The computer science of everyday things

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LECTURE NOTES

Computers are physically everywhere, mostly embedded inside everyday objects like CD players, telephones and cameras, and they affect our lives in numerous ways. Companies use computers, and almost all of our daily interaction with organisations, whether our employers or our supermarket, is constrained by what computers will allow. How we handle all sorts of information, from conventional magazines and library books to DVD and MP3 is affected by ideas of copyright that are driven by computers. There is far more to the excitement of computers than the internet and the world wide web.

Researchers are looking at more ways in which computers can help us and make our lives easier. Houses are being built that know who is around and what they are doing — and what they want. If cars have got dozens of computers and hundreds of sensors in them, why don't we treat our bodies at least as well? A few people already have implants, and surely the advantages of implants — health, security, making life easier — will soon persuade us all to have them. Bodymedia make a $995 armband that monitors many health factors: it can be used for personal well-being, programme compliance, or for monitoring employees to save companies money.

Only a few years ago nobody would have imagined that we'd all have mobile phones and be playing computer games all the time. Remember when the telephone was invented? "Who'd want to telephone Maine?" Remember when Atari invented the first console game? When the world wide web was invented, a description of it was turned down by a scientific conference because nobody understood its implications. Things take us by surprise, and there are many more surprises in store. We might not believe an episode of Star Trek if it had some of our *current* technology in it.

In 1965, Intel's Gordon Moore made a famous observation, now known as Moore's Law. Computer power will double every 18 months. According to Intel the law is still true today, 36 years later. Today's computers are much smaller, more powerful and more versatile than anyone could have imagined. Hitachi's mu chip, while not strictly a computer, is only 0.4mm square and includes a radio transmitter. It is small enough to embed in paper, say in banknotes or even to inject into things. Combine these impressive gains in miniaturisation/power/performance with the scale of the world wide networks now availablet to us all, and we can harness power and convenience undreamt of. Napster's music library used about 50 million computers. The SETI@home project uses 3 million computers across the world.

Yet something is not quite right. The recent dot com collapse shows just how mistaken some people were about the future promise. The 'productivity paradox' is the recognition that despite introducing computers everywhere in our society, GDP has not gone up as expected. There are some conventional answers: computers are not as easy to use as they are

made out to be. Your video recorder is the classic example, but anyone who has used a desktop computer will understand that productivity does not happen automatically, particularly if you have to learn something incomprehensible and then spend your time rebooting it, or installing upgrades. Why did my local hospital have to spend £750,000 fixing Y2k problems? In our capitalist society, I might use computers to be more efficient, but so do my competitors. If my competitors are getting better, then I have to work harder to keep up. The promised efficiency gains evaporate.

Another explanation is externalisation. If I am a service company, I might replace all of my helpful staff with automatic telephone answering services. I save enormously on costs, but now my customers spend more time on the phone — and probably even pay me for calling. My internal costs have been shifted outside the company. And of course the people I make redundant to become more efficient have got to go somewhere else in the economy.

Moore's Law promises exponential growth, but we can only take advantage of it if we are prepared to upgrade everything we do. And the computer science of every day things is now a fashion industry. Last year it was WAP, this year 3G. Last year it was the internet, this year the Grid. Last year it was web delivery, not it is automatic checkout. All of this exponential progress means, and in fact relies on, exponential wastage. Great Britain currently throws away about a million tonnes of electronics every year, which ends up as landfill. We have about the same amount of rubbish in our lofts and childrens' bedrooms that is no longer used, and is just waiting to be thrown away. Most of this electronics waste is difficult to recycle, and it contains many pollutants. Even if we do not worry about the environmental impact, which is largely unknown, it's plain that exponential growth means our landfill sites will be completely full in about five years' time. What will we do then?

It's not "what will we do *then*," but "what can we do *now*?"

The simplest thing to do is realise that we are all accepting shoddy products and services, and most of us think these things are magic. As Arthur C. Clarke said, "Any sufficiently advanced technology is indistinguishable from magic." Certainly computers are sufficiently advanced technology to be indistinguishable from magic. And we are like the sorcerer's apprentice, so entranced by the promise of magical power and an easy life we are no longer anything like in control of our magic.

