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How the world will change as computers spread into everyday objects

print-edition iconPrint edition | LeadersSep 12th 2019

6-8 minutes

ON AUGUST 29TH, as Hurricane Dorian tracked towards America's east coast, Elon Musk, the boss of Tesla, an electric-car maker, announced that some of his customers in the storm's path would find that their cars had suddenly developed the ability to drive farther on a single battery charge. Like many modern vehicles, Mr Musk's products are best thought of as internet-connected computers on wheels. The cheaper models in Tesla's line-up have parts of their batteries disabled by the car's software in order to limit their range. At the tap of a keyboard in Palo Alto, the firm was able to remove those restrictions and give drivers temporary access to the full power of their batteries.

Mr Musk's computerised cars are just one example of a much broader trend. As computers and connectivity become cheaper, it makes sense to bake them into more and more things that are not, in themselves, computers—from nappies and coffee machines to cows and factory robots—creating an "internet of things", or IoT (see Technology Quarterly). It is a slow revolution that has been gathering pace for years, as computers have found their way into cars, telephones and televisions. But the transformation is about to go into overdrive. One forecast is that by 2035 the world will have a trillion connected computers, built into everything from food packaging to bridges and clothes.

Such a world will bring many benefits. Consumers will get convenience, and products that can do things non-computerised versions cannot.

Amazon's Ring smart doorbells, for instance, come equipped with motion sensors and video cameras. Working together, they can also form what is, in effect, a private CCTV network, allowing the firm to offer its customers a "digital neighbourhood-watch" scheme and pass any interesting video along to the police.

Businesses will get efficiency, as information about the physical world that used to be ephemeral and uncertain becomes concrete and analysable. Smart lighting in buildings saves energy. Computerised machinery can predict its own breakdowns and schedule preventive maintenance. Connected cows can have their eating habits and vital signs tracked in real time, which means they produce more milk and require less medicine when they fall ill. Such gains are individually small but, compounded again and again across an economy, they are the raw material of growth—potentially a great deal of it.

In the long term, though, the most conspicuous effects of the IoT will be in how the world works. One way to think of it is as the second phase of the internet. This will carry with it the business models that have come to dominate the first phase—all-conquering "platform" monopolies, for instance, or the data-driven approach that critics call "surveillance capitalism". Ever more companies will become tech companies; the internet will become all-pervasive. As a result, a series of unresolved arguments about ownership, data, surveillance, competition and security will spill over from the virtual world into the real one.

Start with ownership. As Mr Musk showed, the internet gives firms the ability to stay connected to their products even after they have been sold, transforming them into something closer to services than goods. That has already blurred traditional ideas of ownership. When Microsoft closed its ebook store in July, for instance, its customers lost the ability to read titles they had bought (the firm offered refunds). Some early adopters of "smart home" gadgets have found that they ceased to work after the firms that made them lost interest.

That tilts the balance of power from the customer to the seller. John Deere, an American maker of high-tech tractors, has been embroiled in a row over software restrictions that prevent its customers from repairing their tractors themselves. And since software is not sold but licensed, the firm has even argued that, in some circumstances, a tractor-buyer may not be buying a product at all, instead receiving only a licence to operate it.

Virtual business models will jar in the physical world. Tech firms are generally happy to move fast and break things. But you cannot release the beta version of a fridge. Apple, a smartphone-maker, provides updates for its phones for only five years or so after their release; users of Android smartphones are lucky to get two. But goods such as washing machines or industrial machinery can have lifespans of a decade or more. Firms will need to work out how to support complicated computerised devices long after their original programmers have moved on.

Data will be another flashpoint. For much of the internet the business model is to offer "free" services that are paid for with valuable and intimate user data, collected with consent that is half-informed at best. That is true of the IoT as well. Smart mattresses track sleep. Medical implants observe and modify heartbeats and insulin levels, with varying degrees of transparency. The insurance industry is experimenting with using data from cars or fitness trackers to adjust customers' premiums. In the virtual world, arguments about what should be tracked, and who owns the resulting data, can seem airy and theoretical. In the real one, they will feel more urgent.

Then there is competition. Flows of data from IoT gadgets are just as valuable as those gleaned from Facebook posts or a Google search history. The logic of data-driven businesses, which do ever better as they collect and process more information, will replicate the market dynamics that have seen the rise of giant platform companies on the internet. The need for standards, and for IoT devices to talk to each other, will add to the leaders' advantages—as will consumer fears, some of them justified, over the vulnerability of internet-connected cars, medical implants and other devices to hacking.

Predicting the consequences of any technology is hard—especially one as universal as computing. The advent of the consumer internet, 25 years ago, was met with starry-eyed optimism. These days it is the internet's defects, from monopoly power to corporate snooping and online radicalisation, that dominate the headlines. The trick with the IoT, as with anything, will be to maximise the benefits while minimising the harms. That will not be easy. But the people thinking about how to do it have the advantage of having lived through the first internet revolution—which should give them some idea of what to expect. ∎