



Laser Scanning Reduces Cost of Reverse Engineering Project

Switching from a coordinate measuring machine (CMM) to a laser scanning system has reduced the cost of reverse-engineering automotive components by 90% while improving accuracy by a factor of 10. Generating a Class A surface model of an automobile door, for example, with a CMM required about three weeks of scanning and six weeks of surface modeling and resulted in a model whose accuracy left much to be desired. Switching to a laser scanner mounted on the Techno CNC gantry positioning system reduced scanning time to 16 hours and surface modeling time to 16 hours. The accuracy of models produced with the laser scanner is substantially higher than before, typically 0.001 inch over the length of a larger component such as an automotive door.

Reverse-engineering – producing an accurate surface model from a physical object – is a critical task in several areas of the automotive business. While automotive OEM's have largely switched to electronic models as the masters for development of new vehicle designs, physical prototypes are still used extensively. These prototypes often needed to be digitized, such as when changes are made to the prototype, and these changes need to be incorporated into the digital master model. Companies that modify or customize production vehicles, such as builders of limousines and hearses, also frequently use reverse-engineering techniques. These companies normally require a 3-D CAD model of the vehicle they are working with in order to begin their design process. In addition, aftermarket component suppliers often require reverse-engineering in order to match original equipment parts.

Previous Difficulties

Lawford Fabrication makes dies used by automotive OEM's, rebuilders, customizers and component suppliers to produce automotive body components. In the course of its normal business, the company is frequently called on by its customers to scan physical prototypes and production parts for which a die needs to be built. As a result of the expertise that it developed, the company began to be hired on a regular basis to reverse-engineer components even without ever being involved in building the die. Yet, Lawford has long had problems in finding a satisfactory method of reverse-engineering components to the demanding standards required to produce Class A automotive exterior surfaces.

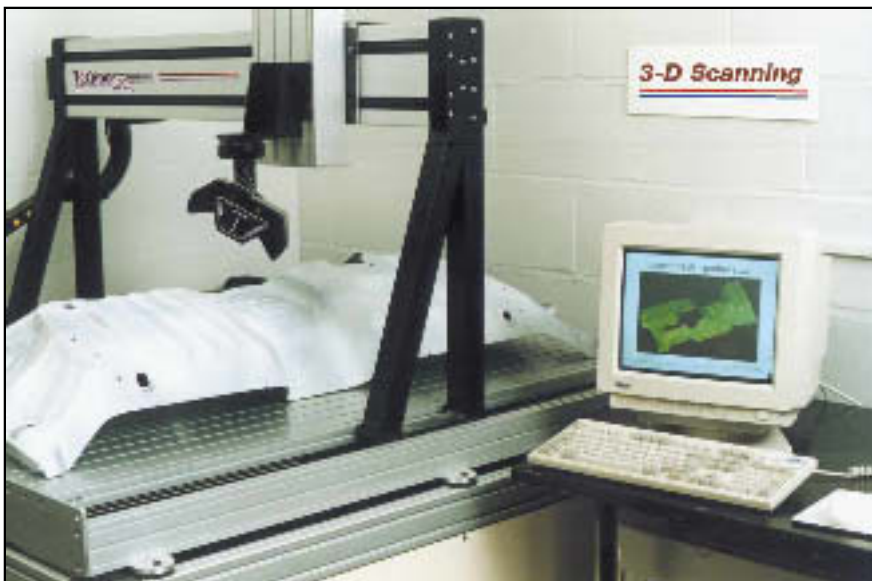
The primary method that was available in the past was hiring a

contractor to scan the component with a high-end CMM machine. Such a CMM machine is easily capable of achieving the required 0.001-inch accuracy for any given point. But a CMM machine is not well suited to the task of scanning a complete surface. The operator must carefully move the probe of the machine all over the part. This takes a lot of time, several weeks typically for an automotive door, which raises costs since the process ties up a high burden rate machine. Any particle down to the size of a speck of dust on the surface of the part will produce a measurement error. The scanning process also requires extreme amount of care on the part of the CMM operator. If the operator loses contact with the part surface for an instant, accuracy suffers.

Previous Expenses

In the experience of Lawford Fabricating management, these types of problems made it impossible in most cases to obtain high quality scans with CMM's. The company typically paid \$2,000 to \$5,000 to have a typical component scanned, then found that the scan was of such poor quality that the same point in X-axis and Y-axis sections had coordinates that varied by up to 0.050 inch. This lack of accuracy meant that point clouds generated by this approach typically required weeks of touchup work in order to produce an acceptable surface model.

