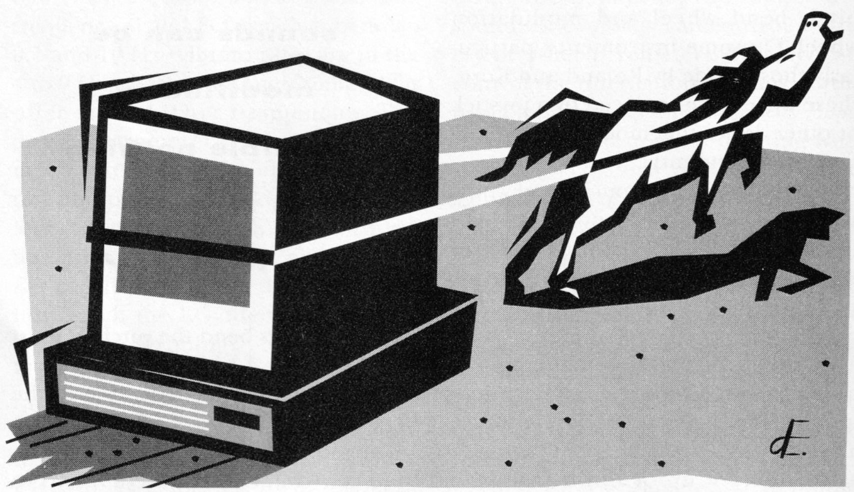
Computer Music Workstations

By David (Rudy) Trubitt

Music software developers harness the DSP horsepower offered by computer workstations.


DAVE EMBER

Let's talk about the *other* workstations. Not the keyboard-synth-sequencer combo, but computer workstations: machines that fall somewhere between relatively inexpensive personal computers and high-performance mini and mainframe systems. The definitions are blurry, but I'll try.

I think calling a computer a workstation means it's not an IBM PC or compatible, Apple Macintosh, Atari ST, or Commodore Amiga. Now, before those manufacturers come after me with lit torches, let me qualify that. It's not that any of these machines couldn't be configured as a workstation. It's just that the basic, entry-level machines from workstation manufacturers generally are more extensively (and expensively) configured than baseline personal computers. Workstations have faster processors with more memory and disk space than entry-level personal computers. Also, most workstations run some variant of the multitasking UNIX operating system, support SCSI, and have Ethernet (a high-speed local area network) built in to their basic configuration.

So, to what sort of musical purpose might we turn the PC's larger cousins? This month, we'll take a look at the sonic possibilities of two machines: the Silicon Graphics Indigo and the NeXTstation. Once we cover the particulars of each machine, we'll spotlight two cutting-edge musical applications of this technology.

SILICON GRAPHICS INDIGO

From a company with a name like Silicon Graphics, Inc. (SGI), you'd expect the computer to have strong visual capabilities, and you would be right. Many of the gee-whiz computer graphics we're used to seeing come from SGI machines. Last summer, the company introduced the IRIS Indigo, which lowered the price of these systems to the four-digit range.

The Indigo is a small box, just over one foot tall and nine inches wide. It's powered by a MIPS R3000 RISC microprocessor, rated at 30 million instructions per second. The system can hold from 8 to 96 MB of RAM and includes a Motorola DSP56001 chip.

On the audio front, the Indigo is equipped with stereo, analog and digital (AES/EBU) audio ins and outs. It supports stereo sampling rates from 8 to 48 kHz, with 16-bit resolution. There also is a mic input and a headphone output. While the Indigo has no built-in MIDI ports, it works with standard Macintosh MIDI interfaces. The base Indigo ships with a 420 MB, 3.5-inch hard drive and has room for two additional SCSI devices. A floppy-disk drive and DAT backup also are possible options. Interestingly, their DAT deck can operate in data or audio mode.

Silicon Graphics' commitment to digital audio is well-represented by musician/programmer Roger Powell of *Texture* and Utopia fame. "SGI views itself as a computer manufacturer, not a software developer," says Powell. "However, we've concentrated on developing the tools to get people started [a library of low-level software routines]. We are developing some simple programs, too.

