THE MICRO-COMPUTER AS AN INPUT DEVICE FOR MUSIC ANALYSIS OR COMPOSITION BY COMPUTER

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The need to "translate" standard musical notation into alphanumeric data has caused major difficulties for those using the computer as a tool in music analysis or composition. To date, most of the more than forty methods developed have depended on some sort of music representation utilizing the standard ASCII character set. DARMS developed by Stefan Bauer-Mengelberg[1], MUSTRAN developed by Jerome Wenker[2], and the "Plaine and Easie Code" with its' extension ALMA developed by Barry Brook, Murray Gould and George Logemann[3] have been the most widely used and seem to be the most fully developed. Such representations are far from ideal. It is necessary to learn and use a whole new set of symbols to replace the conventional symbols of notation. Making this "translation" can introduce errors into the material. Checking the encoded music is time consuming and difficult because of the unacustomed symbols.

Other methods of entering music into computers have also been tried. Among them: music typewriters[4]; playing the music on a keyboard instrument[5]; the light pencil and cathode ray tube[6], and optical scanning of previously printed music[7]. Each of these methods suffers from one or more of these weaknesses: The equipment is highly specialized and quite costly. The theoretical capabilities exist, but

in addition to special hardware, highly complex software remains undeveloped. The input device (particularly true of the music typewriter and the idea of playing a piece at the keyboard) lacks the needed characters and/or flexibility to input all of the relevent information.

What is really needed is an input method that would: allow the musician/user to work with standard notational symbols; allow easy visual and aural checking of the entered material; and that would be inexpensive enough to be economically feasible. This report describes the first steps toward such an input method.

My work began as part of an ongoing effort to develop ear-training programs using a micro-computer. Micro-computers are rapidly becoming a part of the American scene. When Commodore announced the PET home computer in 1976 they were so swamped with orders the demand could not be met. The computer I use, the APPLE II is in such demand that some Minneapolis outlets can not keep a display model in stock. About a year ago I made an examination of the then available micro-computers to see if any might be suitable for ear-training applications. I felt such a machine needed to provide generation of at least one pitch at a time, be capable of reproducing music notation on the display screen, and to be reasonably inexpensive. The APPLE II meets all those needs very well. In addition, it can be interfaced to most large systems through an RD-232 interface, and the company provides disc drives, printer interfaces and

other items to expand the usefulness of the micro.

The programs being shown today are a logical outgrowth of several programs being developed for melodic dictation work. The user types the notation symbols on a simply modified keyboard. This allows him to work directly with music notation in much the same way some music typewriters would. However, the computer keyboard can be "redefined" at any time. It is not limited to some 48 symbols as is the music typewriter. As the user enters the notation it appears on the display screen. Notation on the screen may be edited at any time. Once the basic notation has been entered supplementary information may be appended. The computer will "play" the music notated on the screen with correct rhythm and pitch as an aid in checking accuracy. My method could easily be expanded to include any symbols a user needs. What is demonstrated is only a small subset of what could be done.

Internally the music symbols are stored numerically. All information is associated with the particular note or bar line closest to where it occurs. This storage method could be adapted to any current computerized music system. All the information is saved. Presently, I am not paying much attention to the internal storage method. It can be adjusted after routines for accepting all of the various vagaries of music notation have been developed.

My system is developed this far:

1. Clef signatures may be located on any line.

F and G clefs are available, and C clef is easily added. No provision has yet been made for change of clef within a part, but that is not difficult to add.

2. Meter signatures are requested at the start of the program. Standard signatures including C and ¢ are presently available. No provision has yet been made for change within a piece, but that is easily added. Provisions for automatic barring of a part, or for checking the rhythmic values within a measure for the correct total could easily be added too.
3. Standard key signatures through six sharps or flats are available at the beginning of a piece or part.
4. Any pitch symbol from two ledger lines above to three spaces below the staff in use can be displayed. This range could be increased. The internal pitch generator is limited to notes from C below the bass staff through C above the treble staff, but display capabilities are not so limited.
5. All of the standard rhythmic symbols from whole note through 16th note and whole rest through 16th rest are available. Extension to smaller values can be done. Dotted notes are available. Triplets and other unusual rhythmic subdivisions will soon be available. Ties and beaming can be added, though beaming is difficult to program.
6. The addition of slurs, articulations, text and other "secondary" information is under development.

