3D Scanning—Magic Made Practical

George Hatzilias

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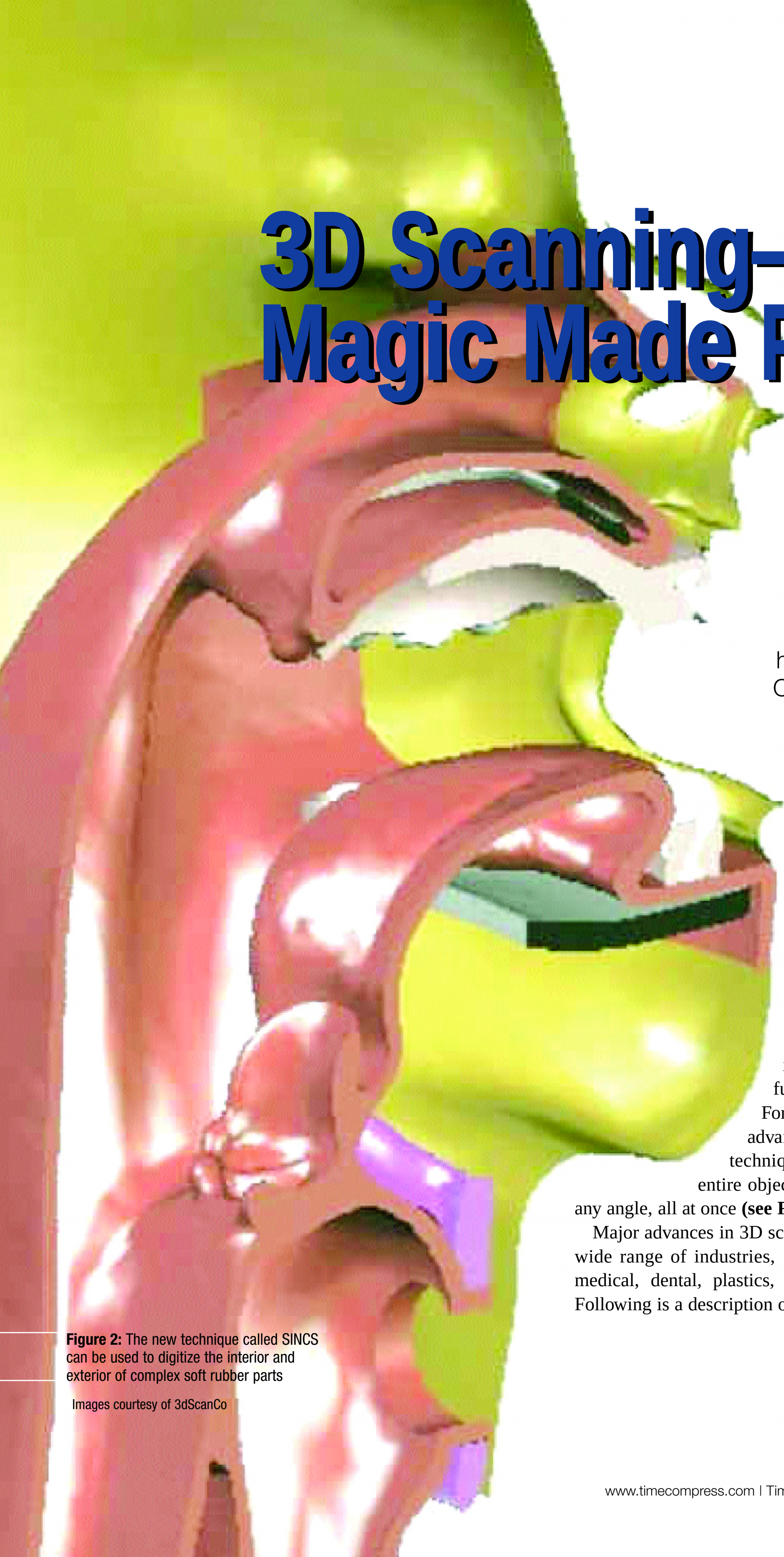

Figure 2: The new technique called SINCS can be used to digitize the interior and exterior of complex soft rubber parts

Images courtesy of 3dScanCo

WHILE 3D LASER SCANNING equipment has been available for more than 15 years, computing power has only recently caught up with 3D technology, resulting in a quantum leap for reverse engineering and quality inspection applications, which can now fully use large amounts of digital scan data.

