Synclavier A New Appraisal

New England Digital's Synclavier is one of the world's most respected electronic instruments. Constantly under development, its design is virtually open-ended, while the numbers of successful musicians and producers using Synclaviers on record is evidence of the instrument's exemplary sound quality and operational behaviour. In a special report, Paul White **and** Geoff Twigg **analyse how the system works and what facilities are currently on offer from within the Synclavier's copious repertoire.**

The problem with high-technology music systems like the Synclavier, the Fairlight or the PPG is that they all look similar, and their appearance gives little or no clue as to their capabilities. Usually there's a keyboard, a computer terminal and a large anonymous black box with an assortment of disk drives scattered about the place, which isn't an arrangement many musicians really feel at home with – yet.

It is partly because of this faceless hi-tech look, and partly because of these instruments' fairy tale prices, that the full capabilities of these machines are rarely understood by anyone other than the manufacturer, the distributor and a few élite owners, a situation that E&MM is endeavouring to improve.

The Synclavier is perhaps most easily understood if we look first at the way in which it generates sound or, to be more precise, how it generates the electrical signals that are eventually converted into sound.

There are two ways in which the instrument does this, partial timbre synthesis and sampling.

Partial Timbre Synthesis

A sound may be built-up by adding together four elements which the manufacturers define as 'partial timbres', or partials for short. It is not necessary to use all four partials to build up a sound, because they can in fact be mixed in any proportion and the system programmed such that this mix can be different for different parts of the keyboard, allowing interesting and/or 'natural' sound variations to be created.

Before proceeding, it is necessary to define a partial and the ways in which its parameters may be varied.

Each partial may consist of up to 24 harmonics, which are under the control of a six-stage envelope generator for amplitude control and another one for harmonic control. Fully variable delayed vibrato, tremolo and portamento may be imposed upon the partial, and the decay envelope may be related to the keyboard position.

This is useful for simulating piano-type sounds where the decay period for low notes is much higher than that for the high ones.

In addition, a chorus facility may be implemented on any or all partials, and keyboard control of stereo placement is also possible.

An eight-voice Synclavier system has eight partial timbres, a 32-note system has 32 partials and so on. As previously mentioned, up to four partials may be triggered from one key, which gives a total of 96 harmonics, and this enables highly complex sounds to be generated.

FM

Each partial may also be frequency modulated, which enables either dramatic or subtle harmonic changes to be implemented, and a further six stage envelope generator allows dynamic control of this function.

Although the FM facility is not nearly so complex as that used by Yamaha in their DX keyboards, its use is more instinctive and the fact that four partials may be overlayed means that complex sounds may be built up relatively easily.

Portamento is polyphonic, enabling complete chords to slide together on the keyboard, and up to four portamento rates may be operational on the keyboard at any given time. They can even be programmed to slide in different

directions, and the rate itself is variable from instantaneous up to around two minutes!

The number of keys that may be played simultaneously depends on how many voices each particular Synclavier is supplied with, and how many partials are allocated to each sound. For example, a 16-voice machine using two partials per note would allow eight keys to be played simultaneously.

Partial timbre synthesis does not rely on the disk system for its operation, but sound 'patches' may be stored away on disk, enabling a library of favourite sounds to be built up for later use.

The functions used to create the partials behave as oscillators, but in fact they exist only in software. The computer calculates the result of the user's harmonic manipulations, and this is represented by an eight-bit digital signal. Eight bits may not *sound* like a lot of resolution, but in this case, amplitude control is exercised by using a further eight-bit code *via* a DAC to control the reference current of the output DAC, giving amplitude control at the point where the digitally encoded waveform is converted into analogue. The outcome of this is that full eight-bit resolution is maintained for all amplitude levels and in practice, this gives results of very high sonic quality.

The main computer however is a specially-designed 16-bit machine, and this is employed to the full in the sampling mode.

