



KONICA MINOLTA

## TECHNICAL APPLICATION BRIEF

### 3-D Non-Contact Scanning In Manufacturing

#### **"RE-ENGINEERING" ONCE AND FUTURE THINGS: 3-D DIGITIZING OF EXISTING PART CONTAINERS REDUCES NEW CAR MANUFACTURING COSTS AND GIVES NEW LIFE TO OLD PRODUCTS**

One of the thrills of being a design engineer is working on some really neat new thing, be it a radical visual element for a car, a revolutionary new aircraft shape, an "over-the-top" consumer electronics device, any product that you can later point out to family and friends as "my work."

Then there's all the other important work that design engineers do everyday but only a few very important people really appreciate. Those few are often the same customers as the higher profile projects.

RMK Industries, Inc., Madison Heights, MI, is a relatively new design engineering firm (paradoxically boasting more than 30 years experience) that has set its sights on becoming a top provider of innovative technical solutions for challenges some may consider "not very exciting," but clients consider very serious matters, indeed.



RMK Industries, Inc., Madison Heights, MI

#### "Dunnage"

Take, for example, the seemingly unglamorous world of "dunnage." Dunnage is an auto industry term for the holding and transport fixtures required to store and move components safely, such as body panels, windshields, transmissions, engine blocks, the whole myriad of parts which must come together to make a finished vehicle. Not nearly as cool and exciting as engineering the latest super-charged, gas-sipping, high-performance sport coupes, dunnage can be, however, a major and costly headache for their makers.



RMKI chose the Konica Minolta VIVID 3-D digitizing scanner as the ideal instrument to turn existing dunnage parts, such as this plastic automotive electronics shipping case, into modern CAD/CAE/CAM software files.

"At RMKI, we understand both sides of the design and manufacturing engineers' world, the glamorous and the mundane, because we've done and do both," said Kevin LaRose, General Manager. He explained that RMK Industries is a 2001 off-shoot of the well known AMI Engineering, Inc., Pontiac, MI, which since 1967 has been design engineering automotive bodies, interiors and powertrains for the world's major automakers.

VIVID™ 3-D DIGITIZING



LaRose said that the automaker's primary interest in dunnage design is simple economics. He explained, for example, that in a typical "powertrain rack," the main transport and storage unit for engine/transmission assemblies, there are four to six different styles of dunnage fixtures and any one dunnage style may be used three to four times in a Rack. With approximately 95,000 powertrain racks in service today, he said, the number of dunnage fixtures can be as high as 1.14 million, assuming four dunnage fixtures per powertrain assembly and three powertrains per Rack.

"You can start to see the potential cost savings in the ability to re-use a piece of dunnage, and keep in mind that this is the powertrain side only," he commented.

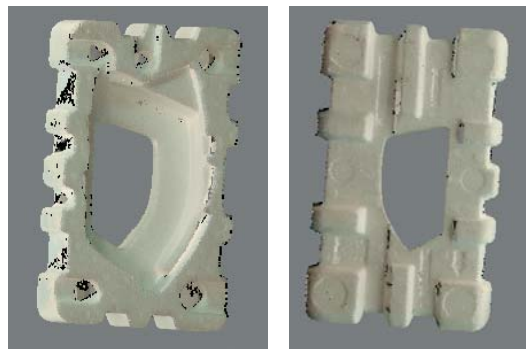
## An Unusual Challenge

The challenge for automakers comes when an auto component, say a transmission, is redesigned. The maker's design team has to determine if the existing dunnage fixtures can still be used, or new ones have to be created. The unwritten rule in past industry practice, LaRose said, was "a new part, a new container, and for a good reason as we learned."

Then one major automaker approached RMKI with an unusual request and challenge of its own: "help us find a better way to make dunnage." The automaker, said Matt Tokarz, RMKI President, "in a major effort to reduce shipping and container costs commissioned us to perform case studies of the ability to re-use steel shipping racks, vacuum formed dunnage trays and fixturing inserts for new products. Tokarz said the crux of the problem "is new physical product isn't typically available to check fit with existing dunnage because the new part is still CAD data, and existing dunnage, typically, wasn't produced from CAD data, but from parts and paper prints. So, on the one hand, they had a 'virtual new part' and, on the other, a well-worn, real world matting part."

The mission RMKI accepted, he said, "was to determine the technical means and methodology to solve the problem." The solution was to turn the existing units into modern digital objects, something easier said than done.

The first thing RMKI learned was that trays and dunnage parts have complex surfaces that are difficult to measure accurately by hand, and that hand measurements or even coordinate measurement machines (CMM) could not achieve the time and cost/benefit goals needed.



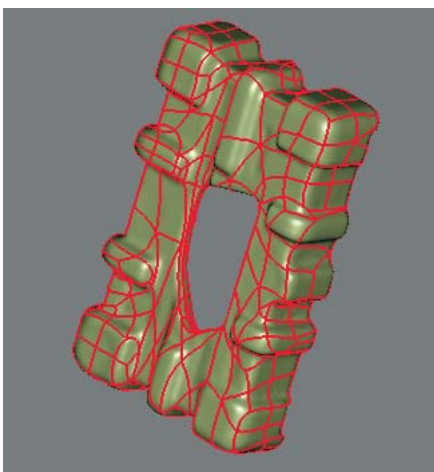
*When the VIVID 3-D scanner digitizes an object, a cloud of three dimensional points is created. This "point cloud" data is then merged and smoothed using the scanner's software to fill any missing data points.*

"We and our customer knew that manual measurement or CMM of thousands of dunnage units just wasn't practical nor desirable," Tokarz said, "and that was our starting premise. We needed a technology that could go fast from the real world to the digital world and into the CAD programs used by our customer."

