THE DEVELOPMENT OF A COMPUTER MUSIC FACILITY
AT THE
AMERICAN UNIVERSITY

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I. Abstract
This is a report on progress being made by a comparatively small electronic music studio toward obtaining a basic capability for the exploration of computer music on limited funds. Computer music has a complex history; one which is particularly difficult for any small studio to keep up with. Such a studio will not have any of those systems or facilities which are usually the result of long-term research programs. These systems are difficult to either obtain or create, and they have large hardware and programming time requirements that must be met before any music can be made. We have opted for the approach of distributing the work of such a system among several smaller and less expensive machines. This "modular" approach, and the growth of our ideas as to its application, should be of interest to anyone who wants to do neat things on a small budget.

II. Motivations
Computer music has become a broadly defined field. There was a time when the term was restricted to the generation of timbral or temporal profiles by algorithmic processes, with these processes either modeled on acoustic properties as revealed by analysis, or almost purely abstract in nature. The development of more sophisticated and flexible interfaces to these kinds of systems for programmers and composers opened up the field to computer-assisted score creation, editing, and realization, as opposed to computer-generated, -edited, and -realized scores. Lately, with the advent of very powerful and inexpensive stand-alone sound generators, and of the MIDI communication protocol, the computer has become a mediator, linking and processing the flow of real-time control, and therefore of the most immediate creative energies, between composers, performers,
and instruments.

There are, of course, many other threads of development worth noting as well, but the particular path just described has a special significance to the authors. Specifically, it is the path of insertion of the human element into computer music. A driving interest in our studio has been to make the sound pallettes, compositional techniques, and performance options of electronic music available to the entire range of our undergraduate and graduate enrollment in the Audio Technology program, in which two semesters of sound synthesis work is required. We strive to develop the student's intuition, the 'feel' for programming and production, while maintaining a healthy respect for fundamental principles and procedures.

We do this by developing the student's skills on several different systems, each of which supplies different kinds of emphasis to those mental models for which material is supplied in lectures, and massages the trains of thought that we are attempting to install. When these skills reach a certain level of immediacy in the student, when the model's parts are well-formed and the basic techniques can be implemented at will, then the systems can be linked. With all the elements on-line, the model's parts can be fitted together according to the student's own modes of synthesis.

III. Studio History

It must be said at this point that this direction of development in our studio was not intentional at its inception. The growth of the studio, and of our ideas, has been rather organic, one, its importance within the program and therefore the attention paid to its productivity shaped largely by funding constraints.

At first, of course, there was a tape system, as befits an outgrowth of an Audio Technology program. Soon afterward, a Moog System 55, originally purchased by the University's Music department, was obtained on 'permanent loan'. This system, and subsequent serious compositional efforts in the areas of electro-acoustic and synthetic music, was undertaken by a fellowship of teachers and students known as the 'Friends of the Electronic Music Studio', and represented the first emphatic interest in the field on this campus. Some years later, after several changes in personnel, the first computer to be dedicated to the studio was purchased; an Apple IIe, and with it the now well-known Mountain Computer digital synthesiser cards. Immediately, interest was generated in various aspects of computer music, and not only did the bouchezher and Music Composer software provide the impetus for a whole new line of teaching, but several independent projects were started, exploring the newly opened
windows into additive synthesis, Fourier analysis, graphic
display, analog/digital interfacing, and more.

Some time after that, we purchased a DX7 on a research
grant, and here, as everywhere else, the world broke open.
The accelerated revolution in electronic music hardware,
particularly in the area of real-time performance control,
made profound changes in our perceptions, and in our methods.
At the same time, however, we did not succumb to 'MIDI
madness', and it was the conscious effort not to do so that
shaped our current mindsets. Rather than abandon the
'obsolete' technology, as has been common in the academic as
well as commercial arenas, we assimilated the new. Rather
than taking the new information to be taught to the end of
an already extended lecture/lab course, we re-worked the
entire course of study into a new whole, teaching Sound
Synthesis in modular components that deal with all available
aspects of any given topic.

However, despite these and other structural and
philosophical changes which were, to us, quite extensive, we
still lacked the capacity to explore 'computer music' in any
real definition. We have not had the money to purchase any of
the larger-scale computer systems on which such projects are
usually founded. Consequently, we have not had the tools that
might interest any but the most expert and intensely
motivated students. As well, those systems that did exist
were unwieldy and frustrating for those that might have been
able to provide the tools. And so costs, in terms of money,
time, and rewarded effort, have until now proven too
high to allow computer music to be pursued with any real
vigor.

But it is truly astonishing what less than a thousand
dollars worth of IBM clone, plus tapping the talent and
energy of people literally waiting for an excuse to perform,
can do.

