

power between the recording industry and musicians. Digital audio workstations allow musicians to produce professional-quality recordings at home, with the result that many recording studios have closed down. Musicians can disseminate tracks though the Internet,

bypassing the distribution channels controlled by the big recording companies. Karl Marx would have approved — control of the means of production has passed from the elite to the man in the street. It is a shame that *Perfecting Sound Forever* doesn't dwell on the political

significance of the developments it charts — a subject for a future book, perhaps. ■

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Q&A: The inventor with an ear for the past

Engineer **Duncan Miller** has spent decades reviving the lost art of acoustic recording to wax cylinders, a technique pioneered by Thomas Edison. *Nature* finds out how his Vulcan Cylinder Record Company, based in Sheffield, UK, has combined sleuthing and modern chemistry to craft a new repertoire for the hand-cranked phonograph.

D. BOCKING

Why did you become interested in old recording techniques?

As a teenager I played with gramophones. I found out that many 78 rpm discs were recorded and played back without electricity. It surprised me that something as complex and delicate as sound should be captured by purely mechanical means. I've studied radio and microphones, and built amplifiers and transistors, but I was drawn to acoustic recording. In 1981, I started making new phonograph cylinders, just as Thomas Edison had done about a century earlier.

When was the wax cylinder invented?

In 1877, Edison patented a device that would inscribe a groove of variable depth using a diaphragm set in vibration by sound. He called it the phonograph. First he tried tin foil as a recording material but it got damaged quickly, turning into a Christmas decoration when played a couple of times. While Edison was inventing the light bulb, the people working for his competitor, Alexander Graham Bell, realized that wax supported on a cardboard tube was more durable. Seeing what they'd done, Edison perfected a phonograph that used a solid wax cylinder. His innovation was to use metallic stearates, which are harder and less crystalline than Bell's wax.

Is it easy to make such cylinders today?

The process by which Edison made a copper mould from a wax master is documented in outline, but I've had to invent the details on my own. Some of it was quite secret; I've examined court cases and figured out what works. He actually stopped using wax in 1912 and moved to celluloid plastic. I have adapted modern plastics to suit the product. The raw materials have also changed — the stearic acid used to make the cylinders more durable is now vacuum distilled, not



Waxing lyrical: Duncan Miller's cylinders can capture more overtones than gramophone discs.

pressed as it was in the 1900s, for example — so minor adjustments have to be made to the compound formulae to get the best results.

How was Edison's 'talking machine' received?

Edison's device was never intended to record and sell music. It was supposed to be a dictation machine; when you finished, you shaved the cylinder and dictated again. But the demand for music was so strong that the Edison company had to crank out recordings. The machines weren't designed to make duplicates, so a band would have had to play all day, simultaneously into 20 phonographs making 20 records at a time. But soon the cylinder had competition from the disc. It was partly a matter of branding. The cylinder was associated with cheap and vulgar music, such as that played by travelling showmen at fairs and circuses.

Is wax recording different for musicians?

The instruments have to be placed at the proper distance from the recording horn to get the right balance. I recently had a nine-piece jazz band in my dining room, which was fine until the sousaphone hit the chandelier. Unlike with a microphone, I can't do anything on the cylinder to make you sound better; if you lose energy the finished record sounds distant. Singers must learn to produce more sound pressure and can feel the way the horn responds to their voice.

Is there a difference in fidelity between discs and cylinders?

A new phonograph cylinder sounds better than most discs. The stylus can vibrate quicker without dissipating energy, so there is nearly another octave of overtones in the higher registers that you need for speech, strings and brass. A cylinder's groove speed is constant, so the recording fidelity is the same at both ends. With a disc, the fidelity at the inside is lower because it's going slower. So a new cylinder will have less noise than a new disc. But when we get our hands on them these days, cylinders have often been badly treated and eaten by mould because the waxes contain soaps and fatty acids. By contrast, the 78 rpm discs, which are often made of slate powder and shellac resin, don't deteriorate so badly.

Is there a market for wax cylinders today?

The Edison company alone made 2 million machines capable of playing cylinders, and thousands of them are still in operation. A fraternity of people has these machines and wants recordings for them. Our goal is to produce a cylinder record that plays well — one that would have stood up to the market in its day. The great thing at the moment is that we have little competition. ■

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