

# 3D SCANNING, *TO GO*

Mobile handheld  
scanners capture  
3D data almost  
anywhere.



Z CORPORATION\*

# 3D SCANNING, TO GO

Leslie Gordon  
Senior Editor  
MACHINE DESIGN

**Y**ou are probably already familiar with 3D scanning-to-printing as a way to build scaled, facsimile models of real-world products. But suppose you are, say, a bottle manufacturer that needs to reverse-engineer large hardware complete with little ribs in the grips. Or a Tier One aftermarket supplier needing to capture a difficult shape in an automobile interior, such as the area between the windshield and instrument panel. Or even a natural history museum needing a replica of

a huge dinosaur bone for an educational exhibit. Whatever the industry — whether manufacturing, health care, cultural heritage, or even arts and entertainment — a significant barrier to 3D scanning has been the expense, bulkiness, and inconvenience of traditional equipment.

It's evident that the capability to bring the scanner to the part instead of vice versa brings huge benefits to applications such as the ones above. A new technology

called "mobile scanning" exactly fits the bill. Central to the technology are handheld and lightweight 3D scanners from **Z Corporation** that easily capture 3D data of almost any object, from a coffee cup to a car, in almost any location.

All that's needed to do the job are the scanner, a laptop, and a handful of the small, reflective targets that go on the object to be scanned. Plug-and-play setup has you up and running in as little as 10 minutes. Once a scan begins, the laptop screen displays an image of the surface being scanned, fully stitched together in real time, making it easy to know when all the data is captured. And the object-based reference system means parts can be moved mid-scan. The scanner software produces an STL file ready for output to CAD software or a 3D printer, which can generate an affordable physical prototype within hours.

Contrast this to traditional equipment for scanning. A laser-based or projected-white light system, for example, might comprise a large scanning device,

## Z SCANNER 800



**The new ZScanner 800 features three cameras for a 40- $\mu$ m scanning resolution and accuracy. The device automatically calibrates the resolution for the type of surface being scanned, an industry first. The ZScanner 800 as well as the ZScanner 700 are uniquely self-positioning.**

tripod, dedicated PC, and maybe even a rotating table. Such tripod-mounted systems are difficult to move at best, and so are typically located in a dedicated lab or conference room.

These older methods require that you set up the part, take a snapshot of it, and then move the scanner or part and take another snapshot. You might repeat this procedure 20 to 75 times. Worse yet, time onsite is usually spent scanning, and only later do scans get stitched together to provide a 3D model. So there is no way to tell, until after the fact, if part areas have been missed.

Other traditional measuring methods can pose difficulties as well. A good example: portable coordinate-measuring machines. Usually made up of an articulating arm with a touch probe, such devices hard-mount to a table. Because the relationship between the base of the CMM scanner and the part cannot change, it's necessary to redo a scan should the part get moved.

Handheld scanners are already widely used in the manufacturing industry for simple data-capture purposes such as documentation. A good example comes from the design of a large metal part for construction equipment. The part represents the engineer's design intent. But when the part goes to the casting house, the company might change an angle or a radius for manufacturing purposes. Ultimately, it is a new design that gets delivered. These changes are efficiently documented by scanning

parts as they come out of the mold.

The devices are competitively priced relative to other scanners that perform as well in terms of resolution and accuracy. Their affordability has opened the door to users such as universities and secondary schools that could not buy a technology like this in the past.

