OK, computer

When ***Marcus Chown*** *was commissioned to write a book explaning everything, he wasn't worried. Then he realised he had to tackle a chapter on computers. He explains what he learnt, and why it was more fascinating than he ever thought possible*

A computer is unlike every other human invention. A washing machine is a washing machine is a washing machine. It can never be a trouser suit or corkscrew or a speedboat. But a computer can be a word processor or a spread sheet or shoot 'em up video game. In fact, with the ability to manipulate matter – and this is coming in the shape of 3-D printers – a computer could indeed be a trouser suit or a corkscrew or a speedboat. This highlights the crucial difference between a computer and all other machines. While they have specialised functions, a computer can simulate anything else. In the jargon, it is a "universal machine".

This is just one of the things I learned when I set out to write about computers. "Your skill is explaining physics to anyone," Neil Belton, my book editor, had said to me. "How about using your skill to explain everything to anyone? How about writing a book about how the world works?" I was daunted. Neil was asking me write about everything from finance to thermodynamics, sex to special relativity, human evolution to holography. Where would I even start? Eventually, however, I took a deep breath and took the plunge.

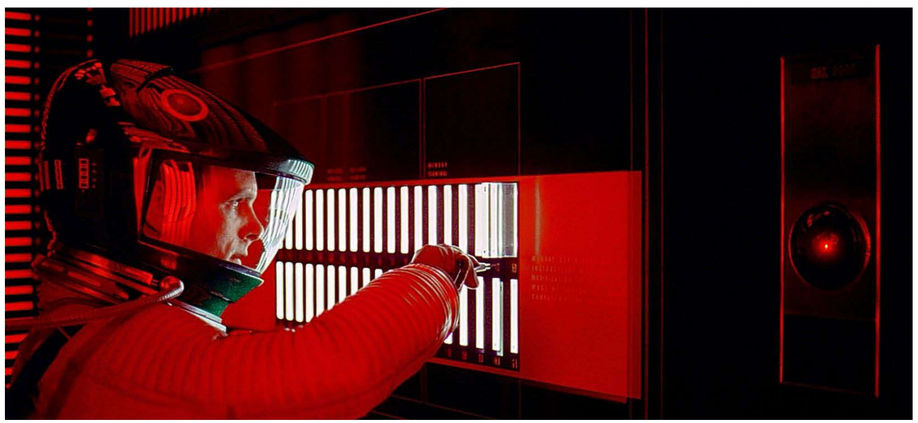
Very soon I realised I'd have to write about computers since they are ubiquitous in our daily lives. My heart sank. Computers are dull and boring, I thought. Surely there is nothing interesting I could write about them? But I was wrong.

As I did my research, I learnt deep things about computers and I learnt quirky, surprising things. Did you know, for instance, that, in 1943, Thomas J Watson, head of IBM, predicted that the global market for computers was ... five. That is not even one per continent. It reminds me of an earlier failure of the imagination from the inventor of the telephone. Alexander Graham Bell confidently predicted that: "One day there will be a telephone in every city."

Here is another surprising thing I learnt. What country do you think designs pretty much all the computer chips in all the electronic devices in the world? America may be? Or perhaps Japan? Or even South Korea? Well, actually, it is the UK. While the big chip manufacturers such as the American giant "Intel" concentrated on making faster, more compact chips for desktop computers, a company called "ARM", based in Cambridge, struck out in another direction entirely. It put entire computers on a chip. This made possible the vast numbers of compact and mobile electronic devices from satnavs to games consoles to mobile phones. It moved chips from dedicated and unwieldy computers into the everyday world.

So much for computer trivia, what about the deep stuff? What, for instance, is a computer? Well, essentially it is nothing more than a shuffler of symbols. A bunch of symbols is fed in – representing perhaps the speed and altitude of a plane – and a bunch of symbols is spat out – specifying maybe the amount of fuel to burn and the angle to orient the aelerons. What turns the input into the output is a set of internally stored instructions. It is because this "program" is infinitely rewritable that computers are universal and can simulate any other machine.

Have you tried switching it off and on again? The idea of super-powerful computers is explored in films such as 'Minority Report' (top) and '2001: A Space Odyssey' (below)



Bizarrely, the computer had its birth not in the everyday world but in the esoteric field of pure mathematics. Long before the first modern programmable computer, the British mathematician Alan Turing imagined a theoretical machine that shuffled symbols on the basis of stored internal programmes. Because he was interested in the limits of such machines, he then asked: Is there anything such a computer can never compute? To his surprise, he quickly found a problem. It is easily stated: If a computer is given a computer program, can it determine, ahead of actually running the program, whether the program will eventually halt – that is, whether it will avoid getting caught in an endless loop, spit out an answer and stop? Turing found that no computer, no matter how powerful, will ever be able to solve this "halting problem".