IV. Studio Orientation

We have developed a physical system and an appropriate
philosophy that works quite well. We understand that,
lacking certain resources, it is unlikely that we will be at
the forefront of research any time soon. What we can do,
however, is bring together the distilled results of such
research so that we and the students can both enjoy the
immediate applications of these tools, and expand upon their
creative potential in a working studio environment. We have
developed a lab for trying things, for playing around with
ideas, and for the deliberate care and feeding of
serendipity.
A. Synthesizers

One of the most significant patterns to take shape in the studio is given both by the history just described and by our recent assimilation of that history into a coherent plan, in the modularization of hardware. There is no single master tone generator in the studio. We have not in any way dedicated ourselves to any single mode of synthesis. Instead, we have attempted to maintain representative examples of all of the mainstream synthesizer types. These include the Moog System 55 console, the Yamaha DX7, an Akai S912 sampler, an Oberheim Matrix 6, the Passport Soundchaser and Decillionix DX1 (an 8 bit sampler card for the Apple IIe), and various subsidiary equipment, such as a Yamaha RX11 drum machine, a C5M computer with SPG-05 sound generator (a 4 operator FM module), a PAIA Vocoder, and a Roland MC-202 MicroComposer. With these devices, we are able to generate a respectably broad palette of synthetic tones, as well as teach the basic principles of several widely variant sound technologies.

B. Computers

As support and control for these sound systems, we have five computers; until recently, an Apple II+, the Apple IIe and Yamaha C5M already mentioned, and a Commodore 64 have been the mainstays of our digital domain. We have just added an IBM PC XT clone.

C. Effectiveness

This array of equipment, while perhaps less elegant than either dedicated WK workstations with tape drives and DACs, or a full-blown Synclavier system, has several virtues. First, it is inexpensive in its parts. As perhaps the most interesting example, an IBM look-alike can now be purchased in parts from discount mail-order houses for something on the order of five hundred fifty dollars, which will get you 640Kb of memory, two floppy drives, and a color card driving a monochrome monitor. Now that's what we call cost-effective.

Second, there is a relaxation in the distribution of burden in the system. No single unit is required to do everything, and each unit's potential can be maximised according to its specific qualities. A corollary of this is that, if no unit or combination of units does exactly what one wants, one can build or buy add-ons, updates, or whole new systems at a very reasonable dollar/effort cost. All one has to keep in mind is to not be completely seduced by the market into believing that if something isn't the newest, most exotic, or most expensive thing available, then it must be obsolete. For example, anyone familiar with the Moog will
have developed their own, probably baroque, method of extracting non-4/4 patterns of greater than twenty-four notes out of the sequencer. The Roland MC-202 MicroComposer is a sequencer that, until recently, sold for about $300 retail. It syncs to tape, uses Roland DIN (24 pulse/quarter note) sync, contains a monophonic synthesizer, and has about a 2000 event capacity for variable pitch and gate time events in two parallel, independent tracks, which appear at the back as controls voltage and gate outputs. And it is pre-MIDI, so is being 'dumped'. We bought one for $80, and the Moog is extremely happy.

Third, the system as a whole is more accessible, and easier to use. A student does not have to learn the interfaces, controls, languages, and subsystems inherent in large scale installations in order to simply make nice music. At the same time, the power is there to link all the units together, through audio mixers and MIDI patchers, and create a custom configuration.

D. Software

The other pattern of modularization that has emerged from our purchasing history is that of software. Small computers are inexpensive, and so we have found it effective to obtain several of these, as opposed to any single larger system. This has allowed us to dedicate each computer to only a few functions. Thus, without needing a large multi-tasking system, which would be expensive to buy, time-consuming to create, and difficult to integrate, we can have several important utilities on-line at the same time. All that is required is that the audio signal flow and the data paths be routed appropriately, according to the pedagogic need or artistic whim of the moment. This approach has provided us with all the benefits of the hardware modularization described, with the additional advantage that no single device carries the burden of the studio. We are not, for instance, dependent on the Apple's functioning on any given day, because we have several types of similar programs available for all the machines. New ideas are easily implemented through the purchase of a new program or computer or accessories and are just as easily integrated into the existing facility. The facility itself is not standardized toward any single, or even few, modes of operation. Different devices, different programs, have different functions, as well as different 'feels' within similar functions, and random access to these is as important as a full range of colors on a palette is to a painter.

E. Homebrews

Another advantage to having several smaller computers at
hand in the studio is that it is easier to produce 'homebrew' software, which is of major interest here. The computers are familiar to many of our students, which makes acquisition of programming technique a great deal easier to accomplish. We pursue this course for two reasons. First, to reiterate a recurring theme in this Newport, it is cheaper. Second, and really more important, is that there is a distinct cognitive difference between just using something, even to the point of mastery, and actually building it. As an educational facility first and foremost, we feel that it is critical to instill a real 'hands-on' intuition for the tools that we make available. Also, this process not only helps to enlighten some students, but those who pursue it with enthusiasm make significant contributions to the studio, as well as their own education, through the application of their insights.

A final point in favor of the studio's organization is that the room is specifically designed as a multi-user facility. Since there is no 'central' system, several people can be working on different phases of their projects simultaneously, without significant interference.