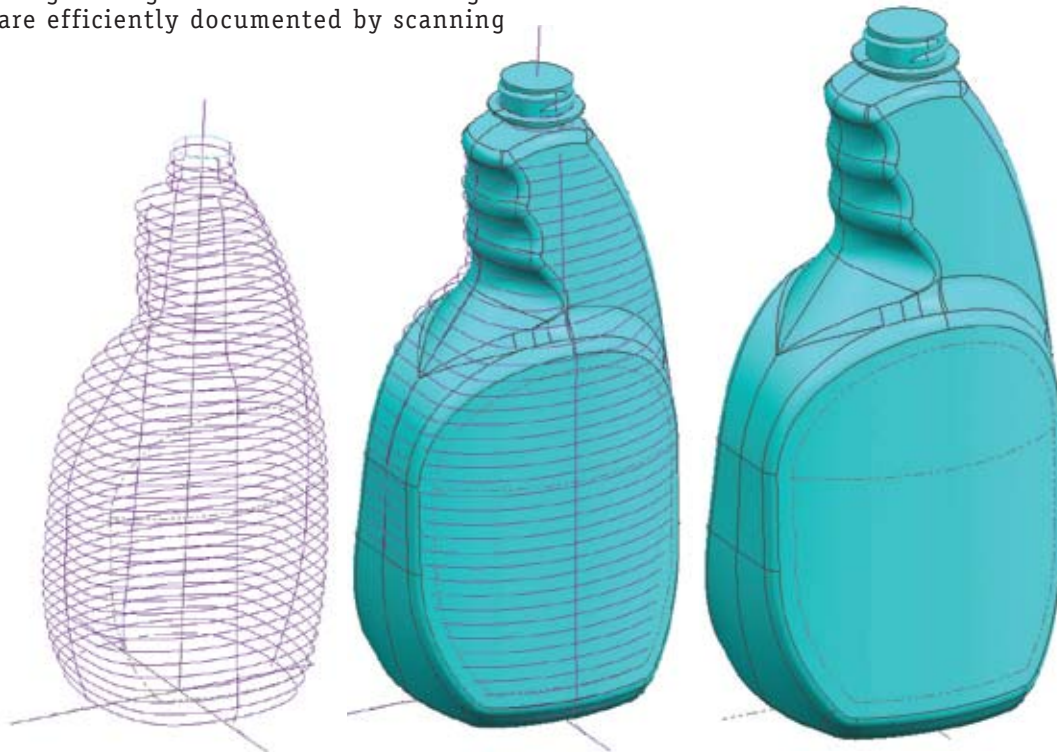


**A 3D printer turns scan data into real-world objects.**

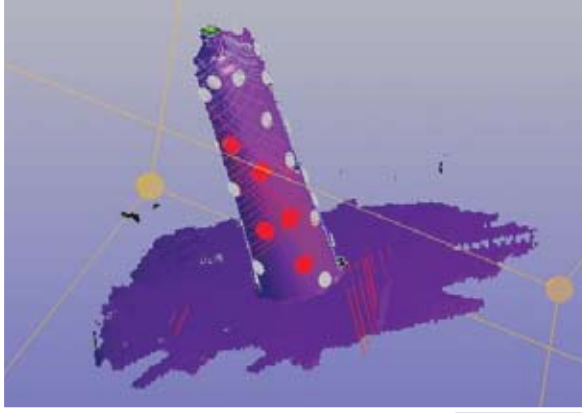
### **From Batman on a bottle...**

When bottle manufacturer **Silgan Plastics Corp.**, Chesterfield, Mo., wanted part of a plastic bottle to be shaped like Batman, it first used a ZScanner to reverse-engineer a real-world toy. The company then imported the scan data into 3D CAD to make the Batman shape part of the bottle model. The company makes hand cream, spritzers, sprayers, and handware (bottles with an integral handle), containers typically seen on shelves of a grocery store, Target, or Wal-Mart.

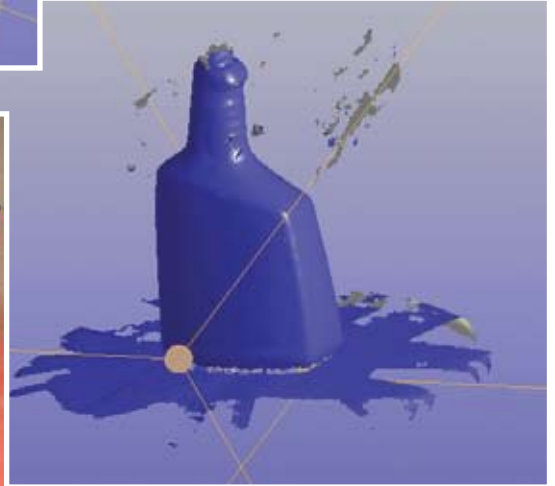
First, the user randomly places  $\frac{1}{4}$ -inch-



