The Design of a Machine Tool for Spherical Lens Production

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Presentation Summary†

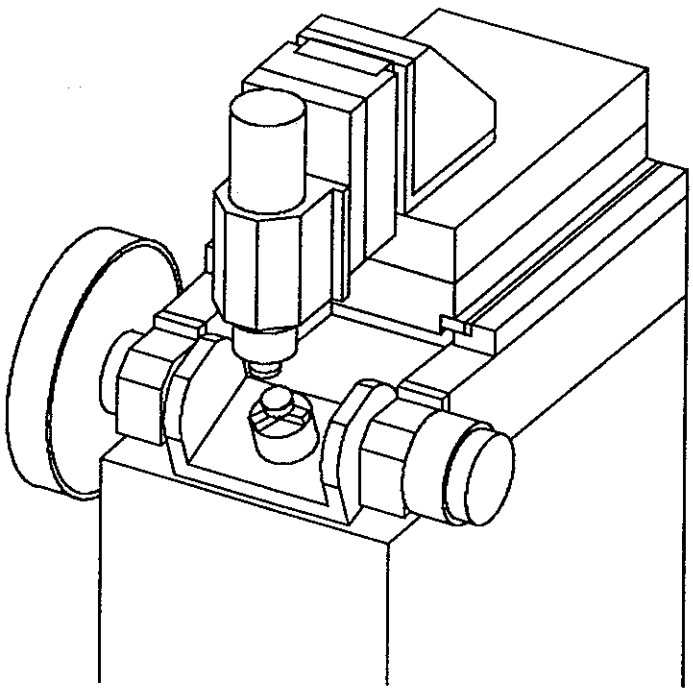
The *Opticam®SM* was designed[1] in the early 1990's for use in the investigation of microgrinding at the University of Rochester's Center for Optics Manufacturing. A multi-axis flexible machining center was delivered[2] to the University in mid-1992, and is now located at the Center's site in Rochester. This first SM machine represented a milestone in the design of machine tools specific to the manufacture of spherical lenses. Based on the experience gained from the construction and use of the original SM, a design is now being prototyped for a new machine tool for general lens production. This presentation will describe the design of this new machine tool, the *Microform®SM*.

Machine orientation is the most obvious design difference between the *Microform®SM* and the *Opticam®SM*. The original SM is a horizontal machine tool (*i.e.* both the wheel and work spindles are horizontal). The new SM machine tool has a vertical orientation, with its wheel spindle's axis always vertical. This orientation change has enabled the machine design to realize several goals. It provides a more visible grinding environment for the operator and greater accessibility for part loading whether manually or with automated robotics. A vertical orientation accomplishes this by reducing the machine's base footprint. This moves the operator closer to the grinding theater, making manual tool loading easier as well. The orientation simplifies some spray guarding considerations by permitting gravity to assist in coolant delivery and collection.

To accomplish all of the desired operations in a vertical orientation, an innovative arrangement of machine elements has been designed. The accompanying figure shows a schematic arrangement of the spindle, rotary and translational machine elements in this new design. Prominent in this design is the division of these elements into lower and upper sections. The lower section consists of a rotary positioning axis that carries the work spindle. The upper section incorporates stacked translational slides that support a vertical wheel spindle. Certain advantages in the modular construction of the machine tool are realized by this arrangement.

The rotary positioning axis located in the lower section is a critical component in the machine design. This axis is mounted symmetrically from two bearing supports on the machine base. Its drive and feedback components are outside the supports. By keeping these components out of the immediate grinding theater, they are protected from coolant splash. The symmetrical mounting arrangement ties the machine together through this axis, and strengthens the overall machine structure. In addition, thermal growth problems in the machine structure are reduced by this symmetry. By extending this axis' range of motion to ninety degrees, the machine is capable of lens segmentation. This segmentation option requires an angular positioning work holding spindle, but does not need an additional slide. The ninety degree flexibility also has advantages in some automatic loading conditions.

The machine's upper section is mounted to the top of the machine base as a superstructure. Its lowest translational slide moves horizontally towards and away from the operator. Supported on this slide is a manual translating adjustment that can be used to bring the wheel and work spindles' axes into intersection. On top of this adjustment is a bracket that supports a vertical translation slide. Between this slide and the grinding spindle is another manual adjustment that can be used to laterally tilt the grinding spindle. These manual adjustments are to be used during initial machine installation and as a field service adjustment when a grinding spindle needs replacement. This stacked slide arrangement reduces the overall grinding theater without decreasing the actual grinding volume. The slides can also provide motions useful in automatic wheel changing.



Microform®SM - Schematic Arrangement

This arrangement of machine elements requires an additional degree of sophistication in the machine tool control system. Unlike the original SM that infeeds the work into the wheel with one moving axis, the new SM requires both translational axes to move. These two axes have their motions coordinated to keep the edge of the grinding wheel positioned along the center line of the lens axis. To make this coordinated motion uncomplicated for the machine tool operator a virtual axis is created in the numerical control software. The virtual axis permits the operator to use simple commands and instructions to create desired part geometries with the machine's numerical control system insuring the necessary geometrical transformations.

The Microform SM design is now in prototype construction. This machine tool is expected to fabricate its first lens during the third quarter of 1994. Beta site testing of this machine is expected this year.

1. Liedes, Jyrki, "Opticam Machine Design", SPIE Vol. 1531, pp. 216-222, 1991.
2. Liedes, Jyrki, "Opticam SM Update", SPIE Vol. 1752 , pp. 153-157, 1992.

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