Computers produce near-perfect sound

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About once every 25 years the public awakens to the fact that an important step has been made to improve the recording of music.

In 1877 it was the tinfoil cylinder that began recording as we know it today. In 1902, the wax-process disc was introduced as the best way to mass produce recordings, and thus paved the way for many people to enjoy recorded music in their homes for the first time.

Twenty-five years later, people discovered the tremendous technological advances that had taken place in electrical recording, and in 1952 the long playing record (LP) came into its own.

So, in 1977, one would have expected an exciting innovation that would turn the music business upside down again. Digital recording has done just that. Early development has shown a degree of accuracy a leap above that of any regular recording equipment.

Since the sound we hear is actually the changing amount of air pressure on our eardrums caused by sound waves, conventional recording systems adapted this principal to reproducing the sound. The height, or amplitude, of the waves is plotted against a length of time, and is recorded on tape, for example, as varying densities of magnetic flux along the tape. When the tape is played back, the magnetic tape is read and converted back into sound.

Similarly, a plastic disc records sound waves as physical peaks and valleys cut into a groove of plastic, and when played the needle reads the grooves and reproduces the sound.

Digital recording, on the other hand, takes a different approach. A computer samples the incoming wavelengths of sound very rapidly and converts the amplitude of particular points on the wave into binary numbers. Binary notation is used in all computers because the numbers, being all 0's and 1's, are easy to represent electronically as "off" and "on," respectively.

The result is a plotted curve almost identical to the sound wave. When the tape is played back, the numbers are converted into voltage and come out as the original sound.

The computer is also used to "average" the curve so that it is perfectly smooth instead of slightly jagged. However, the sampling speed is so high that any roughness in the curve probably could not be detected by human ears.

Since the highest pitch a person can hear is about 20,000 cycles per second (Hertz), the computer must sample the sound waves as least twice as fast to avoid detectable distortion.

Probably the greatest advantage of this new method is that it reduces noise level and distortion to virtually insignificant levels.

Noise level is the tape hiss and other electrical noise that can be heard when someone turns the volume up fairly high when listening to a recording. The electrical noise is caused by the tape passing rapidly over the recording head. With digital systems, there is no magnetic tape to cause the noise, and the result is a very clean, pure sound.

Distortion in a recording is caused by innaccuracies in the waveform, so that when the music is played it is altered and irregular. But through the precise nature of a digital system, irregularities are reduced to a very small amount, and even those are smoothed out by the "averaging" computer.

There are, of course, disadvantages and problems in the new system. The main one is high cost.

QUALITY SPECIFICATIONS

	Analog	Digital
Sound/Noise:	65 to 70 dB	85 to 95 dB
Harmonic distortion:	0.05 percent	0.03 percent
Frequency response:	20-25,000 Hz % or - .5 dB	0-20,000 Hz % or - .5 dB
Wow & Flutter:	0.05 percent	unmeasurable

Since the concept, and therefore the systems, are relatively new, the software for the computers is not fully mass-produced, therefore making it expensive. Also, digital editing equipment is very expensive because it must be able to track down exact numbers on the tape, and with 40,000 numbers per second being recorded on tape, the equipment must be extremely precise.

The best recording systems now sell for about $150,000, making digital recording impossible for some studios. Because of the cost, digital equipment is now used in studios only, and is not commercially available. There are other less complex systems that sell for anywhere from $40,000 to $80,000, which is still quite expensive.

