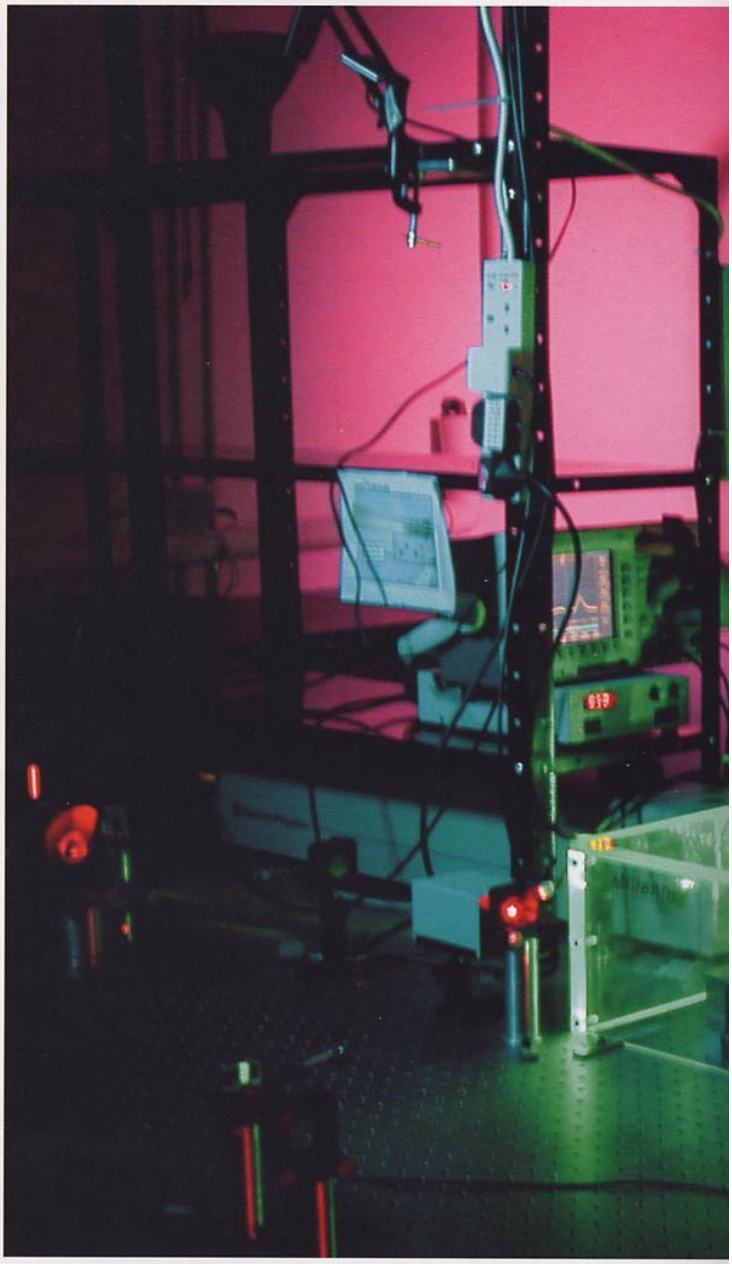
# Brain box

*Artificial intelligence may be the stuff of science fiction – but scientists at Heriot-Watt are making it science fact...*



AN artifical 'brain', which operates using laser light could be the answer to some of the 21st century's most irritating problems, from curing congestion hold-ups on the internet – problems which have led many to dub it the 'World Wide Wait' – to getting the trains to run on time, or even screening programmes for cancerous cells.

The Optically Interconnected Computing (OIC) group, at Heriot-Watt's School of Engineering and Physical Sciences, have been able to demonstrate a fully functional optoelectronic "brain that works on light" which can solve any complex scheduling problem. This is a world first which is the result of six years of continuous effort in both construction and programming from the researchers involved.

The strength of this optoelectonic system is that it uses laser light beams to weave incredibly complex interconnection patterns and carry huge volumes of information in a way simply not feasible in conventional electronics.

The system is principally designed to overcome a key problem in communications; transferring data from one person to another. Although connecting two people seems a relatively simple task, real systems have to handle many connections simultaneously, and often under adverse conditions such as localised overloading or hardware failure. These sort of scheduling problems lead to hold-ups in networks like the internet, with immense frustration for users. Ordinary neural networks can solve these sort of scheduling problems, but the inherent limitations of electrical interconnects on a conventional silicon chip have so far hindered the development of usable hardware systems.

