moore's law expires

The rule the industry has relied on for years, which predicts the growth rate of technology, could cease to apply as manufacturers pump out smaller, faster products at unprecedented speeds. Robert McMillan asks the creator of Moore's Law where we go from here

To mark its 35th birthday, chip maker Intel has buried a time capsule at its Santa Clara campus. It contains, among other things, an Itanium 2 processor, chopsticks donated by Intel's Malaysian subsidiary, and a copy of *Time* magazine featuring Intel co-founder and Chairman Andy Grove on the cover.

In attendance at the evening interment was another of Intel's founders, Gordon Moore, who served as the company's CEO from 1975 to 1987. He is best known as the creator of Moore's Law, which predicts that the number of transistors on a computer chip will double every two years. Though Moore says it took years before he could even refer to his idea as 'Moore's Law', the maxim has proved a remarkably accurate predictor of the computer industry's growth since it was coined in 1965.

Here Moore discusses the amount of life left in his famous theory, whether Intel should follow Microsoft and drop employee stock options, and if Intel's x86 processors will still be around when the company digs up its time capsule 15 years from now.

How long will Moore's Law remain in effect?

What has been driving it since it was formulated in 1965 is the ability to make things smaller and smaller. Eventually the fact that the materials are made of atoms is a real limit.

We've started seeing quantum mechanical effects even in the devices we're making now. I think we've got two or three more generations moving in the same path, then we'll have to change.

We can make bigger chips. It may not be at quite the breathtaking pace it's been so far, but something that doubles every four years instead of every two is still almost unprecedented. The slow down depends on a lot of factors that are hard to predict. Sufficient investment, for example, is a lot easier in a growing market and I expect the market will continue to inflate, but these things are all tied together.
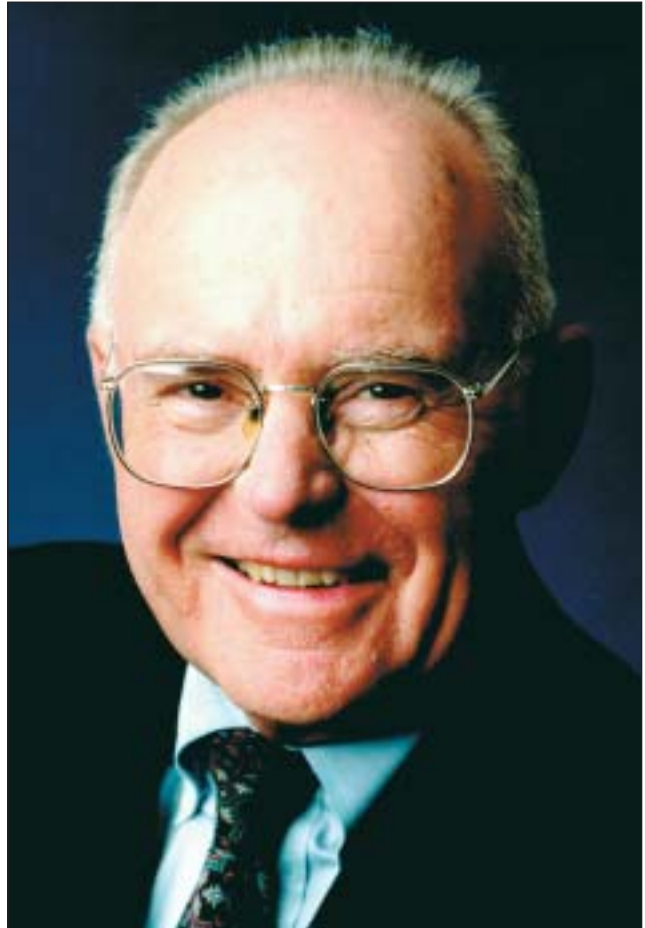
So, even assuming that we slow down to a doubling of transistors every four years, where will that growth come from?

We could just make bigger chips which incorporate more. Once you give the engineers a billion-transistor budget and tell them to design something useful, they've got a lot of flexibility.

