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INNOVATION

Raising the roof on silicon chip capability

COMPUTERS

● The trillion instruction computer is here. JANE BIRD talks to the man who devised it, who is one of the unsung heroes of the industry

A BRITISH computer designer has invented a supercomputer millions of times more powerful than the biggest machines currently available and a fraction of the price. It can execute one trillion instructions per second, and complete in one hour tasks which take months on number-crunching giants like the $5m Cray.

The design comes from Ivor Catt, 53, a maverick computer theorist famous in the industry for cracking the problem of how to build a beermat-sized silicon chip, or so-called "wafer". His new computer, dubbed Kernel, exploits the power of wafers further, by arranging them as a grid and interconnecting them to work simultaneously at very high speed.

Chips are the fundamental building blocks of all computers, but the process of making them is extremely cumbersome. Several hundred separate integrated circuits are chemically etched on to a slice of silicon a few inches in diameter. They are then tested, cut out and sorted.

This is necessary because microscopic faults in the silicon make around half the chips on any wafer faulty. All the good chips then have to be re-mounted in protective packaging with spidery legs to connect them on to circuit boards.

For years computer designers dreamed of skipping the cutting and re-packaging stage. This could be the only way to make computers that are sufficiently powerful to solve the problems of the future. Payroll and sales ledgers can be adequately handled with existing technology but engineers and scientists working on sophisticated projects need to do billions of additions and multiplications in a matter of seconds. Modelling the passage of storms in the atmosphere, the flow of air around hypersonic spaceplanes or how best to extract oil from deep-sea reserves, requires vastly increased computer processing and memory capacity.

Silicon chips, with circuits one hundredth the width of a human hair, are drawing close to their physical limitations

one end, being passed through the chain for processing, and then squirted off the end (see diagram). Every time the wafer is switched on a self-test routine checks which circuits are working, and connects them all up.

It was Sir Clive Sinclair, a kindred spirit in the world of electronic invention, who eventually recognised the brilliance of the idea and hired Catt to develop it six years ago. When times got tough for Sinclair, Catt was laid off, but the wafer project continued, and last month an offshoot of Sinclair Research, Anamartic, launched a wafer memory capable of storing a remarkable 200m characters of text.

However the spiral algorithm has one key limitation – it is a huge bottleneck. Although the individual chips are each capable of functioning simultaneously, the fact that they are connected up in a string means that there is only one route for data to enter or leave the wafer. Large amounts of data can still be handled in this way – after all, the entire information for a television picture comes down one wire – but it is very inefficient.

However, by incorporating a tiny computer on each memory chip Catt has now worked out how to make them communicate with their neighbours on all four sides. This means that there are multiple routes on, off and all around the wafer, and avoids delay getting from one end to the other.

It is not the world's first parallel processing machine. The Distributed Array Processor, from ICL, and computers based on the transputer from Inmos, are already capable of performing lots of operations simultaneously. However the cost and complexity of each processor make them impractical in large connections.

"However, Kernel is based on self-organising, self-repair fault-tolerance, and each wafer costs just a few hundred pounds, so it becomes practical to build arrays of around one million individual processors," says Catt. This way he has created a computer which he claims is far more suited to tackling real problems.

For instance in air traffic control, each processor in the array could correspond to a square mile of airspace and operators could look into the future by speeding up the processors, thereby discovering potential collisions between aircraft. Similarly, weather-forecasters could see at the press of a button whether rain from the west would hit Lord's before the end of cricket play.

CATT has always been a loner. His ideas are too far-reaching to appeal to the short-term commercial objectives of an excessively conservative industry, and some of his most imaginative designs are the result of long hours spent in a caravan in his front garden. "Many people think the computer industry is fast-moving and innovative. They couldn't be more wrong," he comments.

Twenty-five years ago Catt first began trying to persuade manufacturers to adopt his wafer idea. At that time his experience was relatively unusual because he had worked for both the semiconduc and the computer industry.

"That was how I saw t the wafer would solve computer industry's pr lems. The cost of the ch after they had been cut and repackaged was a hund times the cost of the wafer," says, but he was greeted by industry first with ridic then sheer disbelief.

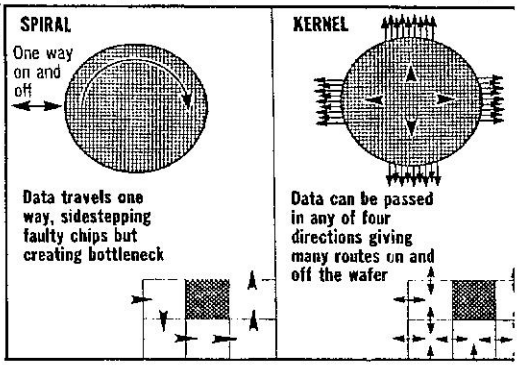
During the 1970s Catt t up sociology, and wrote s eral books, including The C Concept – an amusing s vival guide on how to hang to your job. But he carried refining the wafer idea and due course it was taken up the National Research D clopment Council which p for world-wide patents.

Projects at Middlesex P technic and Brunel Univer

James Morga

Catt among the chips: wonder wafers on displa

Paul Bryant



Dallas spawned the revolution

THE electronics revolution which has had its latest leap with Catt's Kernel logic began 30 years ago. On February 6 1959 an American patent was applied for the invention of the semiconductor integrated circuit, better known as the silicon chip, by Jack Kilby.

The public announcement of

Texas Instruments

from ideal for some of the components. Either of the popular semiconductors, silicon or germanium, would do. He also saw that several different components, all made from the same material, could be built in a single block, or chip of that material: a complete circuit integrated on to a single chip.

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