By Doug Cleminshaw, IDSA
Doug Cleminshaw has been honing his private practice I.D. act for two-score plus years now. He loves to design. He loves plastic. He adds IDSA, HFES and SPE after his name to brag about who he pals around with. He promotes industrial design to the point of teaching it on occasion. (And, by the way, he is better looking than this casting.) E-Mail: cleminshaw@aol.com.

Message: We have a new medium—direct 3D electronic communications. As of mid-1999 all the fundamental pieces have been put in place. It is now possible to input and manipulate electronic 3D form by physical touch. Alternatively, existing physical form can be precisely converted to electronic 3D form by touchless—optical—means. Electronic 3D model forms can be sent on the web to any place there is a rapid 3D physical output means—a 3D printer/SLA/CNC—for conversion to physical 3D form. (The cosmetics of color, texture and graphic decoration in electronic 3D form are not yet integral to the 3D physical form as output today, but . . . sometime soon.)

SEA CHANGE

When it comes to computers, my complaint has been that I cannot feel the model I see on the 2D computer screen. I do not know its actual size by experience, nor the feel of a corner radius.

For nearly 15 years, I've been looking forward to being able to literally put my hands into a piece of space, touch my model material and sculpt it with my bare hands—and then remove it as a solid, for perusal. Now I can!

Shoe created using the FreeForm system.

Okay, so I never do any sculpting with my bare hands in real plastilene or automotive clay except the first pileup—I use sculpture tools. I feel the surface of my work through those tool handles and my eyes. And this is what I have now done with my computer—feel and see. Add material and carve it away, under control. Send the output to a 3D printer, a solid-maker. A quick one.

At Siggraph99, Thomas Massie, founder of SensAble Technologies, Inc., showed the convergence of three new technologies on the PC: 3D interactive graphics, 3D point-addressable printers and the 3D touch interface. "Our FreeForm sculpting software ties together these three technologies to enable the beginning of the next revolution—3D desktop publishing. "Imagine it, carve it, touch it, see it and manufacture it —all from your desktop."

Siggraph99 was special; more frequently than usual, I found myself saying: "Darn it you guys! Now I have to buy one of those, too!" First on the list is the FreeForm system from SensAble Technologies (www.sensable.com, 617.621.0150). Its Phantom input device is a nicely designed six-degrees-of-freedom lever system ending in a handpiece/tool handle with a button on it. Along with its FreeForm software, this system is the closest thing I have seen to what I imagined so long ago: feeling—and seeing—what I am shaping with my hands and brain. Experiencing haptic feedback in the technical languages.

Unlike "data gloves" that are great for pick and place maneuvers, the FreeForm lets me stroke the "clay." The software choices allow control over the hardness/softness and the granularity of the material, so that in my mind there is a real clay tool in my hand, and I can feel the clay I see I am working on.

The SensAble Phantom+FreeForm unit on loan to me has been shared with students and faculty at two of my favorite industrial design programs. After a ten-minute general capabilities demo and explanation, students were allowed to explore at will—all with universal astonishment and real desire. And without a need for a manual!

Nice features abound, like symmetry planes, so that you can work on half of the model while watching the result on the whole model—better than a first surface glass mirror!

Switches allow "negative carving," adding clay with the same ease as removing it, so work can be done in the familiar painterly fashion. Bandsaw or wire-cutting abilities make for easy blanking of shapes. The system is very "green" in the studio, with no clay crumbs or plastic foam chips!

The NT computer required has dual processors and

lots of RAM (512K minimum) but is otherwise unremarkable. FreeForm's native file format is its own clay model, plus output in *.stl (tesselated, stereolithography) format, allowing easy model swap into other 3D programs, as well as direct to 3D printer.

Scan

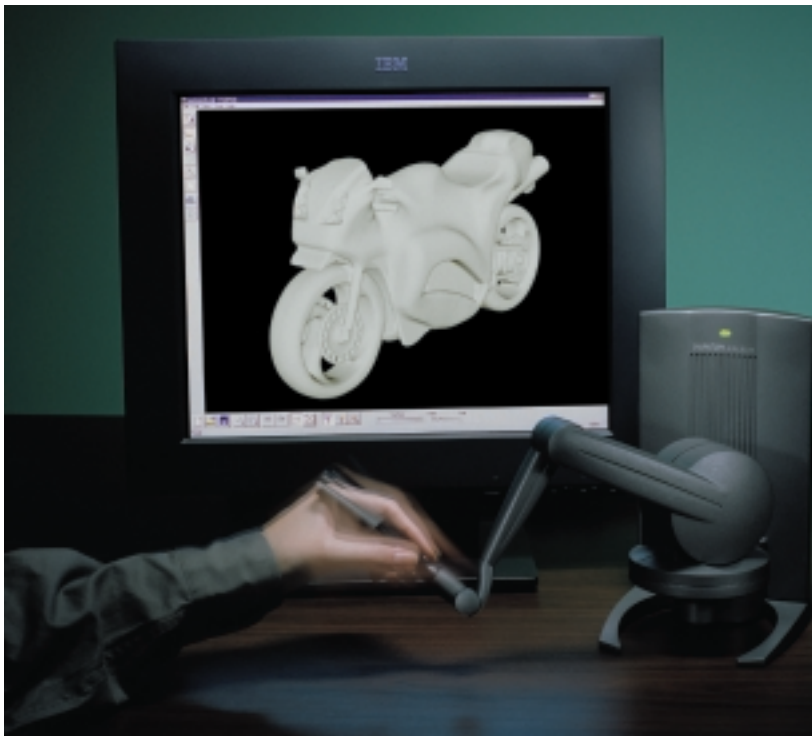
If you still prefer to work in real clay or carving foam, then scan the 3D model into the computer (Phantom+FreeForm or not). To demonstrate, the photo at the head of this column shows a 3D waxlike plastic "print" of how the physical me looked to an optical scanner, at Siggraph99. The "camera" was a Minolta Vivid 700 non-contact scanner, just one of Minolta's optical solutions (www.minolta3d.com; 888.ISD.COLOR ext. 3544 or 201.818.3517). Of course, had my hair and ears and the rest of my head been of interest, I would have been on a turntable and exposed three or more times—to get a model in the round.

