Moving the Virtual into the Physical
Artists Prepare to Explore the New "New Media"

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An overriding theme across all of the arts relative to computing in the 1990's is the emergence of the personal computer as an integral and integrated tool. At the start of the decade, the notion of a virtual artist's studio (recording studio, video production studio, etc.) in a personal computer that could be available to every student seemed a worthy, if distant, vision. Shared use, however, was made possible by the ITS Arts Technology Group within Academic Computing Services, providing students with access to personal computers and arts-related software.

Fig. 1 This piece was created by Eun June Gonzales, an NYU ITP student. A prayer bowl for the cyber age, physical computing technology is used to sense the presence of worshipers and correspondingly modulate the video imagery in the bowl.

These days, access to artist's workstations is increasingly provided by departments and by individual students themselves. Further empowered by the ubiquity of the Internet and the ease of use of the Web, one might wonder whether a sort of plateau in arts computing has finally been reached. Are there new technologies on the horizon that are as technically and economically challenging today as personal computers seemed ten years ago?

The answer to that question is best predicted by examining some of the recent advancements in arts technology in the context of the unique and specific needs of the discipline.

Digital Art and the Real World

Speaking very broadly, most academic computing is an attempt to replicate some aspect of the real physical world in a virtual world so that it can be subjected to further study. Examples might include simulations in the physical sciences, statistical analysis in the social sciences, and conceptual analysis and synthesis via writing and research in humanities scholarship.

This reflects each discipline's non-digital process. Even without computers, scientists or humanists construct mental models that capture and reflect the reality they find in the world. Results ultimately have to be reported of course, but most of the action remains in creating and manipulating a reflection of the world within the computer.

Artists face a different challenge. The traditional artist creates an alternate reality in his imagination that he then extends into some kind of physical manifestation. For the digital artist, the computer serves as a sort of cybernetic dream-space, a place of imagination where the artist can create an alternate reality. But the discipline demands a channel for digital art output that is equal to the virtual object. What artists now seek are new ways to extend their virtual creations into the physical experiential world. Moving the virtual into the physical is likely to be the overriding theme in arts computing this decade. This challenge will be addressed in a number of ways in the coming years, and some of the initial responses are noted in the following sections.

Archival Quality Fine Art Output

Business quality color printing has long been affordable and over the years prices have continued to drop even while resolution has improved. Unfortunately, most of these devices have not been suitable for use by fine artists because the materials used are not of archival quality. There is an expectation that fine art photography and art prints will resist visible fading for well over 100 years, whereas some business quality color output is lucky to last a year.

In recent years, however, archival-quality color digital printing has become affordable and even somewhat commonplace. Devices such as the $900 Epson 2000P bring art-quality output to individual artists. Using six inks, rather than the traditional four-ink CMYK system, the 2000P can print a typical 11" x 17" area and a maximum area of up to 13" x 44". Using a Micro Piezo ink jet technology, the printer offers 1440 x 720 dots per inch. And perhaps of greatest importance to artists, the technology allows the use of long-life MicroCrystal Encapsulated inks and archival quality papers that produce prints that will resist fading for over 200 years. Using a similar print technology, the Epson 10000 can create similarly long-lived output of up to about 44" width and arbitrary length. While this printer is outside the budget of all but the most successful artists and requires some specialized skills to maintain, Epson 10000 service providers can create final output at a very affordable cost. The Arts Technology Group of ITS Academic Computing Services provides NYU artists with access to both Epson 10000 and 2000P printers.

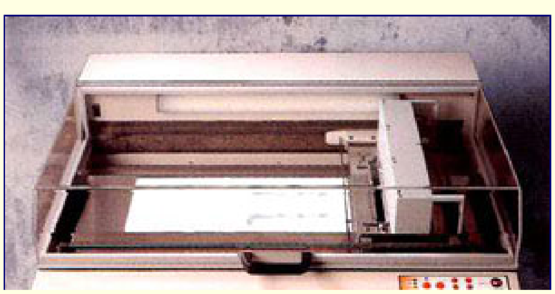
Another alternative is the Cymbolic Sciences LightJet series of printers. The LightJet uses traditional photographic materials from Agfa, Fuji, Ilford and Kodak with archival properties well understood in the art world. Operated by some 500 service providers in the United States, the LightJet creates an apparent 4000 dot per inch photo-print by using red, green and blue scanning lasers to individually expose 300 continuous tone dots per inch using a 36-bit color space. The LightJet can directly expose traditional photographic papers of up to about 50" x 120" in size while bypassing typical large-scale darkroom problems.