For example, 3D scanning inspection has advantages over CMM or optical comparator techniques because it offers a color map of the entire object and can be viewed via color map, from any angle, all at once **(see Figure 1, page S10)**.

Major advances in 3D scanning applications are appearing across a wide range of industries, including aerospace, automotive, marine, medical, dental, plastics, tooling, architecture, and entertainment. Following is a description of some of these developments.

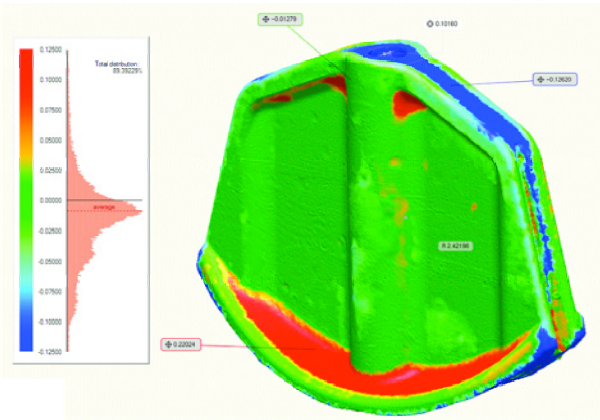

Figure 1: This quality inspection color map shows that the actual model deviates from the CAD intent, highlighted in red. Using a color map inspection, clients are able to identify and solve problems early in the manufacturing process.

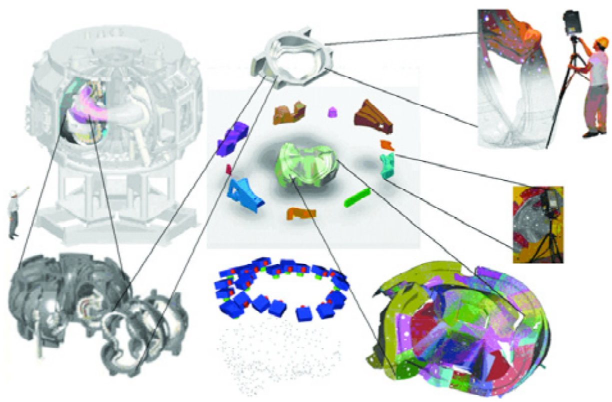

Figure 3: Digital assembly techniques made it possible to scan and assemble this large 40-plus part assembly of patterns used to cast a fusion reaction chamber. This technique determines how the complex cores assemble together to define final casting dimensions.

Soft Internal Non-Contact Scanning (SINCS)

When most people think of 3D scanning, they think of capturing the exposed surfaces of an object or assembly—and rightfully so, because most optical systems are based on a "line of sight." However, the soft internal non-contact scanning (SINCS) breakthrough makes it possible to effectively see *through* parts.

The anatomical CAD model in **Figure 2** (**page S9**) was generated using SINCS. The engineering challenge was that a defunct supplier had left designers with only a physical sample and no CAD. The solution involved a special new compound (SINCOR) that is dimensionally stable, will not adhere to part surfaces, is able to accurately capture internal details, and is able to be removed without losing its shape. The external surfaces were scanned first. Once the inside was cast in SINCOR, the internal casting was removed and scanned in to represent the interior surfaces of the part. Internal and external surfaces can be joined fairly easily by using the simple trick of leaving part of the casting in both the internal and the external scans. The challenge was twofold: (1) capturing the full 360 degree shape of a soft part that cannot support itself, and (2) capturing the internal anatomical features and non-uniform wall thicknesses. SINCS met the challenges of measurement difficulty and complex modeling of human forms.

Digital Assembly

Another new innovative scanning technique is digital assembly **(see Figure 3)**, a technique that relies on capturing the way parts fit together physically. Parts are assembled, then reference markers are placed on the assembled parts. The locations of those markers are captured using photogrammetry or similar techniques. Each part is then separated and scanned individually, but the reference marks on each part are snapped into the coordinate system measured for the entire assembly. With the location markers, part

Can you benefit from 3D Scanning?

By understanding 3D scanning capabilities, design engineers and quality managers in every industry can expand their horizons, improve work methods, and increase efficiency and quality.

