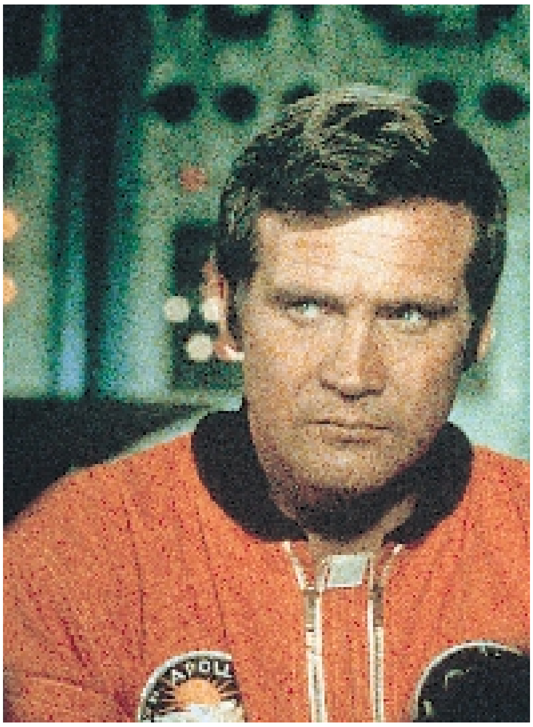
THE WAY WE INTERFACE WITH TECHNOLOGY IS BECOMING INCREASINGLY INTIMATE.

We can rebuild you

ONE OF THE MOST ENDURING of sci-fi fantasies is the assimilation of electronics and living tissue into a hybrid human-machine – the cyborg. Now a Californian research team has brought the fantasy a tiny step closer, by announcing a new bionic chip that allows computers to control cells directly.

When researchers want to introduce DNA or drug molecules directly into living cells, they often use a technique called electroporation. This involves applying a voltage across the cell, which causes tiny pores to temporarily appear in the cell's membrane, through which the molecules can get into the cell. The problem is that different types of cell respond only to certain voltage levels. Previously, researchers have used a kind of 'hammer to crack a nut' approach, by trying lots of different voltages until they're pretty sure that one will have worked. But they can't get any direct confirmation until the effects of the injected molecules start to show.



Steve Austin was a fictional Six Million Dollar Man in the 1970s, but could he be fact today?

PHOTOGRAPH MOVIESTORE COLLECTION

Now Boris Rubinsky of the University of California at Berkeley has developed a bionic chip that gives an answer immediately (www.me.berkeley.edu/faculty/rubinsky). Rubinsky and his team realised that when a pore opens under the influence of an applied voltage, a current should flow through the cell. Their new chip has two microscopic chambers built either side of an insulating membrane. Each chamber is filled with a conducting fluid, and has an electrode built into its wall. The central insulating membrane has a tiny hole in its centre, small enough to be blocked by a cell.

To use the chip, cells are introduced into one of the chambers, and allowed to settle in a way that one of the cells blocks the interconnecting hole. Then a voltage is applied across the electrodes. The chip will only conduct a current when the applied voltage is the right intensity to induce electroporation in the cell bridging the two chambers. So, when the current flows, you know you've found the right voltage for the cell. Rubinsky's research is currently limited to the laboratory, but he hopes the techniques can be extended to work with living human cells in situ. Knowing which cells respond to which voltages means you can control one cell without disturbing an adjacent one.

A chip that directly interfaces to living tissue is a powerful tool, and many researchers see the symbiosis of silicon and biology as the next big advancement. There has already been some startling progress. Roberta Diaz Brinton from the University of Southern California, for example, has created colonies of rat brain cells living on silicon substrates (www.usc.edu/dept/LAS/biosci/faculty/brinton.html). Each silicon platter supports over 80,000 living neurons. Using a matrix of electrodes embedded in the silicon, the cells can be stimulated and their activity monitored. 'We can eavesdrop and try to find the algorithms that define the cells' activity,' said Brinton.

Then there's the use of computer-controlled electronic prostheses to replace damaged tissue. Several researchers are working on bio-electronic implants to reverse blindness. The Illinois-based company Optobionics has developed a light-sensitive chip that is effectively a 'silicon retina', and has successfully implanted the chip in blind animals (www.optobionics.com). And earlier this year there was much media interest in an experiment at New York's Dobelle Institute, in which a 62-year-old patient who had been totally blind for nearly 30 years was able to dimly distinguish patterns of light (www.artificialvision.com).

While the *Six Million Dollar Man* may still be some years off, bionics research is making amazing strides. The number of people walking around with computers implanted into their bodies is growing every year. Today's small-scale experiments are helping to pave the way for a bionic future.

TOBY HOWARD