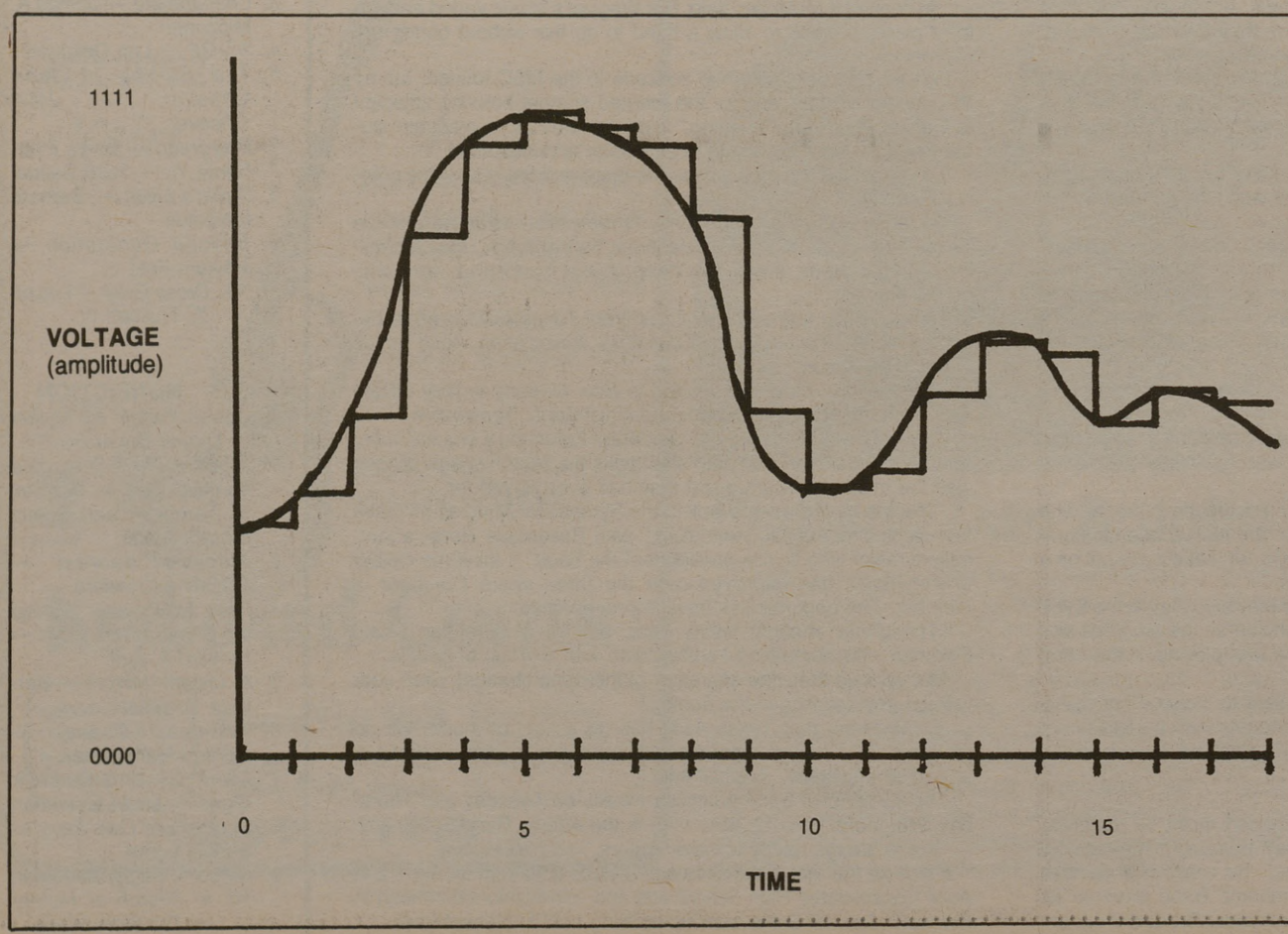
Another problem lies in the noncompatibility of the new systems being produced. Differences from system to system range from sampling rate to number of binary digits (bits) used to record the sound, and they make interchangeability impossible between many systems.

Most studio digital recorders use a 16-bit system that samples at the rate of 40,000 times per second. This means there is a need to process 640,000 pieces of information per second, and to store one binary number every 1/40,000th of a second, which leads to a problem of tape saturation. The equipment must be very complex in order to distinguish between two numbers on the tape, even if the tape speed is as high as 30 feet per second.

All significant problems with digital recording systems, however, can be solved through greater development and coordination of system components. A group called the Audio Engineering Society is presently working to establish standards for professional applications, and better computer technology and improved software is enabling technicians to increase efficiency and reduce cost at the same time.

Naturally, any system that attempts to be as accurate as digital recorders are must have a system for correcting any possible errors in transcribing the sound to the tape. Coding systems have been set up that arrange bits in blocks, so that if one bit is accidentally dropped the computer will detect the error and correct it simply by changing the "1" to a "0," or vice versa. In this way the simplicity of the binary system works to counteract some of the complexity of the system as a whole.

Some commercial recordings have already been made, and the system produces such a clean sound that noise level and distortion are virtually nonexistent. Digital recording is indeed the method of the future; that is, of course, until someone comes up with something better.



DIGITAL RECORDING is based on a system which samples a sound wave, left, at a very rapid pace, and stores on tape a series of binary numbers that very closely approximate the soundwave curve. Keep in mind that the sampling rate is so high (about 40,000 per second) that the irregularities that exist in this simplified drawing become so insignificant as to be inaudible to the human ear.