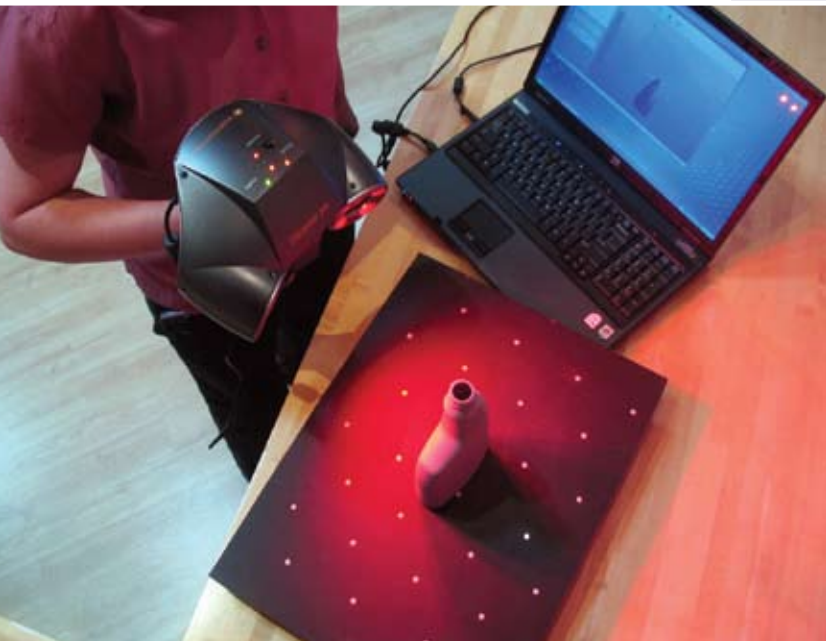
**A few snapshots from NX5 show what scan data of a plastic bottle looks like in the software (left), the surfaces the designer created using the grid information (middle), and the bottle as an editable solid (right).**



**A ZScanner screenshot shows a plastic bottle in the process of being scanned.**



**A ZScanner screenshot shows the finished faceted scan.**



**A designer uses a ZScanner to scan a plastic bottle for reverse engineering.**

diameter reflective registration targets provided by Z Corp. on the toy about 4 to 5 inches apart. "When you begin scanning, the system remembers the position of the dots relative to each other," says Silgan product designer Laura Kent. "Each target has a unique position —  $X$ ,  $Y$ ,  $Z$  coordinate — that lets the scanner recognize where it is relative to the other dots. The randomness of their position is what lets them be used as a positioning-coordinate system. Because the device locates off them, it doesn't matter if someone were to knock the bottle out of position. You can move the part, pick it up, or add more dots at any point in the scanning." This capability to move the scanner or the part is unique in the market.

To easily rotate a bottle, Kent places it on a Lazy Susan. "You just hold the scanner and start scanning. The device has a red and a green light. At the correct dis-

tance from the part — about 1 foot — the green light stays on. So the device tells you where you should be, just one of the many ways it is intuitive."

What's really great, says Kent, is the scanner lets you get in odd places like underneath the bottle handles. "Plus the computer screen shows what you are scanning as you go along," she says. "Other scanners provide no way to see results until a scan is completely finished. This is usually when the realization hits that parts need scanning at a higher resolution. But my biggest problem with traditional scanners: there is no good way to orient a part after the fact if it gets moved. The devices I'm familiar with didn't have software to orient a part back to an  $X$ ,  $Y$  plane."

Kent uses RapidForm software to export the scan as an IGES file into her NX 5 CAD software to design the production mold for blow-molding bottles. "We

then make a prototype part and send it to the customer," she says. "When the customer okays the part, we make a pilot mold for any last-minute changes. Last comes making the unit cavity."

In the past, the company reverse-engineered parts using a comparator and a set of calipers. "The comparator blows a bottle up about 10 times its size," she says. "The calipers were okay for small bottles, but didn't work well for big ones. In one project, for example, I was working on a large bottle for **Bayer**. The company had a bottle it liked a lot and wanted the bottle copied. The bottle was handware with lots of little ribs in the grip. I measured everything and got a model that was real close. But Bayer did not like the results. So when we got the scanner, one of the first things I did was scan the bottle and use the data to start tweaking the model I already had. Suddenly, the model turned into the bottle Bayer wanted. This is just one of the ways the scanner has made our work so much easier and our customers more delighted."