We can do a lot better. In the 1960s Ralph Nader (see his book *Unsafe at Any Speed*) started the consumer movement and sorted out many exploitative practices of the 60s car industry. Consumer pressure, combined with an awareness that is wasn't so much "drivers have accidents" — as the car manufacturers wanted us to believe — but "bad design causes accidents." We're now more critical of safety and other human-oriented features of cars. Why not with everyday computers? If I took my car to the garage with a flat tyre, they aren't going to say they can't fix it unless I buy a new car; why should I put up with that sort of behaviour with computers, mobile phones, fax machines and so on? If you bought a table, but it had a hole in it or splinters, you'd get it fixed. So why do you put up with a computer that has holes all over it? Worse, you happily buy an upgrade and then more memory to fix the problem *yourself*.

Just like safety conscious drivers had to buy their own safety in 1960s cars because the manufacturers could sell without worrying about it. Moore's Law is a business law, not a technology law. Companies the world over are investing in what makes things sell: being

smaller and faster… and Moore's Law results. Not in being more useful or in being easier to use.

It's not difficult to make everyday computers easier to use and more reliable (I'll give several concrete examples in the lecture).[·] Given it's possible: why isn't it happening? Simply because it is not good business. Manufacturers can employ poor programmers, poor designers, poor usability people — if they can easily sell products to undemanding consumers. They work to the standards we require of them. While we think anything they do is magic, they will sell us anything. And they do. The magic is they make a profit out of our collective gullibility.

How can we become less gullible? Clearly becoming more aware of computer science itself seems beyond the manufacturers already. Indeed while our teachers struggle to teach IT and computing — because it changes so fast — we in education are going to be hard pressed to supply the high quality people industry needs. Well, for the time being industry doesn't know it needs qualified people, and the funding of education is driven by indicators such as employment, not indicators such as quality of life.

I can tell a manufacturer how to improve their product; but that's too slow. I'd be overworked! I can tell a manufacturer the principles and processes. A Masters degree in design takes a year, and that's too slow too. Nothing will happen until manufacturers want to have higher standards, and that won't happen until we start being more critical.

Here are two simple rules you can use. First don't get a demonstration of anything; try and figure it out. It is so easy to give a demonstration of anything and make it look really easy and useful — the demonstrator knows how to do it. If you don't know how to do it, has it been designed well enough so you can find out easily? What are you going to do next year when you've lost the manual: is the system simple enough and uniform enough that you can learn it?

Secondly, ask for the user manual. Unfortunately many user manuals are inaccurate, but one of the key findings, hardly surprising if you think about (and few do!), is that shorter manuals are better. Here's an example: the Canon S110 camera I have has a warning not to charge the battery for more than 24 hours. It's written in highlights! I may ruin my battery! Well, why isn't there a simple bit of electronics that stops the battery charging after 24 hours? If that simple feature had been put in, the manual would have been shorter and simpler. I'd have less to learn about the camera, and it would be easier to use and more reliable. You don't have to be too cynical to see that most users don't care about details, whether or not they are buying a quality product, and that most manufacturers would actually like consumers to become dissatisfied eventually — say when the battery fails — because then they'll come back and buy an upgrade.

The battery example is easy to explain, and makes the issues pretty clear. Further examples from tonight's *Computer Science of Everyday Things* lecture show that much more than battery charging is fixable. Depending on time available for the lecture: we might mention

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[·] See for details: H. Thimbleby, "The Computer Science of Everyday Things," in P. Calder and M. Rees, editors, *Proceedings of the 2nd. IEEE Australasian User Interface Conference*, Australian Computer Science Communications, **23**(5), pp3–12, 2001. See `http://www.cs.mdx.ac.uk/harold/srf/auic.pdf`

the user manuals of some fly-by-wire aircraft: where usability is life-and-death. We may mention car radios, where the bad design of everyday objects can cause road accidents. Mobile phones will be discussed as a straight forward example where computer science can improve usability enormously. See the reference or web site for more details.

It all other complicated areas — say, for buying cars — there are legal usability requirements (because an unusable car is unsafe). Why doesn't the law clearly require usability in products: they should be fit for use, so they shouldn't they also be required to be usable? Or at least, why don't places like Dixons provide "MOTs" certifying that their gadgets have passed or been developed to appropriate international standards? (For example, to ISO standard 9241.) Currently Dixons won't even let you look at the user manual because it means opening the box!

If we can reduce the number of toxic heavy metals going into landfill by reducing the number of ruined batteries, just that would be a worthy achievement. At least the environmental concerns are going to force us to start thinking like this. But let's hope that we realise there is more than the environment at stake: making things better for people is going to happen not when we ask not for more magic but when we demand for a proper computer science of everyday things.