The following questions may help you identify when you should be using 3D scanning:

- Complex forms—Do you work with complex shapes?
- Measurement difficulty—Is throughput affected by time/effort spent measuring?
- Fighting CAD—Ever have to fight CAD to get it to do what you want?
- Lacking CAD—Ever have a part with limited, inadequate, or missing CAD?
- Legacy CAD—Do you ever have outdated or inherited CAD models?
- Legacy parts—Ever have parts with limited inaccurate or no CAD model?
- Packing density—Ever need to cram more stuff in tight places?
- Restoration—Do you need to restore old or missing parts?
- Scaling—Do you ever work on parts that are similar but scaled up or down?
- Size—Ever need to assess a large building, structure, or environment?
- Aftermarket—Do you need to design around someone else's parts?
- Fit—Ever have issues making parts fit? Or seal? Do you have complex interfaces?
- Performance surfaces—Does shape affect performance of your parts? (aerodynamics/hydrodynamics/flow)
- Ergonomics—Are ergonomics/human factors important to your products?
- Hand Working—Do you ever hand work designs, prototypes or molds?
- Documentation—Could your part documentation be improved?
- Ornate—Do you ever work on ornate decorative designs?
- Archival Storage—Do you ever run out of storage space for stuff you must keep?

If you answered yes to any of these questions, you should consider 3D scanning for improving product development processes.

scans pop into their proper place in the assembly, and the entire part can be easily scanned.

Photogrammetry

A recent major technological advance combines non-contact 3D scanners with photogrammetry systems. Photogrammetry relies on taking digital images of special coded markers from different viewpoints, and then cross-checking the different viewpoints against each other to form a highly accurate model. It is especially useful in scanning large parts or complex assemblies.

Most standard 3D scanners rely on having significant overlap between each scan shot to align the two patches together. Without photogrammetry, there can be significant tolerance stacks and therefore losses in accuracy. Photogrammetry eliminates the need for overlap since scan patches pop into the coordinate system defined by photogrammetry markers.

"Balancing" and Scaling

Master patterns for ornate objects are often carved by hand. In many applications it is helpful to do the hand work at a different scale than the final part. In **Figure 4**, the sculptor got higher detail by working at a larger scale. The sculptor had the carving digitized and "balanced" into a mathematically symmetrical shape. The digital models were then scaled to 20 different sizes for manufacturing. Rapid prototyping was used to make a pattern for each of the varying sizes to be manufactured. 3D scanning saved the sculptor the time and cost of carving 20 different patterns by hand.

Summing It Up

With recent advances in 3D scanning, if you or your suppliers are using any of the mainstream 3D CAD systems available today, you are more than halfway there. 3D scanning technology has been tailored to mainstream CAD, resulting in unprecedented compatibility and broadened applications. 3D scanning realizes significant time and cost savings over traditional measurement methods and accelerates product development cycle times. **TCT**

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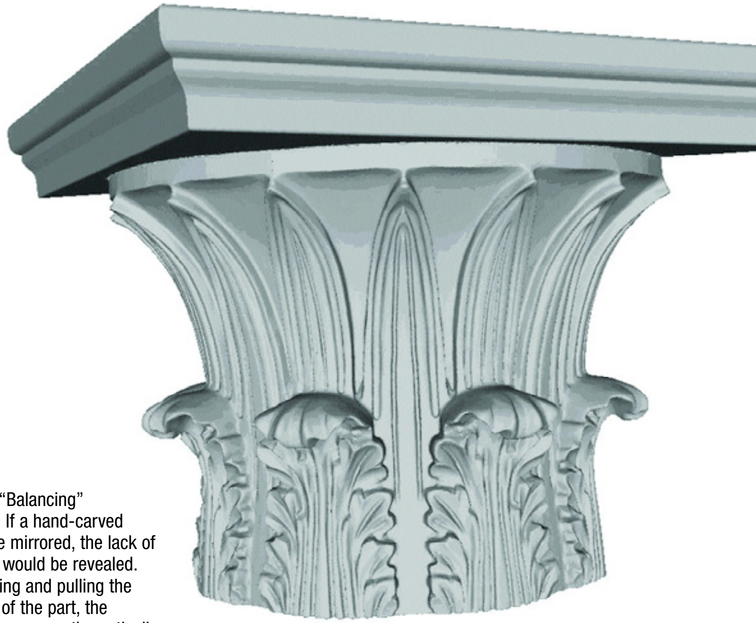

Figure 4: "Balancing" technique: If a hand-carved piece were mirrored, the lack of symmetry would be revealed. By stretching and pulling the scan data of the part, the design becomes mathematically symmetrical, improving manufacturability.

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