"We have a third-party developer's program going," Powell continues. "I'm pleased to announce that we'll be working with WaveFrame. They are developing *TidalWave* and *TidalWave Pro*, which are 8-track hard-disk recording and editing applications for the Indigo. In addition, they are interested in using the Indigo as the front end for their existing system to provide much greater performance than they've had with PCs. Also, they may develop a package that will run stand-alone on the Indigo.

We view them as a key professional-audio developer for our systems."

But what about MIDI? "Again, we've produced a library of basic MIDI calls," says Powell, "One of our key developers in this area is Blue Ribbon Sound-Works, who is well known in the Amiga world. It turned out to be a good fit for them, as the Amiga is multitasking and has a graphics and video orientation. The Indigo represents a powerful implementation of these features, and they're excited about porting their sequencing applications to SGI."

Who might need an SGI machine? Those involved in computer-generated visuals who also work with audio are the most likely candidates. After all, a fair chunk of the Indigo's cost—the base model lists for $9,500—is related to its high-speed graphics. While release dates have not been announced for WaveFrame and Blue Ribbon's products, once they are available, I'd encourage anyone who requires (and can afford) high-performance graphics to consider the Indigo for their MIDI and digital audio needs. While I haven't played with the Indigo, I've had years of good experiences with Silcon Graphics' earlier systems for graphics applications.

THE NEXTSTATION

Introduced early last year, the NeXTstation uses a Motorola 68040, running at 25 or 33 MHz, holding anywhere from 8 to 128 MB of RAM using 16 MB SIMMs. A base-model machine costs $4,995. The NeXTstation has a slotless, pizza-box-style case, a departure from the 3-slot NeXTcube, which is still available. (Both models have the same computing power.)

One of NeXT's strengths is its user interface, called *NeXTSTEP*. *NeXTSTEP* includes a suite of objects and object-oriented development tools that greatly simplify programming chores. The underlying operating system that runs *NeXTSTEP* is a variant of UNIX called "Mach," which was developed at Carnegie-Mellon University as a multiprocessing OS for super-computers.

Like the Indigo, the NeXTstation uses Mac MIDI interfaces, although not all are compatible due to serial-port differences. All NeXT machines have CD-quality D/A converters and a microphone input. For sampling applications, you must connect an external analog-to-digital converter to the NeXT's built-in DSP chip. One such peripheral is Ariel's digital stereo microphone, which has its own built-in A/D converters and connects to the DSP port. According to NeXT's Rob Poor, "Our DSP input port is a very efficient way to get real-time data, such as digital audio or digital video, into the machine. These [A/D converter] interfaces can sell for under $500 because a lot of the work is done by the computer's internal DSP."

The DSP chip also can synthesize sounds with up to 9-voice polyphony, using FM synthesis, the Karpus-Strong plucked-string algorithm, waveshaping, and wavetable (sample) playback. A variety of music- and sound-related source code is provided with each machine. "We don't run *Vision* and *Performer*, but these kinds of programs are coming," Poor continues. "The real advantage of the NeXT is integrating MIDI and digital audio."

Lots of digital audio hardware is available for NeXT, and a lack of commercial music software hasn't stopped people from successfully using the machine. Let's look at two applications done with custom software.

NEXT SOUND

Tom Hajdu and Andy Milburn use NeXT computers to create sound for music, advertising, and film projects. "We write all our own software because there's very little music software available for the NeXT," Milburn says. "We're using the machines as bizarre signal-processing engines. I like to write weird, Rube Goldberg-like software that mutilates sound in an out-of-control way. We dump hours of sound into the Cubes and subject them to random processing. Then, after a day or two of crunching, we cull through the aftermath and find pieces of sounds that are useful. The results are almost always used as components of bigger pieces, although once in a while an emission from the Cube stands on its own."