Rapid Prototyping Technology

Originally developed to support the industrial design sector, rapid prototyping technology is a cluster of hardware and software that uses digital plans to directly build a physical object. With the ability to bypass expensive and time-consuming machine shop fabrication, industrial designers can freely experiment on their computers while benefiting from the feedback and verification one can only get from handling and fitting together corresponding physical parts. Currently leading the pack is the 3D Printer from ZCorp. The 3D Printer allows an artist to use a 3D modeling package to design a sculpture or other object, and then to "print" that object, creating an artifact that can be directly finished and shown or used as the first step for traditional molds and metal casting techniques. The 3D Printer works by making repeated passes with an inkjet-like mechanism to spray a binder over very thin layers of starch- or plaster-based powders. After each pass, a new thin layer of loose powder is spread over the previous layer and the object is incrementally built up. Once the object is finished, the excess powder is blown off using compressed air. Objects can be up to 8" x 10" x 8"--or up to 20" x 24" x 16" using the largest and most expensive industrial model--with resolutions as fine as .003" per layer.

Fig. 2 This complex sculptural object was created using 3D modeling software, and then directly fabricated using a ZCorp 3D Printer.

The fully formed object can also be further treated with infiltrants that can toughen the material for fine sanding, or even render the material rubbery and flexible. For artists directly creating objects rather than casts and molds, some 3D Printers can also inject CMYK-based dyes to create fully saturated color objects.



Artists are also often interested in creating 2D objects cut from flat materials. Such objects may be components for a larger construction, parts that fit together to make puzzle-like pieces for flat art, or something as simple as engraved text on signs. Laser cutting devices such as those from Universal Laser Systems can cut and engrave sheet materials including acrylic, plastic, rubber and wood to create forms up to 32" x 18" in size. Use of such a laser cutter is safe and simple. Using a popular package such as Adobe Illustrator, the artist merely creates a 2D design with color codes to mark those

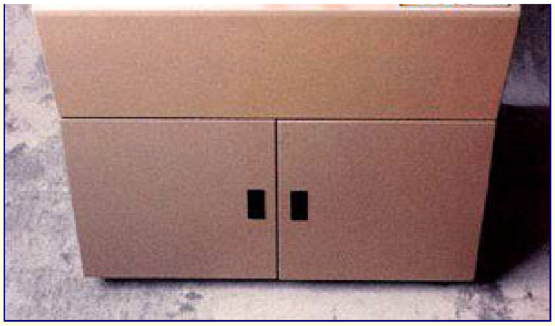


Fig. 3 The ZCorp Z402 3D Printer is an office-friendly rapid prototyping device. Note the powder bed sprayed with binder in the center, and the scanning inkjet device to the right.

contours which are cuts and those which are engraved marks. The software driving the laser cutter takes that file as input and does all of the work. The operator of the laser cutter, however, must first mount the materials and adjust the focal length, speed, and resolution of the laser-cutting beam.

Physical Computing and Robotic Art

For some time, artists have been integrating computers into gallery spaces and other installation spaces. Thanks to improvements in the packaging of electronics and in computing power, it is now possible for artists to cross over into the realm of engineering and to embed computer chips and custom circuits into art objects.

Recently NYU Tisch School of the Arts' Interactive Telecommunications Program (ITP) has underscored this trend by creating a required Physical Computing track. Prof. Tom Igoe notes:

> Physical computing takes the focus of computing away from the computer and puts it on the person. Working with microcontrollers (small single-chip computers the size of a postage stamp), simple sensors, motors, lights, and other tools, students learn to think about interaction problems by starting with the body. They look for ways to capture more of the range of physical expression, and tackle the problem of interpreting expression to produce appropriate responses from a computer, device or installation.

In a similar vein, artists are melding computers and machinery to create robotic art. An event called Artbots (www.artbots.org) is bringing together artists from Columbia University's Computer Music Center, the Madagascar Institute, this author, and various other artists/robot builders from across the country to create a one-day robot talent show on May 25th. The robots will operate autonomously as they draw pictures, play music and otherwise perform in real time for a public audience.

Networked Performance Spaces and Telepresense

The Fall 2001 *Connect* reported on a number of multi-site performances between NYU and various other collaborating universities (www.nyu.edu/its/connect/archives/01fall/galanter1.html). Since that story ran, another significant Internet2 performance took place in collaboration with the University of California at Irvine. "Songs of Sorrow, Songs of Hope" was created as a response to the events of 9/11, and not only used high quality projected video and audio to link two sets of performing musicians at two locations, it also integrated video art and live dance as additional elements from afar. (See: www.nyu.edu/education/music/internet2/).

Internet2 technology has already proven to be a compelling medium for cultural exchange, but there are more innovations to come. In future events we expect to see the use of extended sensory information to interact with both the virtual and physical worlds. The movements of dancers at one site may be mapped into the modulation of sound at another. Computer vision technology may allow virtual actors and musicians to interact with their real world counterparts. Using advanced haptic interfaces, the sense of touch can literally be extended over thousands of miles.

For digital artists, personal computers are a starting point, not a destination. The extension of the virtual into the physical is becoming for today's artists as natural as the extension of ideas into paint in former years.

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