While music transcends its time, it eagerly adopts the current technology. Musicians, like anyone else, use new instruments and procedures to reach their desired goals. In the age of computers, this is producing some fascinating results.

Computer-Generated Music

Denis L. Baggi, Xi Computer Corporation

Computer music has existed as a formal application of computer science for at least 35 years. The idea has existed much longer. Ada Lovelace suggested the use of machines in composition a century and a half ago. As far back as the Middle Ages, man merged technology and music in the form of clockwork mechanisms, carillons, and the like. The development of technology for fashioning pipes and mounting strings led to wind and string instruments, enriching the music of the day, just as computers are enriching modern music.

The field of musical composition is changing dramatically. Fast, easily programmed computers allow the composer greater flexibility and a richer source of sounds. These advances result from a marriage of computer and musical expertise.

Computer music has come to mean two things: the direct synthesis of sound by digital means and computer-assisted composition and analysis.

The computer as a musical instrument. In the forties and fifties, new musical sounds were produced with the help of tape recorders and electronic devices, techniques promoted by adherents of Musique Concrète in Paris and Elektronische Musik in Cologne. While the first method favored processing of sounds that originate in "nature," the second emphasized electronically produced sounds — from sine waves to noise. Both techniques contributed to new ways of defining musical composition.

Because analog sound can be approximated by a series of numbers, computers can be used to store and manipulate sounds. Early programs computed sound samples on digital tape which, when put through a digital-to-analog converter, let the programmed sound be heard. It was clear, even at an early stage, that the programming of such systems was cumbersome and time-consuming, in spite of
such computer languages as Music V2,3 to facilitate encoding. These languages implemented primitives — in the form of subroutines — for such synthetic instruments as oscillators, envelope generators, adders, and multipliers (similar to patches in analog computers).

Researchers initially achieved interactive control of the sound-synthesis process in the late sixties through the use of digitally controlled analog machines.4 Eventually, fast digital processors allowed digitally controlled, highly precise, and rapid sound synthesis, due to the direct connection to a host computer. This favored the design of serious musical instruments and caused the emergence of standards.5

Composition and the solution of musical and musicological problems. The advent of artificial intelligence promised the application of computers, not as mere number crunchers, but as symbol manipulators. As a consequence, while numerical methods had been employed in sound-synthesis processes, symbol manipulation and other AI techniques brought new solutions to music theory problems.

Although algorithmic composition can be traced back to the Würfelspiel of Mozart or Haydn (p. 48 of reference 8 and p. 54 of reference 9), the first known computer-generated composition is the “Illiac Suite.”6 It employed a variation of the Monte Carlo method in which notes of a composition written for a string quartet are generated at random and filtered according to a statistical or heuristic technique.

Computer music has evolved to the point where such widely varying problems as harmonization in Western music, Javanese music, jazz, and medieval Masses have been successfully undertaken.8 Programming languages such as Fortran, Lisp, Snobol, and C have been widely used in the generation of music. Similarly, computer disciplines such as expert systems and neural networks10 have advanced computer-generated music.

The pleasure of music comes in its perception, which — as opposed to context-free grammars and computer languages — is hard to model within the constraints of digital systems. Advances in computer-generated music parallel those in the field of visual perception, such as graphics and visualization, and contribute increasingly to the mainstream of computer science. Music, with its rich syntax and subtle semantics, is an excellent vehicle for fundamental research in computer science,11 which as a whole benefits from insights gained by such efforts.

Contemporary trends. Unlike the devices of the forties and fifties, modern hardware lets a sound be heard immediately after it has been conceived. Sound synthesis and algorithmic composition tend to be merged. While research laboratories still study the nature and synthesis of sounds (IRCAM in Paris and CCRMA at Stanford University), most users are satisfied with the sounds created by modern synthesis machines, which are inexpensive and readily available.