## A Real 3-D World Solution

In an effort to find a more cost-effective, accurate CAD model, RMKI started to investigate 3-D scanning. "We basically looked at cost, accuracy, CAD output, capability range and ease of use," explained LaRose. "The investigation was an engineering project in itself," he added.

After extensive research and multiple on-site tests of various scanners RMKI choose the Konica Minolta VIVID™ 900 Digitizer. The VIVID 900 Digitizer is a non-contact, portable, surface geometry and color texture scanner. It uses intrinsically safe Class 1 laser-light stripe triangulation to capture 3-D surface geometry data. In "Fine Mode," the scanner captures 307,200 (640 x 480) 3-D data points per scan in 2.5 seconds. In "Fast Mode," it captures 76,800 (320 x 240) 3-D data points in just 0.3 second.



*Next, point cloud data is converted into polygonal data, called a nurb surface, which is a more "solid" structure used in CAD software.*

The scanner's auto-focus CCD camera captures 307,200 color texture points simultaneously with the 3-D data. It is capable of digitizing various volumes in a single scan from as small as 111 x 84 x 40 mm (4.2 x 3.3 x 1.6 in) to as large as 1,200 x 903 x 400 mm (47.2 x 35.6 x 15.7 in) through the use of interchangeable lenses.

The Vivid unit, LaRose said, offered an affordable price and its accuracy far surpassed the tolerances that are required for dunnage units. "The hardware and software package," he added, "were relatively user friendly, so it was a solution we could implement utilizing our existing personnel."

Once the technical means was in hand, LaRose said, RMKI then developed a methodology to implement it efficiently. The method RMKI uses starts with a quick study of the dunnage surface to determine whether the piece is completely scannable, or may also require some manual measurements as well. Some units can be scanned in their entirety using the VIVID unit's rotating target table. Others, which are too large for the table, are scanned in pieces and registered using the unit's software.

A typical subject, such as an engine component or an electronics module shipping support, explained LaRose, is first examined for size and deep pockets, holes or grooves which may require multiple scans. Then the dunnage piece is prepped for scanning. It is sprayed with a fine white powder which optimizes laser beam accuracy by minimizing any reflectance scattering. The powder is washed off after scanning. Once prepped, the piece is placed on the rotating target table and scanned in several different positions until the entire surface area is in a "point cloud format." Each scan produces a point cloud of a particular surface area. The individual point clouds are then registered to each other by matching common surface areas to produce an entire 3-D model.

The point cloud model is then taken through several processes to produce a final CAD model. The process includes converting the point cloud to a polygon model and then creating surface sheets which fit the polygon model. The final surfaced model is then exported to the CAD system which enables "check-fit" comparison of the dunnage piece to the new automobile CAD part. It also expedites CAD modification of the dunnage piece should a new piece be needed.

Although time and cost savings for the RMKI customer vary depending on the particular dunnage piece, LaRose said on average, lead-time is being reduced by 50 percent and cost savings are about 30 percent per unit compared to the customer's previous reverse engineering techniques. "One part we digitized, a comparison study of a new tool, actually found that the first run physical part was off by one-quarter inch from the math model. That potentially saved the customer from making 4,000 non-conforming pieces and the loss of a few production weeks. Imagine what the loss could be if it were an engine dunnage piece of which 100,000 were needed."

LaRose characterized their VIVID 3-D scanning process for dunnage as not so much "reverse engineering" in the classic sense, but "Re-Engineering" past products into modern digital formats so that they can be made once again, and even made better.

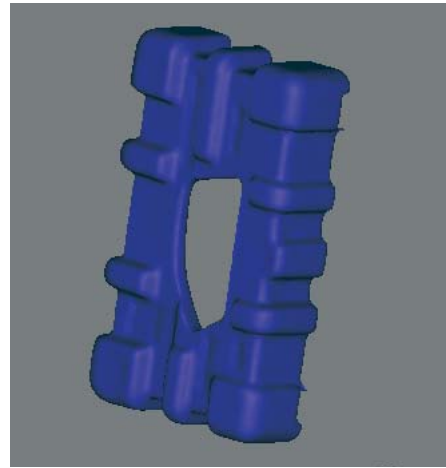
### **Once and Future Products**

Looking beyond the dunnage project, Tokarz and LaRose said RMKI has been examining other applications for the Minolta VIVID 3-D scanning methodology that they have developed. "In addition to our regular engineering work in other areas," Tokarz said, "such as design, reverse engineering and program management, we see our 3-D laser scanning methods for dunnage and shipping containers applicable across a broad range of industries, in appliance manufacturing, civil and commercial and military aviation, defense supply and transport systems and many more. They have their versions of 'dunnage' too."

But what gets both Tokarz and LaRose really excited are the other potentials of the "3-D Re-Engineering" process that they have successfully developed.

"Think of the possibilities beyond current industrial products," Tokarz mused, "classic car parts that are no longer available but could be made again, even less expensively, if they existed today in modern CAD form. The same for civil and commercial aircraft of all types, many of which are 20 to 50 years old and still flying but owners have to scrounge bone yards and old hangers for parts. And then there is the home decor and architectural element business where much of what was old is fashionable and desirable again, and could be sold if only it could be made affordably again."

LaRose added, "Our VIVID 3-D process really can work to recreate products people want. So, now that we've done it successfully for dunnage we're going to start doing it on the more glamorous side of our engineering business."



*The final 3-D virtual object, called a wrap file, contains all the mathematical data needed for use in modern computer aided design, engineering and manufacturing software systems.*