1. INTRODUCTION

The Bradford Musical Instrument Simulator is a digital, microprocessor controlled generator of waveforms for musical sound. It is capable of accurately simulating conventional musical instruments in real-time and of generating a wide range of sounds for additional applications. The system was developed by the Microcomputer Music Research Unit within the School of Computing at the University of Bradford, West Yorkshire, UK. Funding came from the British Technology Group and from the University.

2. SYSTEM DESCRIPTION

The simulator is modular in concept with a modular for sound generation, user interface and back-up memory. Modules are joined together by link-cable, allowing systems of any size and capabilities to be easily constructed or expanded.

Electronic hardware is built from low-cost industry standard components, supplemented by two semi-custom gate arrays.

The sound generation module is called the Music Module. This is implemented in a single VME module offering 14 Note Generators, each of which is an independent source of musical sound. Communication between the Music Module and other system modules is by a 16 signal, 80 pin, link-cable interface. Up to 16 Music Modules can be connected to the MUSICUS, providing a total complement of 352 Note Generators.

Interface with performers is handled by the Scanner module. The Scanner supports standard and pitch sensitive reedheads and possesses digital and analogue parts which a variety of input and output devices may be connected. Remote performance interface may be connected to the Scanner via MGBS.

A Playby Disc Module gives the simulator facilities for recording instrument specific and musical performances. Instrument specifications can be loaded into the simulator in a few seconds, while musical performances, which are recorded as a series of times, performer initiated events, can be edited and replayed without loss of sound quality.

Figure 1 shows an arrangement of modules for a 14 Music Module simulator.
Software has been structured to use new speech and new links to provide new work of using Note Generators can in added without disturbing existing facilities.

5. SETTING UP MUSICAL INSTRUMENT SIMULATION

The native mode of operation of the interfaced Music Instrument Simulator is as a true time additive synthesizer.

In some circumstances it is possible to set up instrument simulations with one Note Generator, referenced a timbre, allocated in each partial. For example, a set of percussion sounds with up to eight drum cymbals per note can be simulated in this way and played polyphonically, using the resources of the Music Module and some intelligent Note Generator allocation software.

Usually, however, it will be necessary for several partials to make a note Generator. The flying partials are necessarily locked in pitch as well as the sound amplitudes, but only as grouping, sound results can be obtained. For example, a good quality pipe organ simulation can be made using a group of partials and 4 Note Generators per note. The single cycle waveforms representing the groups of partials are generated into the Fast memory by the high speed Wavetable Synthesizer at the time our pipe simulation is selected by the performer.

Organ simulations may use as few as 1 or 2 Note Generators per note to stop, or 2 or more may be used to simulate instruments in each mode. This arrangement effectively maintains 12 bit resolution for very loud channels with a 60 db range.

4. SOFTWARE CONTROLS OF THE MUSIC MODULE

A primary aim of the Music Module has been to maximize flexibility and minimize controls by assigning many control functions to be automated. A very high amount of computer power is therefore needed to control the Module. Most of the process parameters are set up and two 6 or more Z80 microprocessors with 32K type of memory have proved adequate. Assembly language programming has been necessary for this arrangement.

One of the microprocessors handles MIDI input, output, and selecting parameters in the Wavetable synthesizer and allocation of Note Generators to partials. The other microprocessor is responsible for note Generators pitch and amplitude "window" control. The microprocessor communicate with a PIC in one direction and a register in the other.

Music Module software requires have been made as general as possible, to minimize constraints on new work. New partials can be added to the system as they become available. The software is specified by means of data tables, which are created and manipulated through a high-level language editor. Much of the data can also be manipulated interactively, with the results of changes being immediately available for assessment.

With such a processor an engineer can use a stack of tools. Note Generators, after allocation, are processed through a stack of tools, each activating appropriate routines to mark the various stages of their sounding life.

IGMRC66 Proceedings 302
The range of simulated instruments is to be expanded in the next future. Longer term research is directed toward expanding and improving interactive voice facilities, with particular emphasis on improvements in scope and generality and on the use of graphics.

The next generation of hardware is being designed for implementation in LSI, it will allow waveform storage sizes of up to 4K samples, with a maximum addressable waveform memory size of 16K samples. Output sample rates will be substantially increased, amplitude modulator resolution improved and hardware assistance with amplitude envelope control provided.

1. CONCLUSIONS

The Bradford Musical Instrument Simulator uses digital synthesizer and microprocessor control to obtain high quality musical sound. Audio waveforms may be internally generated by additive synthesis or may be loaded from an external source.

The simulator's low cost, modular hardware allows a wide range of system configurations to be constructed. Simulated instruments are specified by means of data tables which may be manipulated interactively and stored on floppy disc.