A significant reason for this is the MIDI (Musical Instrument Digital Interface) standard,7 which has defined among other things the communication between musical devices such asexpanders, synthesizers, keyboards, and MIDI instruments. These instruments may be wind controllers, saxophones, guitars, trumpets, drums, and even the digitized voice, as in the case of pitch-to-MIDI converters. MIDI is a hardware specification for a serial port and a protocol for transmitted symbols that may represent note, velocity, channel specifications, controllers, and exclusive messages to control a device. At a higher level, MIDI is also a standard for structuring files of musical data.

With some sequencers (software that lets a home computer record and store pieces of music and communicate with the synthesizer), users can point directly to a musical score on the screen to view the notes they have played or to hear and edit the whole orchestra. Such advanced user interfaces — unthinkable just two decades ago — dramatically change musicians’ approaches to composition and performance.

The music and sounds generated by most of the projects in this issue have been produced by MIDI. The standard has made sound synthesis easy and available to everybody, has permitted musicians to merge equipment from different manufacturers, and has encouraged researchers to exchange software and data.

The exponential progress of computer technology has affected practically every discipline, scientific or humanistic. A yearly doubling in performance not only implies qualitative changes but also causes radical jumps in the use of technology, as shown by the different interfaces represented by punched cards, terminals in time-sharing systems, and personalized graphic user interfaces.

The use of computers in music is revolutionizing established musical credentials or procedures. While some Hollywood movies show nervous composers struggling with paper and pencil over a grand piano or trying to listen to an orchestra inside their heads — as Mozart does while he dictates his “Requiem” to Salieri in the movie Amadeus — musicians of the nineties click a mouse on the score in a window and immediately hear the effect through a synthetic orchestra. No doubt the very essence of composing is changing. As yesterday’s difficulties are mastered, emphasis passes on to something new (the multiplication taught today in elementary schools was a subject for the most advanced Italian university students in medieval times).

Future trends. Musicians will no doubt exploit any advance in technology, digital or otherwise — as they have for at least the last 40 centuries. Due to the rapid growth and general availability of standardized hardware, it is unlikely that specialized architectures may be widely diffused. The emergence of workstations with built-in digital signal processors connected to ordinary main boards encourages the adoption of standards.

A major trend in modern computer music is that of multimediality. The combination of music and other expressive media is as old as music itself, as exemplified by dance, ballet, and musical theater. A typical example is the combination of video, such as graphic synthesis, and sound. Since the same technology underlies artistic creativity using these media, it is not unlikely that the traditional boundaries between artistic disciplines may begin to wither away, or that new kinds of artistic creation, possible only with computers, will come into being.12 [See “About the Cover.” p. 4.]

The projects in this issue. The articles represent a wide spectrum of research interests and show what is possible to obtain with contemporary technology.

The main purpose of this issue, and of the music that goes with it, is to dispel the notion that computer music is only a
Virtuosity alone does not make good music, and too much technique diminishes the quality and mars the semantics. In other words, the technique — musical, electronic, digital, or what have you — must always serve the music.

These articles were chosen because they represent a significant effort in the direction of music quality, at the level of tools, composition strategies, representational models, and abstract methodologies.

Long and short articles show the variation of activity in computer-generated music. The long articles give insight into important aspects of the topic, while the project overviews concisely show the rich and varied nature of this promising aspect of human endeavor.

Audio examples for this special issue are available in the form of a compact disk or audiocassette and may be purchased according to the instructions on the next page. Maximum benefit is obtained by first reading the articles and then listening to the examples. The authors/composers do not hide the electronic nature of their work. However, the musical quality is similar to, though distinct from, that generally associated with acoustic music.

At one extreme, computer musicians demand "faster" and "more powerful" operation the same way everyone else does. (Better hardware and software may contribute solutions to hard problems like analysis, where syntax depends on musical semantics.) At the other end, music encoding has been reduced in size (from pulse code modulation to MIDI) by at least four orders of magnitude. In fact, all known music may now be stored on a few compact disks (see M. Hawley, "The Personal Orchestra, or Audio Data Compression by 10,000 : 1," in Computing Systems under "For more information.

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References

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