Sound Sampling

Unlike other sampling keyboards that have very limited sampling times imposed by the size of available memory, the Synclavier uses a system whereby sounds may be stored or recalled in real time from a Winchester disk unit. This gives a storage time of around 100 seconds for the 10 megabyte system and, with the maximum disk storage capability available, a whole album could be sampled with a sound quality rivalling that of the best digital tape recorders currently available. This long storage time is particularly useful in a recording studio, where whole sections of songs may be stored or vocal lines corrected in time and pitch before being re-inserted into the mix.

The 16 bits are used conventionally as 15 data bits and one sign bit, a sampling rate of 50 kHz giving a true signal bandwidth of 22 kHz.

When a sample is played back, the initial data comes from RAM within the system, but before this has run out, the disk unit is busy filling up the buffer so that a continous sample can be maintained. At present, the true sampling mode is monophonic, transposition being implemented by varying the rate at which data is clocked in and out of the buffer memory, but plans are afoot for a polyphonic system in the near future. In order to make the sound as realistic as possible, several samples may be recorded and allocated to different parts of the keyboard to reduce the effects of extreme transposition that occur when only one sample is used.

Once a sound has been stored, editing is simply carried out by moving the cursor along the Synclavier's screen display (which is configured as a graph of amplitude against time), and the scale may be expanded, allowing extremely accurate editing to be carried out. Edited sections may be rearranged into a different order, and each section may be independently manipulated in a variety of ways.

Samples can be blended or reversed, and digital filtering may be imposed on the results before the new edited version is stored under a new filename.

A frequency spectrum from one sound may be imposed upon a different sound enabling – among other things – digital vocoding to be produced, while complex spectral shaping or even inversions may also be accomplished by this technique, giving rise to new ways of manipulating real sounds to produce quite surreal effects.

Although the sampling system is monophonic, a new software release enables a fascinating new technique called Timbre Frame Synthesis to be used on existing machines and, in line with the manufacturers' policy, the software update will be supplied free of charge to existing owners.

Timbre Frame Synthesis

In this mode, a sample is examined at several points throughtout its duration and the spectral content analysed in 24 bands, the amplitude and phase of each component being measured and stored.

This information is then used to set up the partials so that these slices of sound spectrum are in effect resynthesised and can be faded into each other in sequence in order to recreate the original sound. The authenticity of this approach depends, of course, on how many frames are taken for a given length of sample, and a practical maximum seems to be around 50 frames per sample.

This technique is not limited to purely immitative synthesis, however, as the individual frames may be further modified, and a random vibrato function is incorporated which enables the random 'out-of-tune' effects of real instruments (such as brass) to be imposed on any sound.

As with the partial timbre synthesis, chorus may be added to enrich the sound, and special effects may be generated by deliberately undersampling the original sound so that only a few frames are used in the resynthesis process, giving rise to effects that embody the elements of both natural and synthesised sound.

In all modes of operation, the frames may be displayed in a 3D graphical fashion so that frequency and time may be examined simultaneously – useful for deciding on the breakpoints for subsequent digitial filtering.

16-Track Digital Recorder

This section memorises notes as they are played on the keyboard, and may be effectively treated as the equivalent of a 16-track tape recorder. On replay, however, the number of notes that can be played at any one time is limited by the maximum number of voices of the machine in question, but for more involved compositions, the Synclavier may be synchronised to a conventional multitrack machine for overdubbing.

Once stored, sequences can be bounced from track to track and varied in both time and frequency. Sections may be moved backwards or forwards in time relative to the other tracks, and whole sections can be looped, transposed or even inverted.

Between 8000 and 9000 notes may be stored in total, and there is a choice of temporal resolution enabling timing to be tightened up or otherwise modified.

Music Editor

New England Digital provide a powerful tool for the composer in 'Script', their own music notation system. The language is entered in lines of alphanumeric notation, usually in pairs – one for pitch and the other for rhythm. In conjunction with the music-printing option, you can print out scores in up to 16 parts with one or two voices on each. The updated software incorporates an extended library of music symbols, the ability to add or delete notes and insert text or symbols anywhere on the score by means of the cursor.

Once you have entered a composition in Script notation it may be compiled as a file in the Synclavier's Memory Recorder and played as if it were a recording made in the conventional way, that is, entered at the keyboard. Your composition can of course be manipulated to give precisely-controlled syncopation and polyrhythms which would be difficult to enter at the keyboard.