**And concept cars...**

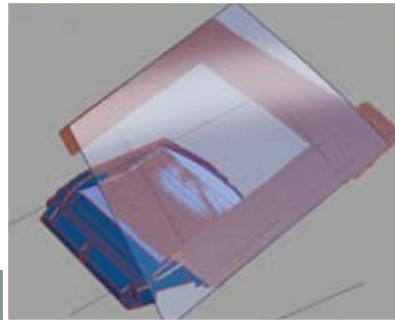
A Tier One global automotive supplier purchased a mobile 3D scanner to reverse-engineer products and more efficiently develop working prototypes using what the company calls its automotive intellect. **Visteon Corp.**, Van Buren Township, Mich., designs, engineers, and manufactures many different product lines, including climate, interior, electronic, and light-

ing components for OE vehicle manufacturers and aftermarket firms.

"Automotive intellect is a combination of our extensive experience and knowledge about all aspects of vehicle design," says Mechanical Architecture Lead Engineer Daniel Vander Sluis of the company's Advanced Systems Group. "Our team builds up cross systems, a merging of lighting, climate, interior, and electronic components. We also develop multifaceted housings, interfaces, and elements for connectivity," he says.

"Often, this means figuring out how to understand the packaging and design environment we are going to work within. So we scan interiors to establish setup shapes, and then figure out how to fit in electronic and mechanical components. Scanner data therefore provides a reference from which to develop and innovate. Then, using a Z Corp. 3D printer, we produce prototypes ranging from circuit boards up to complete instrument panel trim," he says. "Three-dimensional printing goes hand in hand with mobile 3D scanning and definitely compounds its value."

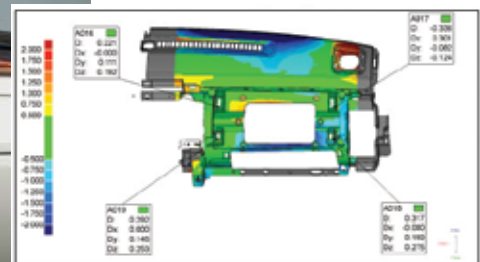
In the past, the group outsourced these



The results of scanning an automotive instrument panel through the car's front windshield are shown in Alias software.



A demonstration vehicle interior shows the forward-innovated instrument panel and console.



An inspection scan of an instrument-panel surface (colored area) is being compared to the original CAD model in Geomagic software. Red areas show the distance in millimeters that the scanned surface is above the CAD model



**The automotive cluster concept was constructed from several ZPrinter printed parts.**

prototyping tasks to a firm that used large, complicated equipment, and then purchased the resulting SLS and SLA files. "In the final analysis, it was the mobile scanner's ease of use and versatility and the 3D printer's capability to simultaneously print multiple colors that really drove our purchasing decisions," he says. "In any case, building prototypes ourselves is proving much more cost effective than the old method and makes us more competitive."

The scanner's versatility is a key benefit in Visteon's work. "It's the only way to scan from the interior of the car because it's self-positioning," says Vander Sluis. "After placing the reflective targets, just adjust the scanner to the darkness or lightness of the part color. When the scanner sees three of the reflective targets, it knows where the part surface is. As you move the scanner, it 'gives up' one of the targets and scans further when it sees a third reference point, including the two existing ones. Just move around the part and watch the surface appear on the screen."

After scanning, the group imports the scan into CATIA CAD software to add volume and features for manufacturing the part. CATIA files are exportable as STLs for the 3D printer. Sometimes, the group uses the scanner for inspection by scanning a part and comparing results to an existing CATIA model.

