Ever wondered where those voices in your head come from? Radio interference in your mind chip.

A chip in your shoulder

Silicon implants have traditionally been reserved for *Baywatch* stars, but scientists have been working on microchip implants for other parts of the body, including the brain. Imagine being able to call up dictionary definitions, historical dates, maps and the daily newspaper in your mind's eye. Better still, imagine being able to call up other people's memories or to save every aspect of your own experience to be recalled later with complete clarity.

▲ IN THE FUTURE SILICON COULD BE USED TO ENHANCE YOUR BRAIN AS WELL AS YOUR LOOKS

PHOTOGRAPH THE MOVIE STORE COLLECTION

While being woken up by an alarm clock in your head and checking your email using telepathy may seem like the stuff of science fiction, researchers are experimenting with basic technologies that could eventually yield such benefits. According to Dr Leslie Smith, head of the department of computing science and mathematics at the University of Stirling, such work is incredibly difficult, not least because neurons and silicon chips work so differently. The frequencies are vastly different, and so are the environments — one is wet, and one is dry, after all.

Nevertheless, BT has already predicted that it could have a retinal implant chip that will be able to record all the memories gathered in an 80-year lifespan by 2025. This was based on calculations that we process 10TB of data during a lifetime, although this figure appears to ignore the storage of unknown quantities such as emotional data. The Soul Catcher, as researchers are calling the chip, could theoretically be used to relive crimes from the victim's point of view, even after death.

Many people may scoff at the idea of brain implants, but researchers already have equipment that allows people to control computers using thought. In 1997, the Emory University in Atlanta developed a set of brain implants that allowed a physically disabled man to communicate using a computer system. Neurons were grown onto an electrode that was then implanted inside the motor cortex of the brain. When the patient thought about moving a part of his body in a certain way, the neurons were fired and the electrode was triggered, causing a signal to be sent to a receiver, which was amplified by a device worn on the head. The signal was then beamed to the computer. Although the system was limited, it was advanced enough to let the patient select icons which were used to communicate basic needs and feelings.

Emory University's system worked by using a natural human substance, taken from the patient's knee, to encourage the neurons to grow onto the electrodes. Interfacing neurons to microchips is more complex, but researchers have been making advances in this area too. A group at the University of California has developed a 'neurochip', a device that enabled rat neurons to be grown in a silicon chip. It works by using electrodes inside small holes in the silicon. Brain cells placed into each hole grow extensions that connect with their neighbours.

In the short-term it is more likely that we will see useful implants in other parts of the body rather than the brain itself. Professor Kevin Warwick of the department of cybernetics at the University of Reading had a glass capsule about 23mm long and 3mm wide, containing an electromagnetic coil and a silicon chip, implanted into his elbow last year. The implant meant that computers in his building could recognise him when he walked in and then turn on the lights in the appropriate room or tell him whether he had email waiting. It also meant that his secretary could find out where he was in the building at any given time of the day.

Warwick said that technology such as this could be put to a number of different uses. Chips could be recognised by sensors linked to the Internet and used by home automation systems, so that when you leave the office your house would switch on the oven, turn on the TV and run a bath for when you get home, for example.

But the real barrier to this type of technology is likely to be people's fear of becoming half human, half cyborg. Then again, someone with a silicon chip embedded in their motor cortex probably wouldn't appreciate the prospect of dealing with a blue screen of death.

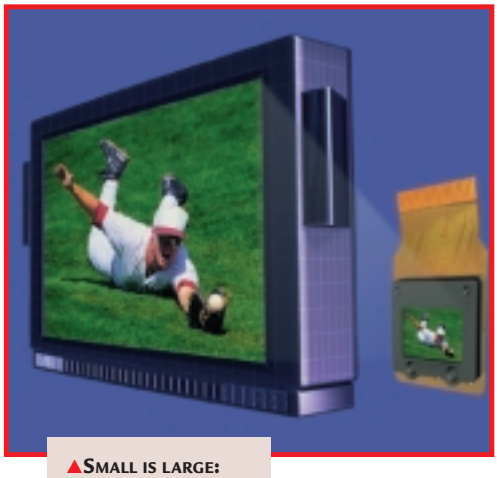
DANNY BRADBURY

We move away from food pills to give you some more realistic predictions for the new century.

Scrap your silver suit

Predictions for the future generally revolve around the idea living off food pills and wearing silly shiny silver suits, but it is possible to look forward to the next millennium without making such ridiculous assumptions. Here's what we think will be the technology driving the PCs of the next century.

One certainty is there'll be a move away from silicon chips. Great strides have been made to create smaller, faster and cheaper chips, but there's a limit to how small the process can become before electrons start to skip between the microscopic paths inside the chip. Manufacturers may reach this point as early as 2002.



▲SMALL IS LARGE: MICRO DISPLAYS CREATE A TINY IMAGE WHICH CAN BE BLOWN UP TO NORMAL SIZE

One option may be a move to gallium arsenide and then use a technology called quantum cellular automata (QCA). The fundamental building block of QCA is a cell with four quantum dots arranged in a square pattern. Each dot can be equated to a comfy place for an electron to rest. Two electrons are placed in the cell, but because they repel each other the electrons end up in the quantum dots diagonally opposed to each other. This allows for two possible configurations, representing a one or a zero. QCA technology has great potential as it operates at a tiny scale and consumes negligible power. The trend towards mobile computing could make this last factor a huge advantage.

Another area that will see rapid development is screen technology. Field Emission Display (FED) technology is expected to hit the mainstream before 2001. FED displays will offer the image quality and wide viewing angle of CRT screens while at the same time being at least as thin and power-efficient as LCD displays. But there is another miniature development of great potential. Micro displays can create an image on a thumbnail-sized LCD-like panel on the top of a silicon chip. Display manufacturers can then use a variety of optical techniques to enlarge the image. This technology could be used in laptops, PDAs or mobile phones. Other researchers are working on head-up displays which use direct retina projection – projecting the image directly onto the back of the eye. This would give a totally immersive experience, ideal for virtual reality or just simple gaming fun.

Storage technology is also set to be further miniaturised. IBM's Compact Flash 2 slot-compatible 340MB Microdrive is only the tip of the iceberg. Researchers at the California Institute of Technology are looking at ways of storing data using holograms in crystals. Laser beams alter the state of the particles in the crystal, creating an electronic pattern that can be read by another laser and converted into data. In theory this technology could store around 12GB on a crystal the size of a sugar cube. Holographic storage technology can be read quickly, as the data needn't be read sequentially – potentially at data rates of one billion bits per second.

For audio, Sony is already shipping its Super Audio CD format, which uses a new form of audio encoding called direct stream digital (DSD). This could replace PCM samples for use in multimedia products such as games and digital encyclopaedias. DSD produces a much more realistic placing of sound than PCM.

Current PCM samples have a sampling rate of 16bits at 44.1KHz. PCM can be improved using extra bits and higher sampling frequencies, but those tweaks provide no linear improvement. Increase the bit and sampling rates used and the the jumps in perceived audio quality diminish. DSD, however, can easily provide 120dB for audio bandwidth up to 20Hz – quality which is almost impossible using PCM technology.

Further improvements in sound quality are likely to come from digital speakers. These are different to the USB digital speakers available today. Digital speakers would bypass the current Digital to Analog Converters (DAC), producing audio directly from the digital source material held on CDs or DVDs. They are also lighter, more power efficient, and less distortion-prone than their analog equivalents. A British company called 1... limited (pronounced One Limited) already has a limited prototype in operation.

Although some of these technologies may not get to the mainstream market, one thing's for sure, you'll always be stuck in that upgrade cycle.

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