The most important part of any music composition language is the facility for editing, analysis and synchronisation to other media. To complicate matters slightly, it is possible to store, recall and edit music in the Synclavier in three different formats: Script notation, normal music notation and computer music notation. This may be seen as an attempt to satisfy the needs of a variety of different users, whether academic musicians, rock producers or music publishers.

The music printing option is among the clearest and most accessible we have seen, and will be further improved with the updated specification mentioned earlier. The only serious problems, which relate to all music analysis and printing systems, are due to the precision required when entering notes in real time. If you make any sort of mistake (by the computer's standards) this is analysed and represented in full graphic detail on the score. For instance, if, as we did, you press a note down gently and hesitate as it triggers, it's quite possible to record a double-headed note which is duly printed. Also, syncopations are represented to whatever resolution you have selected with no sympathy at all for rubato or musical license. This, of course, is why the secondary editing has to be so good,

and on this system there can be no grumbles on that score!

Controls

The keyboard console layout has been kept deliberately simple for ease of operation. All parameter and function switches are illuminated pushbuttons, there being only one rotary control at the left-hand side of the panel which adjusts the value of whichever parameter is selected, the actual value being displayed to the right of this control by a four-section, LED alpha numeric readout. As yet, the keyboard has no dynamic control and no performance wheels are fitted.

It is neither possible nor desirable to outline the precise control functions as to do so would entail reproducing most of the manual (which in this case would need to be serialised over the next 100-odd issues), but what can be said is that the manual is clearly and concisely written and that the software presents a user-friendly approach whilst displaying a lot of relevant information on the monitor screen.

Guitar Synth Interface

An interface unit is currently available that will allow an existing Synclavier system to be played from a Roland GR Guitar Synth controller, and a small console is provided which can be mounted either on the guitar or on a suitable stand so that the patches and relevant parameters may be easily changed.

The pitch is extracted by means of a zero crossing to digital converter, and some control over picking dynamics can be exercised.

Pitch tracking is fairly well behaved, but unless the release time is fairly short, the pitch will go flat during the release time unless the quantisation facility is invoked.

This may be programmed in semitones, quarter tones or eighth tones, making experimentation with oriental scales possible, and I imagine that this guitar interface shouldn't take too much getting used to, providing that you have some experience or understanding of guitar synths. However, experience has shown that setting up an orchestral string patch on the Synclavier and proceeding to play Motorhead riffs is not a particularly fruitful exercise...

Conclusions

No instrument can be all things to all people, and so we're not about to join in the argument as to whether this is or is not the world's greatest musical instrument; after all, even a relatively inexpensive acoustic guitar will always give a more realistic sound than a machine regurgitating an acoustic guitar sample.

The possible uses of the Synclavier system are extremely diverse. Some users have bought systems without the keyboard purely for the spectral analysis capabilities, whilst some producers use the storage facility extensively for salvaging backing tracks recorded by artistes of somewhat dubious technical skill.

The synchronisation facilities enable the Synclavier to link to SMPTE devices *via* a suitable interface, making it potentially a very useful machine for video production work.

It's difficult to comment on the sound of this instrument, as theoretically it will reproduce any sound required, but the specification in terms of sound quality is exemplary.

Whether or not this type of machine is worth its asking price of a country-semi must be a business decision; if it will do what you want it to do and will make you more money than you would get by investing the capital elsewhere, then the answer has got to be yes.

The Synclavier's design philosophy, assuming New England Digital adhere to it, means that the instrument will not become out-of-date in the foreseeable future, and the policy of automatically updating all owners' software when improvements are introduced makes for a refreshing freedom from planned obsolescence.

E&MM

Just as this issue of E&MM went to press, news reached us of some significant new hardware developments for the Synclavier, and we hope to bring you details of these in the September issue. Meanwhile, further details on the Synclavier system as it stands now should be available from the UK distributors, Turnkey, at Brent View Road, London NW9 7EL. ☎ 01-202 4366.