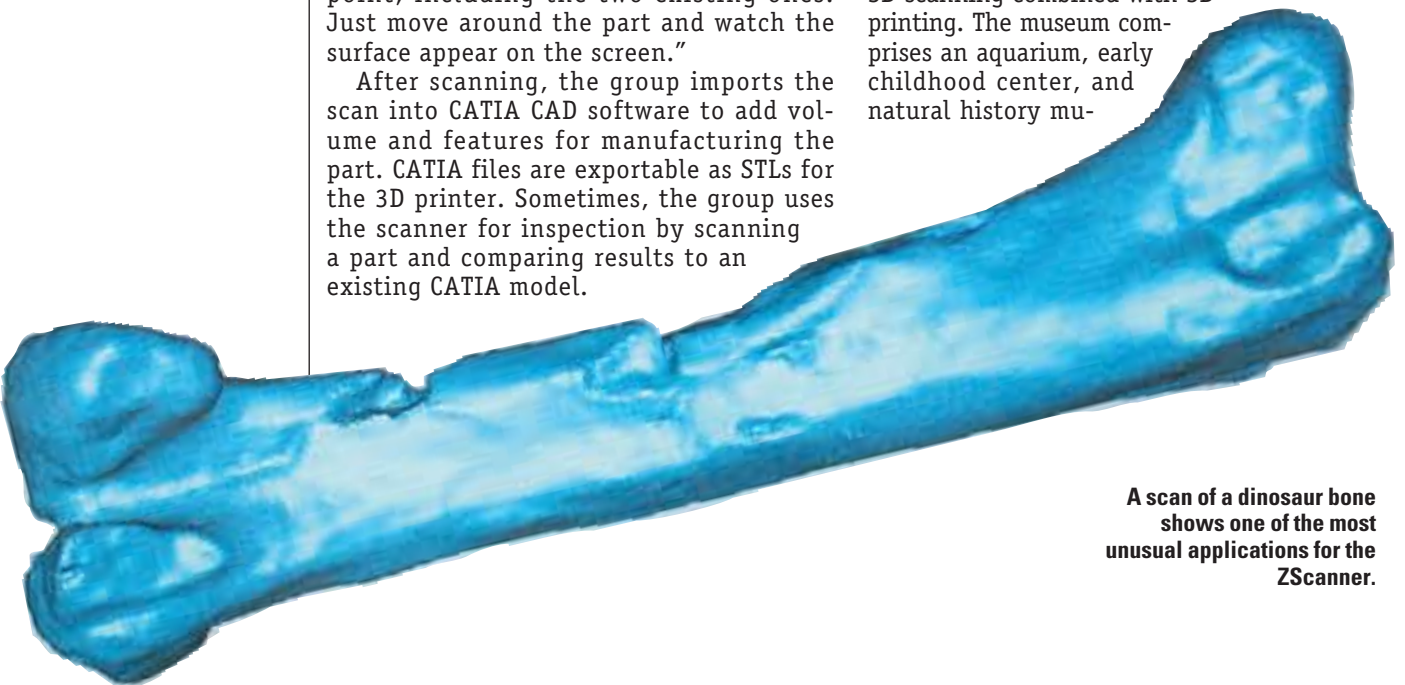
"It's possible to use the scanner software itself as a postprocessor to print parts," says Vander Sluis. "But STL is a monochrome file format, so we also use Alias software to specify color before importing the file into CATIA. This lets us take advantage of our 3D printer's color capability."

Three-dimensional scanning and printing also helps Vander Sluis's group quickly and affordably mock-up development vehicles for large trade shows, as well as for internal and external executive and customer reviews. The team either works with an OEM, or alone after identifying a vehicle market to target.

"When we used to send cars out for scanning, it necessitated shipping and setting-up vehicles," says Vander Sluis. "This might seem trivial, but the task actually took time and effort we could not afford. When building a development vehicle, we complete in a matter of six months what we normally would do in a production sense over a two-year period. After reverse-engineering, we forward-innovate, concurrently working with other groups of designers, artists, and human-factor engineers. We go through iterative cycles and 3D print a prototype whenever a team wants to see what a part will look or feel like. The scanning and printing equipment is a great in-house asset."

### **To dinosaur bones...**

The **McWane Center**, Birmingham, Ala., provides another example of the power of mobile 3D scanning combined with 3D printing. The museum comprises an aquarium, early childhood center, and natural history mu-



**A scan of a dinosaur bone shows one of the most unusual applications for the ZScanner.**



The McWane Center placed reflective targets on a fossil's fingers (right), used a ZScanner to capture the data, and then printed the bones on a ZPrinter.

seum, all rolled into one.

"Usually, pieces are missing from dinosaur skeletons or other fossil animals intended for natural history museums," says Curator of Paleontology James Lamb. "We purchased a mobile 3D scanner, a Z Corp. 3D printer, and a CNC router to replace tedious older methods that had us manually carving missing elements."

For example, the museum received almost all of the left side of a dinosaur for its Dinosaurs Roaming exhibit, but was missing the right tibia and thigh bone, says Lamb. "Our old method required making a mold of each bone," he explains. "I would build a clay form around the bone, divide the object in two with indexing tabs, put a separator on the bone, paint on many different layers of molding compound, make a hard-shell plastic mother-mold over that, flip the whole thing over, and, finally, strip the clay away. The process could take a week just for a thigh bone. Instead, I now scan parts, digitally mirror them, and either 3D print or cut them on the CNC depending on part size. I can build a bone in a fraction of the time,



and the result is much better."

