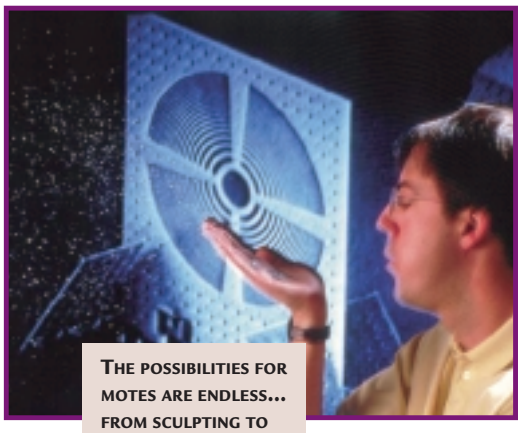
DON'T DITCH THAT DUSTER YET – 'SMART DUST' COULD SOON BE BLOWING YOUR WAY.

Byte the dust

TO MOST OF US, DUST is just a nuisance. It clogs up our PCs and spoils our houses. But there's a growing community of researchers who believe that dust could be the next big thing. The dust they have in mind, however, will be 'smart', and each tiny particle will be a fully-functioning computer.

Kris Pister of the University of California at Berkeley is leading a team whose goal is to create devices no bigger than 1mm cubes. Each device, or 'mote', will contain sensors, an on-board computer and power supply, and an optical communication system, enabling it to talk to other motes and conventional computers.



THE POSSIBILITIES FOR MOTES ARE ENDLESS... FROM SCULPTING TO TRANSLATING SIGN LANGUAGE GESTURES

The key to Pister's ambition is a technology called MEMS (Micro Electro-Mechanical Systems), which permits microscopic mechanical structures to be created using the same photo-lithographic techniques that are used to make silicon chips. Pister's current prototype device is a 5mm cube, into which is packed an amazing collection of components: a steerable laser diode transmitter, an optical receiver and passive optical transmitter, a CPU, and a battery with a solar-cell charger. In two years' time it should be possible to shrink the mote to sub-millimetre size.

The idea is that each mote is entirely self-contained, and includes an environment sensor whose data can be broadcast to other motes or an external computer. Pister's team has chosen optical communication rather than radio, because optical systems require less power. They've already demonstrated the effectiveness of the technique by monitoring a weather station that was broadcasting its data using a modified laser pointer over a rather impressive 21km distance.

As for sensors, a range of prototype motes has already been built that can monitor temperature, humidity, pressure, illumination, spatial orientation and magnetic fields. Currently, there's enough power on board to keep a mote in continuous operation for about a week, but this will get longer as techniques are developed for dynamically shutting down parts of the circuitry when they're not in use.

The potential of having hundreds, or even thousands, of these motes monitoring an environment is enormous. Suggested applications include 3D interaction that is truly wireless and unencumbered. With orientation-sensitive motes dusted over your fingers, your gestures could be precisely relayed to a computer, which could interpret them as commands for sculpting in virtual clay, for example, or playing musical instruments. Foodstuffs could be dusted with motes sensitive to moisture or acidity, which report when the food is past its 'best before' date.

Then there's the whole area of interfaces for the disabled. Dust could be used to precisely and unobtrusively monitor muscular movements, or to translate sign language gestures. Another possibility is to create 'smart offices', which automatically adjust their temperature and humidity in response to the requests of smart dust sprinkled on our clothing, or even our skin.

But Pister's funding comes from DARPA, the US agency for military research, so there's a strong bias towards the possible military applications of smart dust. On his web page at http://robotics.eecs.berkeley.edu/~pister/SmartDust Pister is understandably coy about the details of such applications, mentioning only ideas such as battlefield surveillance and Scud missile hunting.

Some technology observers have suggested more insidious uses for smart dust, especially in the realms of surveillance. Imagine a cloud of dust released into a room. Perhaps one or two of the dust particles will be smart, capable of monitoring your conversation, or even videoing you, and quietly transmitting the data to an eavesdropper who may be miles away.

Pister is philosophical about such suggested applications. 'Every technology has a dark side,' he said. 'So deal with it.' But with an almost invisible technology such as smart dust, the real problem is that you can never be sure what it is you're dealing with.