Non-contact 3D scanners easily image and digitize a standing human figure, or a tall refrigerator-sized object, all at a single pass. Each scanner supplier touts its own special strengths. Complex motion capture is a huge and very active subset of the specialty of non-contact scanning.

A scanner of particular appeal for industrial design use is the hand-held FastSCAN device from Polhemus (www.polhemus.com; 800.357.3159). With this lightweight 18" (45 cm) "wand" in hand, you use a spray-gun motion to "paint" the scanning subject with laser light while checking the result real-time on a computer monitor. Where you see you need a little more precise data, just go back to the subject and "paint" it in. Computer requirement is a modest Pentium II with 64 Mb of RAM.

Print

Fully dot-addressable 3D output has been available for several years, the most commonly recognized form being hard resin stereolithography models made on 3D Systems' proprietary equipment. Without getting into a discussion of multi-axis CNC mills or other 3D printer suppliers, I will simply assert that the drawback to this process is the time length of the model-to-print cycle, especially when there is a queue for the equipment. Finished electronic model to finished stereolith part is, in practice, measured in days not hours. Too long for instant feedback.



The FreeForm system combines the ease of use and intuitiveness of clay or foam with the power of digital tools. Motorcycle by Matt McGuire.

3D Systems differentiates stereolithography as being a product line for production and industrial applications, with 3D printing being better suited to design office applications. Solid imaging, but of two different types.

As example, that model of my face at the head of this column was made by 3D Systems on a ThermoJet solid object printer. The procedure is similar to ink jet printing, except with proprietary TJ88 paraffin-based thermopolymer, applied molten in tiny drops that immediately solidify into each other. Layer by layer, it builds up a wax-like model up to 10“ x 7.5“ x 8“ high (25 x 19 x 20 cm). The polymer is waxlike enough to use as a direct investment casting pattern. For design recycle, the designer modifies by hand, scans the model back in, then prints the modified version. All this in a machine that takes up no more floor space than a large copier. (www.3dsystems.com; 661.295.5600).

An attractive 3D printing alternative comes from the Z Corporation with its Z402 system, using core technology developed and patented at the Massachusetts Institute of Technology. A big advantage is build speed, at 45 minutes for a typical 8“ x 4“ x 1.5“ (20 x 10 x 3.8 cm.) The model medium is an astonishing starch and cellulose base powder (or alternatively a plaster-base powder), bound together with proprietary liquid binder dispensed from an off-the-shelf ink jet print head to form layers 0.005“-0.010“ (1.2-2.5 mm) thick. Largest part size for the Z402 is similar to the ThermoJet at 8“ x 10“ x 8“ (20 x 25 x 20 cm)—and the machine is light enough and small enough at 300 pounds by 29“ wide (136 Kg, 74 cm) to roll from office to office on its own wheels.

With the Z402 system, no support structure for the model need be created, because all sections of the model have support from the unbound powder medium until fully cured. This feature allows for the building of parts and assemblies that would be impossible on other systems. Completed models for direct handling can be filled with various two-part plastic resins—epoxies, urethanes, etc. Completed parts can be alternatively be infiltrated with non-toxic paraffin wax, to serve as masters for investment casting of metal parts. Metal sprayup of temporary tooling for plastics molding can be used (www.zcorp.com; email: sales@zcorp.com; 617.628.2781).

Instant gratification? Not quite yet, but close enough to be able to say “Sure, we can have a model done for this afternoon’s meeting. It won’t be painted, but we’ll have it!”

Otherwise

Another Siggraph99 display featuring the 3D Systems ThermoJet solid object printer had as its main feature Rhino(cerous) NURBS software, by Robert McNeel & Associates. This compact (installs at 12.6 Mb on NT) inexpensive (US $795) NURBS modeler is what industrial design modeling software ought to be! I had been aware of Rhino previously, but as of Siggraph99 it immediately went to the top of my “gotta have” list.

I’m not about to give up my immersion in Alias Studio, SDRC I-DEAS or SolidWorks, nor stop talking to friends like Side Effects Houdini, Catia and ProENGINEER—but I sure like Rhino as the starting point. I think enough of Rhino to have advised it as the initial software for current industrial design students to learn. Check it out (www.rhino.com)!

What is briefly covered above is indeed a major sea change for all of us who practice industrial design. I personally welcome all of these changes, for I recognize each as freeing a part of my own creative bent from the complex morass of important details that surrounds any project produced by that wonderful medium called industry. Technology serving the cause of freedom for a part of me? I like it! ●