It is in keeping with these philosophies, and in particular the last, that the IBM we have recently purchased is being installed, not as a final 'master controller' which will make all other systems subordinate, but simply as another module, representing certain expanded capabilities. It is true that, at this moment, a great deal of effort is being focused on it, but the thrust of the work is to use the machine to add options to, not consolidate, the functions of the studio.

V. Studio Functions

The studio has four primary purposes. First, it is a teaching facility. As such, it supports its parent Audio Technology Program by providing a lab in which the fundamentals of audio recording and signal processing can be taught. It also provides the utilities for teaching three distinct, parallel courses of instruction: in sound synthesis technology, in applied synthesizer programming and recording, and in electronic music composition.

Second, it is a performance studio, containing a multi-track tape facility, as well as providing a full range of utilities. Among these are sequencers, control-voltage and MIDI, sequencer-oriented and real-time; libraries for patch and other data storage; processors, audio and MIDI, for a broad range of effects types; controllers, control-voltage and MIDI, and programmers, for rack-mounted synthesizers, as well as for configuring the system quickly on start-up. One of the main uses of the IBM in this capacity will be as an
integrating unit, a sort of master synchroniser for much of
the above.

Third, the studio provides support for a recent project
at the University, which we are calling TAU-M0. The American
University Music Lab. With support from the Mellon
Foundation, an on-campus composer, Jerry Sapieyevski, is
collaborating with the authors on the development of a
portable performance system, in which a Kurzweil MidiBoard,
enhanced by being processed through an Atari ST-series
computer, drives an array of Yamaha, Oberheims, Akai, and
Roland synthesizers and processors. This system, which has
already been used in performance with the ensemble Syzygy in
Washington, D.C., will soon form the core of an entirely new
course of studies in electronic music orchestration and live
performance methods.

A. Research

Last, but by no means least, the studio is a research
laboratory, and it is here that the acquisition of the IBM
clone has made its greatest impact. To begin with, it has
allowed us much greater speed and flexibility in one of our
most fruitful current pursuits; that of making FM synthesis,
as represented in the Yamaha DX7, a great deal more
intuitively approachable. We have just released the first
version of our "DXTutor", and work on its successor proceeds
apace. We hope to eventually present a tool that freely
translates between Fourier spectra and FM programming
parameters, while providing a full range of dynamic controls,
informative displays, and MIDI linkage between the computer
and synthesizer.

On-going research also includes the area of psycho-
acoustics. Here, the computer will be used to generate
waveforms from a variety of techniques, and load them into
the studio's sampler for playback and aural comparison. We
can also take control of playback pitch in all our machines,
allowing the exploration of alternate scales and pitch
programming research by one of our interested graduate
students.

These same techniques will also, of course, enhance the
performance aspects of the studio, as now, using the sampler
as our 'sound file', we can make use of the various exotic
forms of wave synthesis, such as Karplus/Strong and VOSIM, in
our compositions.

In the area of composition, the accessibility of the
computer, along with the ease of learning and application of
higher-speed compilers than are available on lesser machines,
have made it possible to teach just about everyone to program,
and we now have an undergraduate undertaking the task of
writing a computer-composition program, the first one that
will ever exist in this lab.

It is our intention to guide the development of work on the IBM clone in the direction suggested by Shawn Decker (Decker et al., CMJ 1986). We are constantly overseeing the programming projects involved, to make sure that, while useful in their own right, they all enhance, in some way or another, the 'system' as an abstract construct. The machine is small, after all, so we can not install any kind of shell that would make it recognizable as a 'control unit' or 'workstation' unique to the studio. Nor can we expect true multi-tasking. But DOS version 3.0 and higher can 'pipe' information, in the form of temporary files, between programs, and we believe this is sufficient. With an agreed-upon command and file structure, using the various programs that people are writing as 'modules' of a system, we can obtain a small-scale version of the ideal.

VI. Futures

And so it goes. A continual process of acquisition and integration. Already, with those things described above literally just under way, new plans are being considered. SMPTE synchronisation will be added to the room, with all its attendant processing equipment, in order to allow us to support the needs of the University's School of Communications' Film and Video department. Even now, we believe that one IBM isn't enough, and plan on installing an Atari ST. Investigation is being done into the acquisition of a nine-track tape drive and DAC for either the IBM or a DEC PDP-11 to which we have access. Such an event would open up a whole new set of possibilities for us, such as sound file storage and other 'classics' modes of computer music with which many readers of this Report will probably be familiar.

Clearly, there is a lot of work to be done. Among other things is the need to communicate. As a group, we do like to tinker, but we're not crazy enough to try to re-invent the wheel. To that end, we are opening ourselves up, and announcing our presence. For instance, event-lists are going to be an issue, as we begin to try to integrate the outputs of the various program modules that are being written. We need, therefore, to talk to those with experience, as at Northwestern and Toronto. We know that there is a lot to learn. We believe, also, that we have, if not the physical wherewithal, then the energy and creativity to provide some real contributions to the field of computer music.