Lawford CAD designers would typically machine a wood component after surfacing the original scan and check its dimensions against the actual part. These checks would typically reveal that major modifications were



required in order for the model to accurately match the part. Three to six iterations or modifying the model and cutting a new wood model were typically required to achieve satisfactory results. This typically took 3 people about 150 hours each to complete the surfacing at a rate of \$50 per hour, resulting in a total surfacing cost of \$22,500.

Having experienced these difficulties for several years, Lawford Fabrication managers were interested when they heard about a new non-contact method of reverse-engineering. The Replica, offered in the United States exclusively by NVision, Dallas, Texas, is a laser scanner mounted on a Techno CNC gantry that can generate a 3-D CAD model from any physical object regardless of its material, geometry and color, as long as it fits within the boundaries of the machine's table. NVision also offers a portable laser scanning system, ModelMaker, which can scan virtually any size product.

Laser Triangulation

The Replica generates 3-D models from physical objects using a principle known as laser triangulation. A laser diode and a stripe generator project a laser line onto the object. The operator moves the stripe along the object as if they are painting with an air brush. Built-in optics view the laser at a 30° angle to detect height variations in the geometry. Real time rendering of images gives immediate feedback to the user. The mechanical arm's six degrees of freedom allow scanning from all angles. The Replica uses a dedicated 3-D image processing board to capture the contour in real time.

Lawford Fabrication management made the decision to purchase the laser scanning machine. The first opportunity to use the new machine came in a project for Superior Coach, Lima, Ohio, a major manufacturer of limousines. This company needed a Class A scan of an automobile door. After installing the new machine, Lawford Fabrication operators scanned the automobile door in a series of stripes in a total of about 20 hours.



They scanned the door by digitizing points every 50 microns, providing a considerably higher level of point density than could be achieved with the CMM. They then exported the point cloud into the AutoCAD computer-aided design program. They generated their initial surface model and quickly verified the accuracy of the scan. When they compared X-axis and Y-axis sections, points lined up perfectly. This high level of accuracy meant that only 16 hours were required to generate a surface model that is accurate to 0.001 inch, 5 times better than the customer's requirements for this project.

90% Cost Reduction

Lawford Fabrication began using this tool for all of its reverse-engineering projects and has experienced similar positive results on nearly every job that it has taken on since that time. The level of accuracy that it has been able to achieve is substantially higher than contact gauging methods. In addition, the company has been able to substantially reduce its cost for these services.

Typical cost for a laser scanning job is now 16 hours for scanning, at a cost of \$100 per hour, or about \$1600, plus 16 hours for surface modeling, about a cost of \$50 per hour, or about \$800. The total cost of \$2400 is only about 10% of the cost of typical job when contact gauging methods were used. As a result, Lawford

Fabrication has substantially increased its reverse-engineering business.

The quality improvements and cost reductions that Lawford Fabrication has been able to achieve have helped the firm to apply reverse-engineering methods to several new applications. The company has obtained a number of inspection/gauging jobs. Parts produced during start-up are scanned and then the Quality software module from Metris Corporation is used to automatically compare the scanned data to the original CAD file. In another application, reverse-engineering is used to produce IGES surface models of dies that have been modified on the shop floor during the start-up phase. Producing accurate mathematical models of the final die geometry makes it possible to machine the dies back to its geometry when they are repaired, eliminating the need to requalify the die after repairs.

Headache To Profit

All in all, switching from CMM gauging to laser scanning has dramatically improved the reverse-engineering process at Lawford Fabrication. The overall cost of reverse-engineering has dropped by 90% while accuracy of the finished surface model has improved by a factor of 10. These improvements have helped Lawford win additional business in traditional automotive reverse-engineering applications as well as open up new application areas. Reverse-engineering has changed from a headache into a major profit center.

NVision is the exclusive distributor for all of North America for the Replica laser scanner produced by 3D Scanner Ltd., London, England. NVision is also the exclusive distributor for other 3-D scanner products including the ModelMaker portable laser scanner and the Reversa laser scanner, which is designed for mounting on a CMM or a Techno CNC gantry machine. NVision operates a solution center in Warren, Michigan, the heart of the automotive styling industry. This center offers product demonstrations, training and service.