries: the aerospace industry with high-performance connectors, defense communications and developmental work; the medical industry with surgical tool, surgical implant and medical developmental work; as well as other industries including telecommunications.

IDEAL MICROMACHINING SOLUTION

As the face of North American manufacturing continues to change, the need for more complex, micro and nano projects is on the rise, and EDM Department has seen an increase in new and challenging requests and design reviews.

“We consistently find ourselves confronted with the need to do things smaller than we have ever accomplished before,” says Raleigh. “When we began to consider the addition of micromachining capabilities, we were producing features and elements at the 100-micron level. Today, 25-micron features are quite common, with recent challenges to control 10-micron features and elements. We needed a robust and stable micro-tolerance machining solution that would get us closer to the 1-micron scale.”

EDM Department turned to Makino for this solution. Looking for micromachining technology (http://www.makino.com/about/webinars_events/8-7-2008/Latest_Advancements_in_Micromachining) that would define the future of the company, EDM Department purchased Makino’s EDAC1 Ram EDM machine. And, after running it through initial positioning, surface finish and general machining tests, EDM Department realized relatively quickly that it was exactly what they had been seeking. “In the beginning, we ran this machine through the

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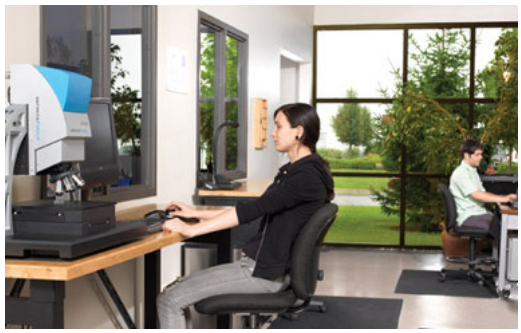
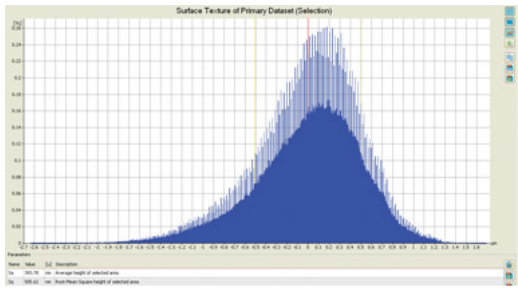


EDM Department can now see and measure the parts they produce, proving their manufacturing quality and helping them to provide complete solutions.



Histogram overlay exhibits the safety

full gauntlet, resulting in precision accuracy with extraordinary repeatability," says Raleigh. "We discovered that the EDAC1 is actually two to three times as capable, compared to what was expected."

Makino's EDAC1 is an ultra-high-accuracy Ram EDM (http://www.makino.com/about/webinars_events/1-11-2007/The_Worlds_Most_Accurate_Sinker_EDM) ideal for micro-tolerance mold applications. Designed and built for industries requiring the highest precision achievable, this ultra-precision machining center is capable of producing corner radii of 0.00019 inches (0.005mm) and surface-finish quality of 0.000024 inches (0.6 micron) Ry, while providing repeatability in the submicron range. It also achieves positional and pitch accuracies of ± 0.00004 inches (1.0 micron).

With thermal barriers and a Z-axis stabilizer, the EDAC1 is able to cool the Z-axis and decrease thermal growth for increased accuracy. The machine's C-axis and Mi head also allow for precise electrode positioning accuracy at multiple angles.

The most prominent impact that EDM Department has seen with the EDAC1 lies in its increased accuracy and stability. They are using this machine within all of their applications and are experiencing tighter micro-tolerance and improved process capabilities as compared to previous machines.

"To quantify accuracy and stability, we have to include the effect that the environment creates, so we continuously reference our machine position over time," says Raleigh. "The average daily true positional drift with the EDAC1 is less than 2 microns, and less than 3 microns over a 27-day period for the XY plane. The Z-axis is less than 1 micron daily and is considerably less than 2 microns on a 27-day period."