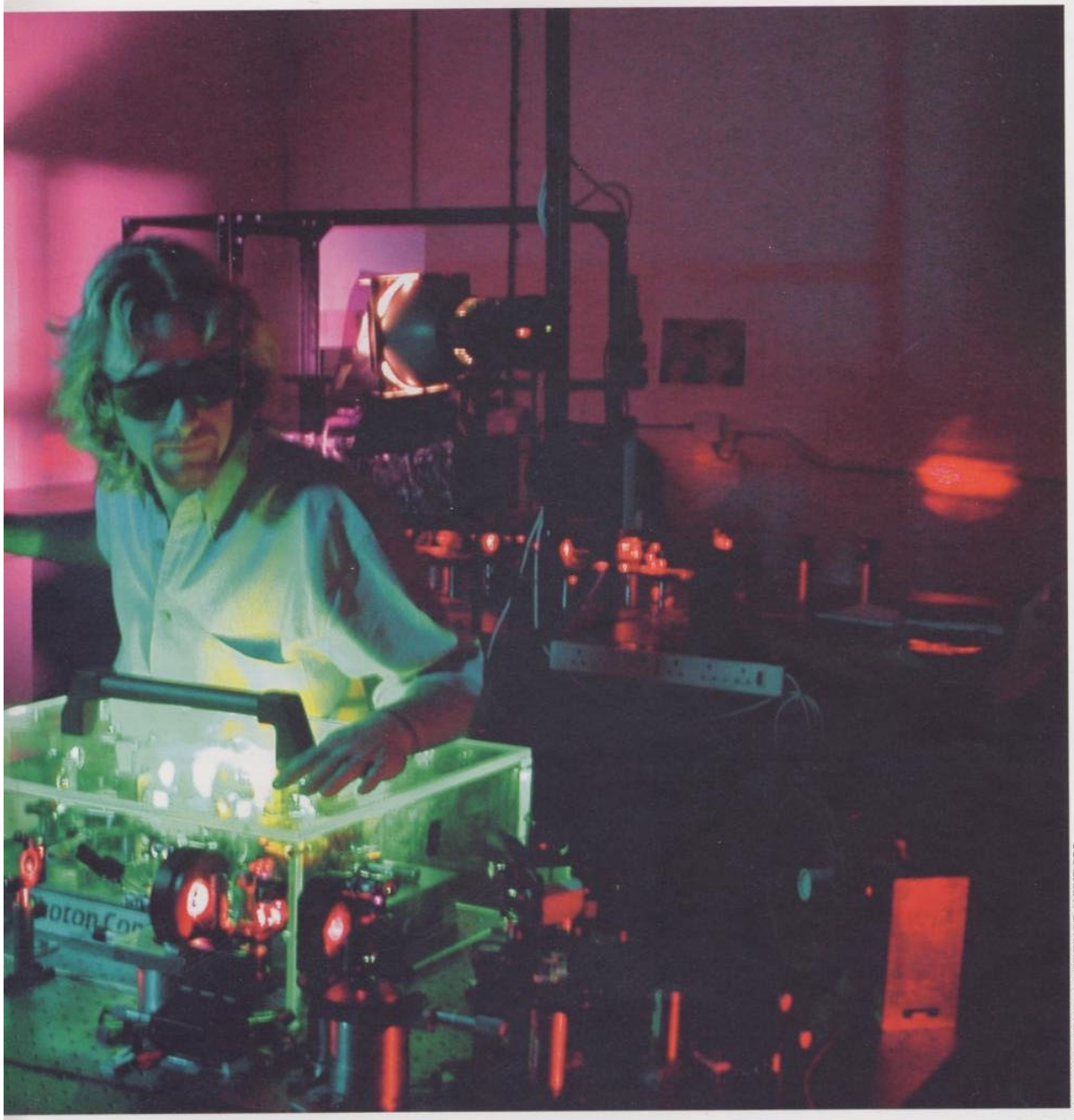
Heriot-Watt's optoelectronic neural network overcomes these difficulties by using optics to provide high-speed, high volume interconnections, combined with off-the-shelf-electronics to add information processing facilities, or 'neuron functionality'.

The technology used by the Heriot-Watt group is advancing rapidly, both in terms of functional abilities and, perhaps more importantly from an industry point of view, in terms of packaging.

The first generation demonstrator they produced, in collaboration with BT, took up almost the whole of the surface of an optical bench. The recently completed second-generation demonstrator, as constructed by Dr Keith Symington, could fit into a shoebox. The third generation version will integrate many of the components used in the last system onto a single chip, and they hope they will be able to fit two neural networks into a demonstrator the size of a pencil case. At this level of integration they believe they will be getting near to the size of system required for commercial viability.

Team Leader Dr John Snowdon said, "We are all excited about our recent success in these optoelectronic systems. In technical terms we have found that algorithmic adaptation and optimisation, specifically for the hardware used, has increased system scalability and performance. This would, therefore, allow continued expansion of networks such as the internet. This result is unprecedented and could not have been be imagined in a traditional, purely digital electronic system."

He believes that the range of problems that neural networks



Left: laser technology is put through its paces in a range of physic applications.
Below: Dr Keith Symington with the second generation optoelectric brain.

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can solve is potentially as great as those only normally possible for the human brain itself. "Our system can provide solutions to a variety of tasks that are relatively intractable to even the fastest digital machines. These range from image recognition, for example differentiating between healthy and cancerous cells, to general optimisation and task allocation problems like distributing jobs efficiently amongst multiple processors in a cluster or supercomputer system.

**"Successful applications could include heart-rate monitoring and stock market prediction!"**

"Other successful applications could include heart-rate monitoring and stock market prediction! The versatility and fault tolerance of this type of circuitry makes it a very attractive computational component of the near future, and Heriot-Watt is leading the way in this exciting new field."

● *Contact: Dr John Snowdon. Email: J.F. Snowdon@hw.ac.uk*