for a greener tomorrow

MITSUBISHI ELECTRIC
Changes for the Better

Reliance Tool Reduces Ceramic Bearing Production Time and Costs with Mitsubishi Electric Robot

Case Study

Solution

- RV-2SDV-S15 Robot
- CR-750 Controller

Reliance Tool Product Benefits

- Significantly reduces machining time
- Helps reduce production time and costs
- Operates upside down to precisely position laser

Mitsubishi Electric Value-added Advantages

- Repeatability
- Dependability
- Flexibility
- Compact design

"Manual setups in the ceramic machining process compromise the ability to achieve repeatability in a timely manner. The Mitsubishi Electric robot has solved this problem."
– Richard Roberts, *Director of Corporate Development, Reliance Tool*

BACKGROUND

Reliance Tool was awarded a contract to refine and quantify processing costs to machine precision ceramic components in conventional CNC machines. The contract required Reliance to develop optimized machining processes for extremely hard ceramic materials, such as silicon nitride, with the ultimate goal of lowering the cost of commercial production of ceramic bearings.

All-ceramic bearings can operate at much higher temperatures and speeds than steal bearings, making them particularly suitable for aircraft, especially helicopters. Ceramic bearings are also lighter and help reduce aircraft weight, thus helping to consume less fuel. However, the cost to machine a ceramic component can be 70 to 90 percent of the total cost of the part.

CHALLENGE

Reliance Tool conducts research and develops machining processes for its customers, predominantly private tier 1 suppliers serving the defense and aerospace industry. The company was charged with developing a laser-assisted machining center to machine ceramics in a production environment for the purpose of lowering precisiondimensioned ceramic component costs. Diamond cutting, the current process used to machine ceramics, is both costly and time consuming.

The company investigated the use of heat to improve the ceramic machining process. Drawing upon more than 20 years of technology innovation in cutting techniques and tooling for hard machining, Reliance developed a process using lasers to locally preheat the work piece immediately preceding the use of cutting tools. The laser plasticizes the material for cutting. The positioning of the laser beam in relation to the cutting tool would be a critical part of the process in order to apply the heat precisely where it is required on the work piece.

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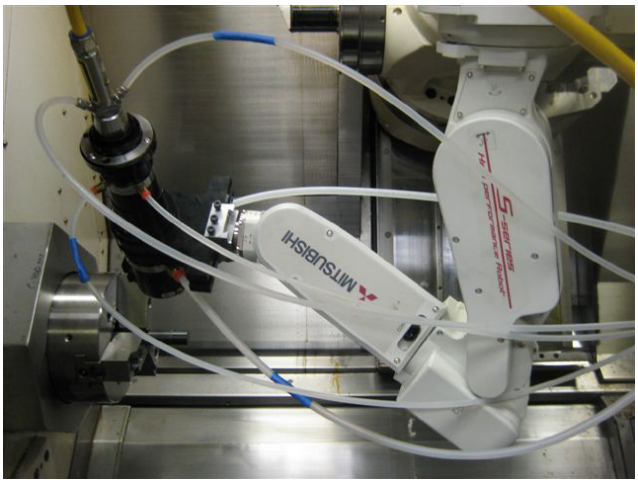
SOLUTION

Reliance Tool's ceramic machining process requires a high accuracy machine tool that allows the laser head to be easily mounted and precisely positioned ahead of the cutting insert. Reliance and NIU developed a systematic method of changing work pieces, as well as detail speed and feed rates, to optimize material removal.

In order to execute these processes, Reliance acquired a Mazak Integrex i200-IV ST multitasking machine equipped with twin turning spindles, as well as an upper and lower turret. The turning center had to be equipped with a compact robot mounted in the roof, so that it could operate upside down. Reliance chose a Mitsubishi Electric RV-2SDV-S15 Robot and CR-750 Controller to install inside the Integrex.

The 6-axis, vertically articulated robot holds a manifold that contains the laser head, pyrometer, and vacuum lines. The robot's speed, path and return home are programmed into the robot's software, while the Integrex CNC turning center controls the robot's start, stop and hold commands. Mitsubishi Electric application engineers used a simple I/O between the robot and the Integrex turning center to interface the two machines. The purpose of the robot is to allow the lasers to provide consistent setup and repeatability of the beams, in order to reduce setup times and ensure the correct placement of the laser each time the cutting pattern is changed.



RESULTS

The Integrex turning center and Mitsubishi Electric robot coordinate their movements – as one moves, the other moves at the same speed. After a part is finished, the robot and laser are sent back to their original position. In a manual process, the laser would be physically disengaged and the operator would have to approximate its location on the work piece. Consequently, the robot's precision allows ceramics to be machined to meet close dimensional tolerances.

Reliance Tool can now machine intricate contours in round silicon nitride ceramics in one-tenth the time it takes to grind them. "Manual setups in the ceramic machining process compromise the ability to achieve repeatability in a timely manner. The Mitsubishi Electric robot has solved this problem," said Richard Roberts, Director of Corporate Development at Reliance Tool. "The robot's repeatability reduces the time to machine each work piece from 90 minutes to 10 minutes."

The robot also allows Reliance to change tools on the fly—the setup of the laser is not dependent upon the position of the magazine. "This flexibility can reduce a 30-minute task to 15 seconds," stated Roberts. "Manually, if we had to change tools from a cutting edge to a drill, for example, we would have to stop everything."

Working together, the Integrex turning center and Mitsubishi Electric robot have helped Reliance Tool achieve its objective of lowering the time and cost to produce precision-dimensioned ceramic components, and the company's ultimate goal of developing a system that other companies can use to commercially produce all-ceramic bearings. Now, Reliance, in conjunction with NIU, is offering a complete ceramic machining system to machine silicon nitride.

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