Fortunately, real computers do not tackle esoteric tasks like the halting problem but only mundane ones like word processing and creating video games, and so they are not limited as Turing's result implies. In fact, Turing himself graduated from theoretical computers to real computers that computed practical things during the Second World War. Using some of the first programmable digital computers, at Bletchley Park and in Cheltenham, he helped break the "unbreakable" Enigma and Fish codes with which the Nazis encoded their most secret communications.

The post-war period saw computers not only increasing in number – way beyond the five predicted by Watson – but in power, too. And in 1965, Gordon Moore, one of the founders of Intel, noticed something remarkable. Computing power – or equivalently, the number of transistors on a chip – doubled roughly every 18 months. Moore's Law, as it became known, has continued to apply and is behind the ever-increasing sophistication of our smart phones, laptops and other electronic devices. It is a sociological law – a law of human ingenuity. Because of the financial incentives, people continually find new ways of putting more transistors on a chip. But even Moore's Law will break down eventually, because there are physical limits set by the laws of nature that are impossible to circumvent, which ultimately determine the limits of computers.

> **"The ultimate computer will be like a fireball of a nuclear explosion. It will be like a billion-degree piece of the Big Bang**

The speed of a computer – the number of logical operations it can perform per second – turns out to be limited by the total energy available. Today's laptops are so slow because they use only the "electric energy" in transistors. But this energy is totally dwarfed by the energy locked away in the mass of the computer, which provides nothing more than the scaffolding to keep a computer stable. The ultimate laptop would have all of its available energy in processing and none of its energy in its mass. In other words, it would have its mass-energy converted into light-energy, as permitted by Einstein's E = mc2 formula.

The ultimate computer, it turns out, will be like the fireball of a nuclear explosion. It will be like a billion-degree piece of the Big Bang. Though it might be nice to have the most powerful computer imaginable on your desk, it might be just a little inconvenient.

Computers turned out to be a lot more interesting than I thought when I embarked on writing about them. Maybe you agree. Or maybe you agree with Picasso: "Computers are useless," he said. "They can only give you answers."

Find out more in Marcus Chown's book, 'What A Wonderful World: One Man's Attempt To Explain The Big Stuff' (Faber & Faber)

iTest James Vincent

Microsoft scores a near-miss with its search for the magic formula

SURFACE PRO 2
Price: from £179
Processor: Haswell Intel Core i5
Screen 10.6-inch, 1920 x 1080
Memory: 4GB-8GB
Flash storage: 128GB-512GB
Battery life: Eight hours

What is it?
Microsoft's attempt to take control of mobile computing by creating a truly hybrid device that offers the portability of a tablet with the working capability of a laptop. Unfortunately, nearly every tech company in the world is currently searching for their own solution to this lead-into-gold alchemy and none have succeeded. With the Surface Pro 2 Microsoft has come the closest yet, but the compromises still show.

Why, where does it fall down?
It's just a bit awkward as a tablet. At an inch thick and 900 grams in weight it's too bulky to hold for extended periods of time, and while Microsoft has built Windows 8.1 from the ground up for touch screen use, there are still problems when compared to rivals' offerings. There's a fairly anaemic app collection that's particularly deficient when it comes to games and sometimes simply getting around can be awkward.

Ok, so how would I use it?
Well, as a laptop it's fantastic. Firstly, Microsoft has improved the kickstand from the older models meaning you can now set the screen at an angle appropriate for an actual computer and not a picture frame; secondly, the Pro 2 has exactly the sort of hardware you'd want from an ultrabook: a sharp screen, top-of-the-line processor, and an already-sizable SSD hard drive that's boosted by the addition of 200GB of free cloud storage. Attach the Type Cover (a slim keyboard that also protects the screen) and you can happily write for the duration of the Pro 2's eight hour-plus battery life.

is it worth it?
This is a premium device in many ways and the build quality is notably fantastic. However, it's also a device that works best sitting on a flat surface with a keyboard attached, which rather kills the whole tablet angle; and if you're not thinking of doing any work beyond email and Microsoft Office all that power goes to waste. If a Surface of any kind is what you really want, then I'd advise looking iat the non-Pro version instead – there's less power, sure, and fewer software options, but it's cheaper, lighter, comes with a free version of Office and has exactly the same build quality. The Surface is a fantastic device, sure, but not at any price.