years. Now that this has been overcome, many top recording studios have installed 24-track digital tape recorders. Using these, the sound reproduction is so accurate that engineers find it impossible to ascertain whether a sound coming from the studio monitor speakers is played by a musician in the recording area or is produced by the playback of a digital tape. But new problems have emerged: it is no longer possible to 'see' where sounds are located on a digital tape, which makes editing more difficult, and splicing is becoming an outmoded skill. Another difficulty is 'studio noise', an unwanted and usually unheard characteristic of some audio equipment. Magnetic tape was not sensitive enough to register this, but digital recordings tend to pick it up.

While 24-track recording is still the prerogative of expensive studios, single-track digital recording of the same quality is available to any owner of a Betamax home video recorder. Video tape is a digital medium, and as such it can be used to encode any type of data. The Sony PCM (Pulse Code Modulator) is a unit that converts a Betamax video recorder into an audio tape recorder. This unit, which costs a few hundred pounds only, has the potential to make similarly sized analogue recorders obsolete.

Digital sound encoding, or *sampling*, is at the heart of the Fairlight CMI (Computer Musical Instrument), one of the best known of the advanced systems. The Fairlight can sample any sound for a duration of up to two seconds, and it will then reproduce that sound across a pitch range of six octaves. Sampling is a real breakthrough in electronic music. For years, engineers and musicians have been trying to simulate the sound of strings or woodwinds by using synthesisers, and in some cases they have come very close to reaching their goal. But sampling will provide not only a remarkable reproduction of the sound of 'strings', it can produce the sound of a *particular* violin. Furthermore, in some cases, it can reproduce the sound of a particular player in a particular room. In the first article in this series, we saw how the *musique concrète* composers of the 1950s spent weeks splicing together tiny snippets of recorded tape, eventually producing large-scale pieces. The computer manipulation of samples would now enable a composer to produce similar results in minutes.

Past Echoes
This piece is taken from 'New Atlantis', a vision of utopia written by Francis Bacon (1561-1626). His descriptions of sounds seem to predict the extraordinary power and versatility of today's electronic music

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From Francis Bacon's THE NEW ATLANTIS, published in 1624:

We have also Sound-Houses, wher wee practise and demonstrate all Sounds, and their Generation. Wee have Harmonies which you have not, of Quarter-Sounds, and lesser Slides of Sounds. Diverse Instruments of Musick likewise to you unknowne, some sweeter than any you have; Together with Bells and Rings that are dainty and sweet. We represent Small Sounds as Great and Deepe; likewise Great Sounds, Extenuate and Sharpe; Wee make diverse Tremblings and Warblings of Sounds, which in their Originall are Entire. We represent and imitate all Articulate Sounds and Letters and the Voices and Notes of Beasts and Birds. We have certaine Helps, which sett to the Eare do further the Hearing greatly. We have also diverse Strange and Artificiall Echo's, Reflecting the Voice many times, and as it were Tossing it: And some that give back the Voice Lowder then it come, some Shriller, and some Deeper; Yea some rendring the Voice, Differing in the Letters or Articulate Sound, from that they receyve. Wee have also meanes to convey Sounds in Trunks and Pipes, in strange Lines, and Distances.

CALLIGRAPHY BY BERNARD JENNINGS

SAMPLING INSTRUMENTS

A sampling instrument like the Fairlight can overcome the natural limitations of musical instruments. For example, it is quite easy for a flautist to produce a warm, breathy tone quality at the lowest end of the flute's range. However, it is impossible for a player, no matter how skilled, to achieve this type of sound two octaves higher at the top end of the instrument's range — the physical design of the flute prevents this. A Fairlight user, on the other hand, can sample the low, breathy tone and then transpose it upwards by two octaves on the keyboard. The result will still sound like a flute, but it is a type of flute that cannot exist in the 'real' analogue world.

The Fairlight can supply a screen display of any of its sampled sounds, which are stored on 8in disks. Different characteristics of an individual sound may be examined in succession: it is often easier to tell what is 'wrong' with a particular sound by looking at it rather than listening to it. Many sounds need to be longer than their original two-second sample duration. By seeing how the different waveforms inside the sound are related, a point can be selected at which the sound could be made to start *looping*, or repeating. If the right point is selected, this will give the illusion of genuine continuity. Analogue sound doesn't behave like this, of course, so looping can give an unusual dimension to the music being produced.

The Fairlight user has two ways of inputting music, apart from playing in 'real time' at the keyboard. The first method, known as 'Page R', gives a five-line stave display, and the user enters notes onto the stave from the music keyboard. Any timing errors are 'tidied up' automatically by the computer in accordance with the metre or time signature that the user has already specified.

The second method is to use an MCL (music composition language). The Fairlight MCL demands that every note-event should be entered