Regular MTV viewers have heard the duo's work. "There's a spot they've been running for years, called *Words*," says Milburn. "It's just white text on a black screen that comes up for 60 seconds and derides the viewer for sitting still and watching MTV. We've got this creepy, industrial choral track that hammers away behind it. That's mostly the result of extreme time-expansion algorithms that we love to play around with. I think it's human wailing that's been stretched by a factor of 50 or 100, so you get all kinds of gross artifacts."

Although most of the team's software is based on one sort of digital signal processing or another, surprisingly little of their code uses the Motorola DSP56001. "Almost everything I write is in Objective C, with the crunching done by the main CPU," explains Milburn. "I don't do much DSP code. We do use it for more menial tasks, such as rescaling a floating-point file into integers, or Fourier transforms. You end up using the DSP as an engine for brute-force, repetitive calculations and not the more racy, weird things." (SGI also requires developers to do their DSP algorithms on the main processor, as their 56001 is not directly programmable by users.)

NEXT MUSIC

Musician/programmer Michael McNabb began his relationship with NeXT by working for the company. "When I came onboard as a consultant," says McNabb, "I had this concept for live-performance software that would be smart enough to anticipate like real musicians do while I improvised. When you're playing in a jazz band, every player is subconsciously analyzing the rhythmic and harmonic structure so they can anticipate what's happening. The computer usually lacks this ability."

McNabb sought to develop a program that would listen and respond to his performance. The program he developed, *Ensemble,* is included (with source code) with every NeXT machine. *Ensemble* "listens" to the player's MIDI performance, not to acoustic instruments. Any MIDI controller can be used; McNabb plays a soprano sax running through an IVL Pitchrider. The music he coaxes out of the system is a remarkable, often inseparable blend of saxophone and synthesis.

Ensemble is a document-oriented program. Each document is a particular configuration of MIDI input data, followed by MIDI processing, which in turn creates MIDI output data, NeXT DSP-based synthesis, and/or soundfile playback. Each input-to-output group is referred to as an "Instrument," and each *Ensemble* document can have up to four instruments. *Ensemble's* MIDI processing includes note-range limiting; controller, note, and chord mapping; MIDI delay; and data-thinning. A gate function can be triggered by any MIDI controller (such as a sustain pedal) to interrupt and restart the flow of notes into any *Ensemble* instrument.

Ensemble's "ears" result from its use of fractal equations. The fractal melody-generator creates phrases from a preset or dynamically changing set of notes. The specific fractal equation that is used affects the contour of the melody, while sliders give you control over higher-level aspects such as the ratio of notes to rests and note duration. Notes in the set can be weighted arbitrarily by the user, or inferred from the input stream based on how often each note is repeated, how long it's held, or how loud it is.

"In performance," explains McNabb, "I use a dynamic mode, where the note set is built up from the notes that come in from the sax and Pitchrider. You can set how many notes it remembers and whether they're sorted by pitch or by the order they come in. If you sort them by pitch, you get harmony similar to what you're playing, but the melody will probably be different. If you preserve the note order, it plays things more like the melodies you played. It's fun to play against; it comes up with stuff I try to play off of."

The notes produced by each of *Ensemble*'s four instruments can be output as MIDI notes and controller data, or generated by the NeXT's internal DSP. One interesting DSP application is the creation of new harmonics based on the fundamental pitch of the current MIDI note. These added harmonics track Pitch Bend in real time, essentially becoming part of the sound of McNabb's sax. The result of this "additive" signal processing gives his horn a unique, bowed metallic edge.

Ensemble requires a lot of computing power. "When I was developing the software, I was using a 68030 version of the machine," says McNabb, "and it turned out to be too slow. It wasn't keeping up with the MIDI processing. Responsiveness is critical, and there's no substitute for horsepower." And computing horsepower is the key workstation advantage.

After hearing a computer actually participate in a musical performance, **David (Rudy) Trubitt** *vowed never to sequence again.*