

# Advanced Optics Manufacturing

## PROBLEM / OBJECTIVE

Optics are the pervasive enabler in a significant number of end item military systems ranging from the individual soldier, missiles, fighter aircraft, tanks, helicopters, etc. which are equipped with fire control sights, laser rangefinder and designators, thermal, and multispectral systems. Designers of optical systems were constrained by their inability to maximize optical system performance due to the surface geometry limits imposed by conventional optical manufacturing technologies.

The objective of this effort was to design an optics system, which can achieve the sub-micron form and figure accuracies required for producing precision spherical, aspherical, and conformal (freeform) optical surfaces.

## ACCOMPLISHMENTS / PAYOFF

### **Process Improvement:**

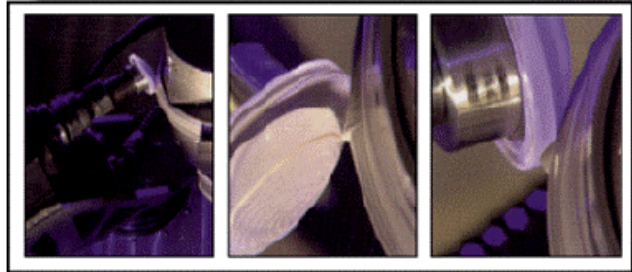
Magnetorheological Finishing (MRF) is truly revolutionary. Its extreme accuracy and computer-controlled stability makes the fabrication and polishing of exceptionally precise spherical, aspheric, and non-traditional freeform optical shapes possible. MRF provides a paradigm shift unprecedented in optics manufacturing technology.

### **Implementation and Technology Transfer:**

MRF has already proven its applicability in present day and next generation military systems.

Present day example: MRF produced a precise aspheric surface in brittle optical materials that reduced the cost of production by a factor of ten with significant weight reduction. This process was instrumental to the Army Night Vision Electronic Sensors Directorate (NVESD) effort to reduce the weight of the Integrated Night/Day Observation Device (INOD) Weapon Sight by redesigning the Eyepiece Lens Assembly using aspheres.

Next generation example: Raytheon's Elcan Optics Division demonstrated the savings that MRF will have on military systems by redesigning an all-spherical 13-element Digital Micromirror Device (DMD) lens assembly. By incorporating two aspheres in the redesign, they reduced the number of optics needed by five. The new eight-element



design not only reduced cost, it reduced system weight by 35%.

As a result of this ManTech program, the Q22 MRF machine is commercially available and has received industry-wide acclaim. In its first year of commercial availability, MRF won the optical industry's two most prestigious awards for technology innovation and achievement, the Photonics' Circle of Excellence Award and the LFW Commercial Technology Achievement Award. Every manufacturer of photolithographic optics and several major precision optics shops in the U.S. have already installed multiple MRF machines to produce ultra-high precision spheres and aspheres - 24 hours a day.

Over 30 MRF machines are now on the shop floor!

### **Expected Benefits:**

The use of this technology will have a positive effect on every military system which requires the fabrication of non-spherical optics.

## TIME LINE / MILESTONE

Start Date: January 1997

End Date: May 2000

## FUNDING

Army ManTech : \$6.015M

## PARTICIPANTS

Center for Optics Manufacturing  
ManTech  
APOMA  
BSI  
Eastman Kodak  
Raytheon  
Lockheed Martin  
Tropel  
QED Technologies  
Resultant Manufacturing Services