7. The editing routines automatically adjust all accidentals so that they conform to the usual rules of applying to all pitches of whatever octave within a bar.
8. ALF Products Incorporated has produced a "synthesizer" board for the APPLE II. It will be generally available about Nov. 11. This board provides three voices with envelope control and limited timbre control. One APPLE can take up to three boards giving a total of nine voices. Pitch accuracy is in the worst case (the C above the piano keyboard) about 1.5 cents off. Microtones are available. With the board come two programs that provide very easy basic routines, and that interface well with my programs giving my system multivoice capabilities of quite great flexibility.
9. With my internal pitch system some tempo flexibility is possible, with the ALF board, almost unlimited flexibility is available.

It is possible that there are some limitations to this system:

1. It is conceivable that a really complete system might need more space than is available to the APPLE, but that seems highly unlikely. My present system has 36 thousand bytes of storage space. About 26 thousand are available for programming if I avoid using the disc drive. The present program is about

12 thousand bytes long. APPLE can be expanded by an additional 12 thousand bytes, giving me a total of up to 24 thousand bytes of extra programming space--more than two times that needed for my already quite complex program.

2. Routines that associate the separate parts for analysis purposes will be needed. The ALF board and programs solve that problem for composers though the board is by no means a complete synthesizer. The routines would not be difficult to write, but lack of storage space within the micro-computer might cause difficulties. This problem is probably most easily solved by connecting the micro to a large computer for processing and storage of the separate parts or by adding a disc drive to the micro. The APPLE disc does not work fast enough for composition, but it should solve the problem for analysts, for they can afford to wait a few seconds.

3. The limitations of screen display might cause some difficulties. Pitches higher than C above the treble staff are terribly out of tune on the internal pitch device, and that is the major reason for the display limits. The ALF board removes that difficulty, and only a bit more programming is needed to adjust the display for higher or lower notes.

4. Rhythmic playback limitations might cause problems for some composers. Virtually any rhythm a user

could write can be placed upon the screen. However, playing back these rhythms would be beyond the capabilities of the internal pitch device. The ALF board has much greater rhythmic flexibility, but might not satisfy the needs of some composers.

If there are such limitations why make this report at all? For these reasons: 1) Even at its' present state of development my system will handle most of the pitch and rhythm symbols common to music. Thus it provides a convenient tool to simplify the arduous task of entering musical data into a larger system. 2) Most of the limitations I can anticipate can easily be overcome. 3) Much of the program development work I have done could be transported to other machines, for it is in a subset of integer BASIC. 4) The age of micro-computers is just beginning. Better and cheaper synthesis devices are, as one can see at this conference, becoming more readily available too. The possibilities of a comprehensive system for entering music into the computer without using cumbersome special symbols are within our grasp. Co-operation now in developing such a tool will alleviate re-inventing the wheel and/or developing mutually incompatable systems less useful to scholars and composers. 5) Besides, what other music input device can you use to play STARTREK when your work is done?

FOOTNOTES

1. The most extensive information available on DARMS is the manual developed by Raymond Erickson and others and available through him. See Donald M. Pedersen, "Some Techniques for Computer-Aided Analysis of Musical Scores", PhD, University of Iowa, 1968 (Um68-16851, DA (1968-69), 1919A). for a good brief overview.

2. Jerome Wenker, "A Computer Oriented Music Notation Including Ethnomusicological Symbols", Musicology and the Computer, Barry S. Brook, ed., Ney York: City University of New York Press, 1970. There have been refinements in this system since that time.

3. Murray Gould and George W. Logemann,"ALMA: Alpha-numeric Language for Music Analysis", Musicology and the Computer, op.cit.

4. Thomas E. Binkley, "Electronic Processing of Musical Materials." Elektronische Datenverarbeitung in der Musikwissenschaft, Regensburg, Gustav Bosse, 1967.

5. Prentiss H. Knowlton, "Interactive Communication and and Display of Keyboard Music", PhD, University of Utah 1971 (Um 71-30080. DA 32 (1971-72) 2649-B). Also earlier work by Alan Ashton and ongoing work by Sherman Gooch and others.

6. Donald Cantor, "A Computer Program that Accepts Common Musical Notation." Computers and the Humanities, 6/2 (November 1971), 103-109.

7. David S. Prerau, "Computer Pattern Recognition of Printed Music", AFIPS Conference Proceedings, 39 (1971) 153-162. Also his MIT PhD dissertation.