EDM Department has also benefited from significant cost saving with the Makino machine due to the impressive repeatability it provides. With this repeatability, they have achieved enhanced precision, production and reproducibility, giving them a competitive edge. Since the purchase, EDM Department's return on investment (ROI) is exceeding all expectations on the development side by approximately 50 percent.

"We're getting what we expected and then some from the EDAC1. It has taken us to the next level of micromachining and is fully capable of what we are trying to achieve," says Raleigh.

METROLOGY ENHANCEMENT

Armed with a highly accurate, state-of-the-art Makino ultra-precision machining center, EDM Department began to look for an equally impressive metrology solution. They found that solution in the Infinite Focus optical 3-D metrology system (http://www.alicona.com/home/products/infinitefocus-standard.html), a unique measurement system that generates high-resolution, repeatable and traceable results. This system enables manufacturers like EDM Department to see and measure the parts they produce, proving their manufacturing quality and helping them to not only provide components but also offer complete solutions.

"The optical 3-D metrology technology found in Infinite Focus has controlled our measurement of components like never before," says Raleigh. "It affords us the chance to look at what we are making and measure the surface finishes in high detail. Where other methodologies are taking 1,000 measurements, we can take millions of measurements with Infinite Focus, allowing us to enhance our end results and solutions."

With this technology, EDM Department is now able to model electrodes before burning them and measure cutters before cutting with them, key advantages in micromachining. They are also able to make the part, model the part on site with 2 million to 3 million measurements, compare it to the solid model and immediately send the results to the customer via e-mail. This enables them to further minimize lead-times, respond expediently and speed up their iterative process from days to hours in some applications.

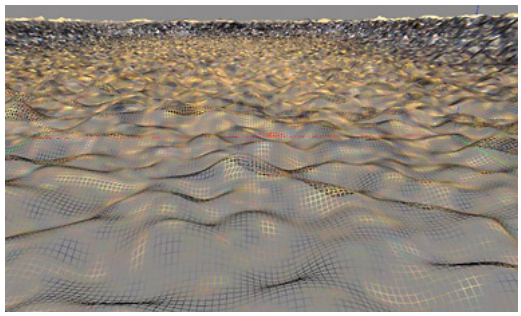
COLLABORATION OF TECHNOLOGIES

With the use of Infinite Focus, EDM Department is able to implement the EDAC1 in unique ways that generate impressive results. By pairing the stability and tight tolerances of the Makino machine with the optical 3-D metrology system found in Infinite Focus technology, EDM Department has been able to achieve overall machine performance that continues to surpass expectations. They are now capable of producing speed, wear and surface finishes not found elsewhere, allowing for unbeatable repeatability, reproducibility and precision.

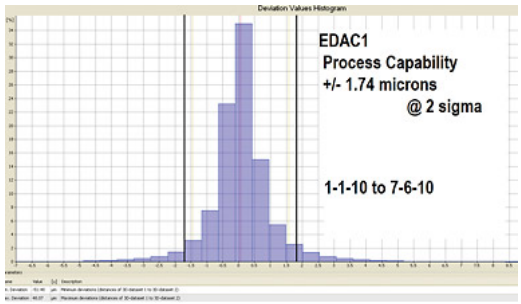
"With a better understanding of the surface being produced, we are now able to reduce the safety margin normally used, giving us better utilization and efficiency of our electrodes," says Raleigh. "The combination of the EDAC1 and Infinite Focus enables even better surface-finish capabilities than initially thought—a 7 percent improvement—and we still have not utilized the machine's full potential."

When EDM Department first purchased the machine, they were able to achieve ±4 microns. By implementing a full tooling, equipment and analysis solution with Infinite Focus, they have been able to achieve 1.7 microns. And, as they move forward, they plan to continue pushing the envelope, breaking additional barriers in accuracy and precision.

"In the past, a number of projects from existing customers had to be shelved, as elements below 50 microns were just not feasible," says Raleigh. "Now, with these two technologies, we have the ability to make, measure and see elements well below 20 microns with stable and accountable margins and opportunities for improvement.