TOBY HOWARD

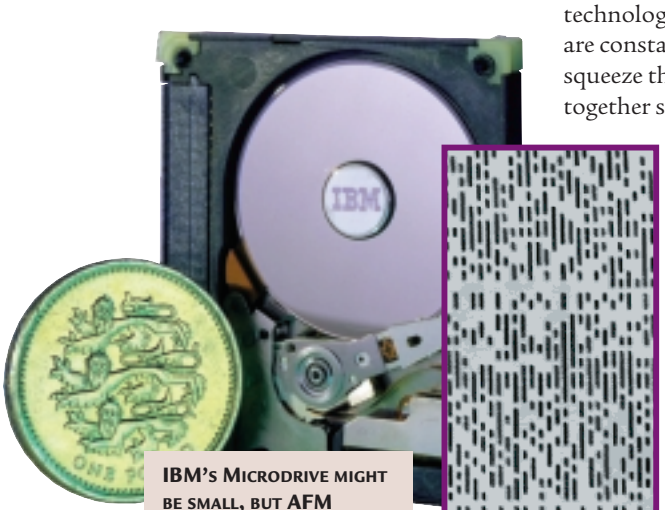
PHOTOGRAPH PETER MENZEL

ATOMIC MANIPULATION TECHNOLOGY COULD BE THE FUTURE OF STORAGE

Up and atom

EVEN WITH THE BEST compression technology available, it is still difficult for hard disks to keep up with the sheer volume of data we are now stuffing them with from applications such as digital video editing.

The amount of data that can be stored by a disk drive is growing, but it can't keep going forever. One of the main problems with current disk-based storage technology is that, like chip technology, designers are constantly trying to squeeze things closer together so they can produce drives holding more data without increasing the footprint – if drive size had increased along with capacity since hard drives were first introduced, we'd doubtless have computers with disk drives the size of merry-go-rounds attached.



IBM'S MICRODRIVE MIGHT BE SMALL, BUT AFM TECHNOLOGY (RIGHT) PROMISES TO OFFER UP TO 300GBITS/IN

Packing magnetic bits together by making them smaller and reducing the space between them is a fine plan, up to a point, but then that party-pooper mother nature steps in to spoil everything with troublesome physics laws.

As magnetic particles get smaller and closer together, they become less stable and are more prone to flip their polarity at will. If a hard drive is unstable and starts corrupting your data, then no-one will use it no matter how portable it is.

Companies are attempting to find new materials that are more tolerant of smaller magnetic particles, maintaining their reliability for longer as the capacity-to-footprint ratio increases. Nevertheless, vendors looking toward the future will eventually need to find new types of storage if they are to squeeze bulging data loads created by video and audio applications into portable devices such as Palm PCs.

IBM's work in this area mainly centres on Atomic Force Microscopy (AFM). The company has already made great strides with atomic-level manipulation, by positioning individual Xenon atoms to write out its own name using a scanning tunnelling microscope.

Now, boffins at its research labs in California are trying to produce storage technology that could result in a storage density 100 times that of today's hard disks. The company believes that current magnetic storage densities will reach their full capacity at 20-50Gbits/in, and hopes that the atomic storage technology could push it to 300Gbit.

Significantly, IBM's technology does away with magnetism altogether. Instead, it works by placing tiny depressions and raised impressions on the surface of a plastic disk. By heating a read/write head that is 40 atoms wide, the plastic can be softened and manipulated.

The company says that the read/write head (a micromechanical cantilever) can read data back at 1.2Mbits/sec. It's not blazingly fast, but it's a good way to store all those old copies of *PCW*.

Californian company Colossal Storage is also developing an atomic-level manipulation device using ultraviolet light to manipulate electrons on a ferroelectric metal surface. The firm is hoping to push the storage envelope from 40Gbits/in up to a whopping 500. This is a big leap from current capacities of around 4Gbits/in.

One of the advantages of this technique is apparently its non-contact, read-write mechanism, which makes it possible for the stored disks to be very stable. Consequently, the company claims that the technology will offer infinite double-sided reads and writes, retaining data for at least 10 years.

The problem with both of these technologies is the investment involved. As with any innovation, it costs a lot of money to get it to the point where customers can afford it. We are therefore unlikely to see devices based on these technologies in the short term, and if they appear, they will be at the very top end of the enterprise computing spectrum.

Colossal Storage, for example, is focusing on producing products for large companies needing lots of storage attached to their networks. The frustration of running out of disk space is set to continue, at least in the short term.

DANNY BRADBURY