The x86 (the most successful microprocessor in history) architecture is now about 25 years old. Did you expect it to last this long?

The x86 microprocessor has evolved considerably over that 25 years. Essentially we took advantage of all the new inventions of the computer architects and academic communities. And while it might carry some baggage from the past, the processor allows us to run all historical applications which is really important.

I think it's going to be around for a long, long time. I don't envisage circumstances that would force us to abandon it right now. If somebody produced completely hardware-independent software then maybe, but you'd still have to go back and take the tens of thousands of programs, the legacy stuff and convert them. I can't see this happening.

I think compatibility is such a powerful asset for the typical user, it's going to keep the Intel architecture around for the foreseeable future.

Its success seems to be, in part, holding back Intel's own Itanium processor.

They are aimed at different markets. Itanium doesn't depend much on legacy software and it really is a big-machine-oriented architecture. It may find its way on to the desktop too if people want to go that way, but I'm a little sceptical. We'll have to wait and see.

How much longer will x86 be around? Do you think it will last another 25 years?

It will still be around when we dig up the time capsule. ■

ink: the recycling issue

The debate over the cost of inkjet cartridges continues, but Andrew Charlesworth looks at the other issue involved – recycling – to see how manufacturers intend to solve this problem

The high cost of inkjet cartridges has led to a healthy aftermarket for refilled and cloned cartridges priced at a fraction of the cost of ink from the printer manufacturers. While the refillers and cloners accuse the printer makers of conning customers, the printer companies justify their prices claiming that only their high manufacturing standards can deliver the quality of printing that customers want.

Beyond pricing, another dimension to the argument is recycling. The WEEE (Waste Electrical and Electronic Equipment) Directive from the European Commission, due to be enacted in UK legislation in August 2004, puts the onus for disposal of waste equipment on manufacturers.

Smart tactics

The refill companies have aggressively lobbied the DTI (Department of Trade and Industry) to have inkjet cartridges included in the WEEE Directive. They are afraid that if cartridges are left out of the new recycling law, the printer makers will use so-called chipped or smart cartridges to ensure they cannot be reused.

Some manufacturers put a chip on their cartridge which communicates with the printer and PC, providing warning messages that the ink is running out.

The printer makers say these chips are there to ensure their customers get only the highest quality output. The cloners and refillers claim they are there to rip off the customers by prematurely indicating low levels of ink and preventing the printer from being used if the cartridge is refilled.

In some cases the printer won't work at all if the cartridges are refilled; in others the printer will work, but the warning messages won't.

Overriding problem

Recent tests by the Consumers Association showed that if the chip was overridden, Epson's cartridges could be squeezed for another 17 to 38 percent of output, before any deterioration in print quality became noticeable.

Of the big five inkjet printer manufacturers – HP, Lexmark, Epson, Canon and Brother – market leader HP, Epson and Lexmark are the most prevalent users of chipped cartridges. Lexmark even took one cartridge cloner, SCC, to court in the US for cloning the chips on Lexmark-compatible cartridges.

The bad news for those lobbying fervently on behalf of the refilling companies is that the WEEE isn't going to include inkjet cartridges.

"Inkjet cartridges do not come under the scope of the Directive," said a spokesman for the DTI. "WEEE is about whole products, not components."

The good news for the refillers is that although they have lost this battle, the war may be swinging their way.

An article promoting eco-friendly design, written into the WEEE Directive at the last minute, makes it beholden upon member states to prevent manufacturers from building in obsolescence to their products.

"The whole point of WEEE, and Directives like it, is to produce an environmental benefit and we will be keeping a close eye on the broader issue," said the DTI spokesman. "The recycling industry is years ahead of the legislation in this respect and we want to actively promote their business. They are doing a marvellous job."

Behind WEEE other EC Directives are in the pipeline that promote reuse and recycling and will not tolerate flagrant waste.

PC Advisor predicts that printer makers are going to have to formulate recycling and reuse programs that are as attractive to consumers as the low prices offered by the refillers, or wave goodbye to a chunk of their inkjet cartridge profits. ■