Landscape of a typical EDM surface finish.



Histogram that represents the difference from targeted results.

The EDAC1 is capable of producing corner radii of 0.00019 inches (0.005mm) and surface-finish quality of 0.000024 inches (0.6 micron) Ry, while providing repeatability in the submicron range.

processes, allowing us to dramatically enhance our micro-tolerance production capabilities and opening the door for several new opportunities."

The pairing of these technologies lets EDM Department showcase the unprecedented ultra-precision machining capabilities of their EDAC1 while analyzing the component in every step of the process for autonomous and natural transfers. It also enables them to respond to customers in real time, a benefit that few other shops can provide. These technologies have ultimately provided EDM Department with the ability to meet the new challenges that their customers are confronted with and help their customers to see increased success in micromanufacturing.

"Eleven of our last 14 customers have come to us based on the micro-tolerance capabilities of our EDAC1 and Infinite Focus. With the stability and precision of the EDAC1, Infinite Focus has been the perfect technology partner," says Raleigh. "We have a bright future ahead of us with a whole new list of clientele that didn't exist before, and we have these two technologies to thank for that."

ENDLESS POSSIBILITIES

For EDM Department, the possibilities for success in this finite industry are endless. As they look ahead to the future, they are hoping to push for even tighter tolerances and accuracies with confidence that the EDAC1 can hold up its end of the deal.

"We are extremely happy with what we have seen from Makino in terms of ultra-precision machining capabilities, and will always welcome additional EDAC1s as the need arises. We are even hoping to help some of our customers utilize and implement these machines on their floors," says Raleigh.

With a stable and accurate Makino machine at the core of their micromachining solutions (http://www.makino.com/about/webinars_events/6-18-2009/Standard_Precision_Machine_Technologies_for_Micromachining), EDM Department has a wealth of development opportunity to look forward to.

"This is an exciting time for micro-manufacturing," says Raleigh. "Because of these two new technologies, we will one day be able to say 'Now accepting 1-micron tolerances.'

"Manufacturers often send out surveys asking what their customers are looking for in the future. EDAC1-caliber machines are the future. They are what we are looking for."

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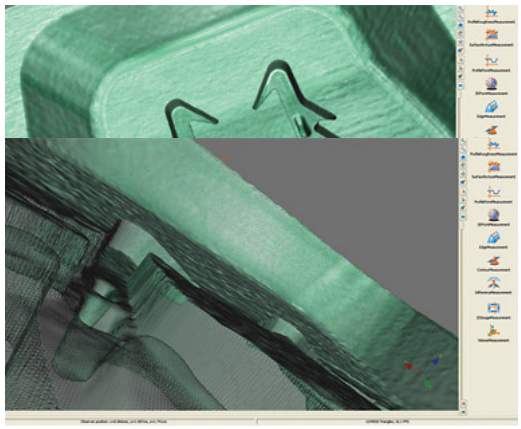
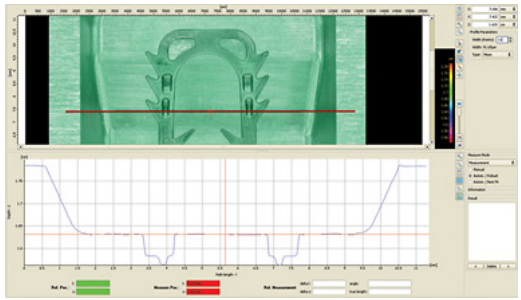


Internal wireframe review



2-D profile view representing the profile at the drawn red line

INFINITE FOCUS

Infinite Focus, which uses Focus Variation technology developed by Alicona Imaging, combines the focus of an optical system with modulated light and continuous vertical scanning to produce a topographic 3-D data model representative of the component's surface. It offers multiple benefits including full 3-D surface characterization of forms; data presented in true object surface color; the ability to measure varying surface finishes simultaneously; the capability to measure and capture steep slopes, high "Z" ranges, roughness, wear, form and contour; full-form measurement of cones, cylinders and spheres; and placement of measurement profiles in the precise position required.

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