

## Ultrasonic and Ceramic Machining Technology and Polished Glass Substrates for Brittle Materials used in Semiconductor, Microfluidics, Aerospace, Defense and MEMS Applications



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“Our ability to machine multiple features at once and to provide a low stress machining solution provides unparalleled value for our customer.”- Tim Beatty

**Interview conducted by:**  
**Lynn Fosse, Senior Editor**  
CEOCFO Magazine

**CEOCFO: Mr. Beatty, what is the focus at Bullen Ultrasonics today?**

**Mr. Beatty:** We do ultrasonic machining of hard, brittle materials like glass, sapphire, quartz and ceramic matrix composites (CMC) for a wide variety of industries including aerospace, semiconductors, and MEMS devices (which includes Microfluidics for DNA Sequencing and Pressure Sensors for Automotive).

**CEOCFO: How does the technology work?**

**Mr. Beatty:** Ultrasonic machining is a loose abrasive machining process in which the mirror image of a shaped tool can be created in hard, brittle materials. Material removal is achieved by the direct and indirect hammering of abrasive particles against a workpiece by means of an ultrasonically vibrating tool. Many industries like semiconductors, aerospace, defense, and MEMS require a low material removal rate, low depth of damage process because of the nature of their applications. You do not want to propagate cracks inside the aircraft engine. You do not want small chips falling off inside body parts. In semiconductors, it can mean the difference between a good computer chip or a bad computer chip. All of these processes are very different in the various industries but the commonality for us is it involves machining our customer's unique pattern on to a hard, brittle material. We have the advantage of machining all the features at one time versus one at a time with competing technologies like CNC or laser. We also have the capability of machining thousands of holes at one time on a glass wafer, silicon wafer, CVD silicon carbide plate, or ceramic matrix composite substrate.

**CEOCFO: Do customers care as long as they get a good end result? Where does process come into play?**

**Mr. Beatty:** First, The most important thing to the customer is the value we provide by machining multiple features at one time versus machining one feature at a time. By using this method, you are able to do it much more cost effectively. That is the bottom line to our customers. It is a better value. Second, we are able to provide a higher quality product using ultrasonic machining because it is a micro-chipping process and it is using very fine, abrasive slurry and ultrasonic energy, which is vibrating thousands of times a second. Those two combinations create a very high quality product that provides real value to our customer.

**CEOCFO: Are there industries that value Bullen's value more than others?**

**Mr. Beatty:** Definitely high precision, high technology industries see the most value in ultrasonic machining due to the tight tolerances and quality requirements.

**CEOCFO: *What is your geographic range?***

**Mr. Beatty:** We have customers all over the world with the majority of our customers being in the United States, Europe, and Asia.

**CEOCFO: *How do you reach out or do people come to you? Is Bullen well-known in the industry?***

**Mr. Beatty:** It is a niche industry for sure. Within that niche, we have been producing semiconductor products for 20 -30 years. We have been in the MEMS industry now approaching 20-25 years and we are relatively new in the aerospace industry because the material that we are machining is a new material called ceramic matrix composites (CMC). When it comes to ultrasonic machining, we like to think that Bullen is a name that people associate with the technology because it is such a niche industry. Because of that, we do not have to do a lot of marketing.

**CEOCFO: *Is there much changing equipment along with change in materials, and how do you evaluate both?***

**Mr. Beatty:** We make our own equipment and we make our own tools. We have aggressively adapted our equipment to adapt to the changes that our customers have required of us. As tolerances get tighter and the geometries get complex we have had to clearly adapt and automate a lot of our equipment over the last five years. We were recently recognized in aviation week as being one of the up and coming factories of the future for some of the work that we have done towards Industry 4.0. We have invested heavily in this transition for the last three to five years.

**CEOCFO: *Is it difficult to get personnel?***

**Mr. Beatty:** We are in a very rural community of about 10,000 people in Eaton, Ohio. We have taken an interesting workforce development approach. There are many things baked into this community that fit well with our process. There is a great work ethic and a lot of innovation that comes from a farming community. There is an intuitive nature around problem solving that fits really nicely with the type of work we are trying to do. As we have had to move more towards automation, the approach we have taken is to invest directly into our current employees to fulfill the needs for design, controls engineering, and process engineering. A good number of our engineers have been developed internally. Several of our managers have started off at the operator level and worked their way up as we have invested in their training and education. We have also invested in our communities, local universities and high schools to prepare the workforce for the skills that are currently needed and will be needed in the future.

**CEOCFO: *When customers come to you, do they know what they want and do you work with them on how to accomplish or maybe tweak what they are asking for? What are engagements like?***

**Mr. Beatty:** Our vision statement states that we desire to partner with our customers. The partnerships that have worked out the best for us have been when a customer brings a problem to us that they are trying to resolve and we are able to work with them to provide a solution. The partnership is usually two sided: We may have to create unique tooling or equipment to meet their needs or they may need to modify their design in order to fit our technology. Those types of partnerships have been invaluable for us and we hope for them as well. We look at some of the roles that we have played in the early development of the semiconductor industry and the MEMS industries and we are proud that we helped to advance those technologies to make things like pressure sensors, semiconductors and DNA sequencing a reality. We are seeing these same developments today with the machining of Ceramic Matrix Composites for the Aerospace Industry.

**CEOCFO: *What is next for Bullen?***

**Mr. Beatty:** We are heavily investing in the machining of a new material that is being used for aircraft engines, aircraft components, and industrial applications called Ceramic Matrix Composites. It is a new engineered material that is hard and brittle so it works out nicely with ultrasonic machining. Some of the types of designs that need to be machined on these are not traditional. They are complex features with contoured designs and compound angles. We are currently working on adapting our equipment to optimize cost, reduce error and allow for adaptability across various platforms.

**CEOCFO: *Why choose Bullen Ultrasonic?***

**Mr. Beatty:** Our ability to machine multiple features at once and to provide a low stress machining solution provides unparalleled value for our customer. Our non-thermal, non-chemical, and non-electrical, process leaves the chemical and physical properties of the workpiece unchanged. This low-stress process translates into high reliability for our customer's critical applications. We have been the established leader in this industry for over 45 years and we continue to invest in our technology to provide unmatched quality to our customers.