LIGHT WORK

A laser catches what the eye can’t see in a truck lamp.

A MAKER OF TRUCK ACCESSORIES was pursuing an idea for a new marker light. It would use an optical cover to broadcast the beam of a single LED wide enough to meet federal standards. Then it could offer a product with the reliability of a light-emitting diode at a price near that of an old-fashioned incandescent lamp.

Every truck more than 80 inches wide is required to carry clearance and ID lamps of this sort. They are amber in front, red in the rear. Down each side, amber rows must end in red. The National Highway Traffic Safety Administration calls them "conspicuity lights," because they're supposed to make a truck conspicuous for safety's sake.

Incandescent and LED lamps are used to mark trucks and trailers, just as they serve as taillights or to signal brakes and turns.

LEDs generally cost more to buy, but tend to make up for it over time. They burn cooler than traditional glowing-filament lamps and draw less power from an electrical system. LEDs are expected to outlast the truck, so they eliminate the cost of replacements.

Breault Research Organization of Tucson, Ariz., had the job of developing the optical part to mate with the LED in the new lamp. The company came up with an injection-molded component to disperse light and meet tight size and weight constraints.

When the initial prototype came back, though, it did not meet requirements, even though optical simulation showed that it should. Measurements indicated that it did meet dimensional specifications.

"Even though our design analysis had predicted that the component would work, test results showed that it was not putting out light in all the right places," said John Koshel, manager of optical design at Breault Research.

Although the crew at Breault knew something wasn't right, they couldn't put a finger on the cause. They couldn't put a probe on it, either. Contact with a coordinate measuring device might damage the plastic and compound the problem. Some features seemed too fine for a probe to trace.

Breault's engineers sent the prototype of the lamp to Laser Design Inc., which operates a laser scanning service bureau in Minneapolis as a sideline to its main business, which is making and marketing scanning systems.

Laser Design used a model called Surveyor, which has a movement envelope of 16 by 20 by 16 inches. The system emits beams of light and records them as they reflect off as many as 15,000 points per second.

As it computes the travel of each beam, the scanner builds a point cloud representing the surface of an object. According to Larry Carlberg, sales coordinator for Laser Design's service bureau, the scan is accurate within 10 to 30 micrometers.

Computer software converts the cloud into a model of the piece as it was built. When a program compares the assembled version with the original 3-D CAD model, color-coding will show where the two differ.

When Laser Design's technicians sent their results to Koshel, he found small ripples in a critical area of the lamp's surface. Although at 0.001 inch they fell within design tolerance, the ripples pitched a critical slope 7 degrees away from the desired value.

"Because they were in a critical location, the ripples were deflecting the light in a direction that made it impossible to meet the requirements," Koshel said.

An insert in the mold transferred ripples to the plastic part. "These ripples, though undesired, are often a result of the fabrication process," Koshel said. "By investigating the tolerances of fabrication we are able to incorporate them into this and future designs." The problem is being solved by using the newly modeled, rippled surface and altering other locations of the optical part.

The in-house alternative to laser scanning would have been to go back to the analysis software and try different dimensional changes until analysts could duplicate the problem. Because of the number of different dimensions to check, Koshel estimates that trial and error on the computer could have taken a week or more, at a typical engineering hourly rate of $200, or a total of about $8,000.