The scanner also lets the museum accomplish other things that were difficult to do in the past, says Lamb. "The device comes in handy for digitizing objects and then changing their scale," he says. "For example, say we have two specimens of the same kind of turtle fossil, but the front end of one is an adult and the back end of the other is half-grown. Now, I just scan

A technician holds up an actual bone with reflective targets (right) and the printed results.

## A FEW TECHNICAL SPECS

	ZScanner™ 700	ZScanner™ 800
<b>Applications</b>	Reverse Engineering, Design, Manufacturing, Digital Mockups, Simulations	Reverse Engineering, Design, Manufacturing, Digital Mockups, Simulations, 3D Inspection Applications
<b>Weight</b>	0.98 kg (2.1 lb)	1.25 kg (2.75 lb)
<b>Dimensions</b>	160 × 260 × 210 mm (6.2 × 10.2 × 8.2 inches)	171 × 260 × 216 mm (6.75 × 10.2 × 8.5 inches)
<b>Sampling speed</b>	18,000 measurements/second	25,000 measurements/second
<b>Number of cameras</b>	2	3
<b>Laser</b>	Class II (eye safe)	Class II (eye safe)
<b>XY accuracy</b>	Up to 50 microns (Up to 0.0019 inches)	Up to 40 microns (Up to 0.0015 inches)
<b>Resolution</b>	0.1 mm in Z (0.0039 inches in Z)	0.05 mm in XYZ (0.0019 inches in XYZ)
<b>ISO</b>	20 μm + 0.2 L/1,000	20 μm + 0.1 L/1,000
<b>Exported file formats</b>	.stl, .txt	.stl, .txt
<b>Regulatory compliance</b>	CE	CE
<b>Data transfer</b>	FireWire	FireWire
<b>Power source</b>	FireWire	FireWire
<b>Laptop compatibility</b>	Intel® Core™ 2 Duo processor, 1-GB RAM, NVIDIA Quadro NVS 320M graphics (256-MB dedicated video memory) required with Windows Vista®, Business, or Windows® XP Professional	Intel® Core™ 2 Duo processor, 1-GB RAM, NVIDIA Quadro NVS 320M graphics (256-MB dedicated video memory) required with Windows Vista®, Business, or Windows® XP Professional

one end, scale it, digitally attach it to the other end, and print a complete animal.”


What’s more, the scanner’s mobility lets the center and another local museum easily pool resources. “There are lots of objects in the two collections, and it always seems as if the other museum has half of a fossil while we have the other half,” says Lamb. “Now it’s easy to put them together and print a new model to have a whole animal for exhibit, a stunningly affordable method in museum-exhibit terms. In the past, we might have paid tens of thousands of dollars for an expert to put an exhibit together.”

Both the CNC router and 3D printer can use the binary STL file the scanner generates. “Sometimes, I clean up a scan with the Geomagic software that came with the scanner,” he said. “I really like that I can then just push the printer GO button, walk away, and do something else for an efficient use of my time.”

When it comes to the CNC, the center uses ArtCAM for toolpaths. “But for both appli-

cations, we are basically using 3D models straight from the scanner, says Lamb.

In the future, the center hopes to print CT scans. “We learned of a recent example involving conjoined twins,” says Lamb. “Doctors CAT-scanned their skulls and printed results on a Z Corp. machine for a lifelike model that showed the location of major nerves and arteries. The surgeons said the model let them reduce surgical time from 8 to 5 hours. We’re not surgeons here, but the ability to print CT scans has promising applications for our exhibits.”

The museum also plans on using 3D scans in a database built with cataloging software. “Our fossil collection contains several thousand objects, and we are slowly getting them on the computer to go into the online visual database,” says Lamb. “This will let a scientist in Japan, for example, call-up the collection, search for a bone, view it, measure it, and rotate the model in 3D, without traveling to the U.S. Even school kids can find the site useful.” 

# 3D SCANNING, *TO GO*



Z CORPORATION®

FOR MORE INFORMATION ABOUT Z CORPORATION, PLEASE VISIT  
[WWW.ZCORP.COM](http://WWW.ZCORP.COM)