# By 2030, this is what computers will be able to do

Developments in computing are driving the transformation of entire systems of production, management, and governance. In this interview Justine Cassell, Associate Dean, Technology, Strategy and Impact, at the School of Computer Science, Carnegie Mellon University, and co-chair of the Global Future Council on Computing, says we must ensure that these developments benefit all society, not just the wealthy or those participating in the “new economy”.

## Why should the world care about the future of computing?

Today computers are in virtually everything we touch, all day long. We still have an image of computers as being rectangular objects either on a desk, or these days in our pockets; but computers are in our cars, they’re in our thermostats, they’re in our refrigerators. In fact, increasingly computers are no longer objects at all, but they suffuse fabric and virtually every other material. Because of that, we really do need to care about what the future of computing holds because it is going to impact our lives all day long.

## Tell me about the technological breakthroughs we have already seen, and what you expect to see in the coming years?

Some of the exciting breakthroughs have to do with the internet of things. In the same way we have a tendency to think of computers as rectangular boxes, we have a tendency to think of the internet as being some kind of ether that floats around us. But quite recently researchers have made enormous breakthroughs in creating a way for all objects to communicate; so your phone might communicate to your refrigerator, which might communicate to the light bulb. In fact, in a near future, the light bulb will itself become a computer, projecting information instead of light.

Similarly, biological computing addresses how the body itself can compute, how we can think about genetic material as computing. You can think of biological computing as a way of computing RNA or DNA and understanding biotechnology as a kind of computer. One of my colleagues here at Carnegie Mellon, Adam Feinberg, has been 3D-printing heart tissue. He’s been designing parts of the body on a computer using very fine-grained models that are based on the human body, and then using engineering techniques to create living organisms. That’s a very radical difference in what we consider the digital infrastructure and that shift is supporting a radical shift in the way we work, and live, and who we are as humans.

And quantum computing allows us to imagine a future where great breakthroughs in science will be made by computers that are no longer tethered to simple binary 0s and 1s.

## How is computing changing? What are the forces driving those changes?

Some of the ways that computing is changing now are that it is moving into the fabrics in our clothing and it’s moving into our very bodies. We are now in the process of refining prosthetics that not only help people reach for something but in reaching, those prosthetics now send a message back to the brain. The first prosthetics were able quite miraculously to take a message from the brain and use it to control the world. But imagine how astounding it is if that prosthetic also tells the brain that it has grasped something. That really changes the way we think of what it means to be human, if our very brains are impacted by the movement of a piece of metal at the edge of our hands.

## How could developments in computing impact industry, governments and society?

First of all, there’s really a disruption of all industry sectors. Everything from the information and entertainment sectors, that can imagine ads that understand your emotions when you look at them using machine learning; to manufacturing, where the robots on a production line can *learn* in real time as a function of what they perceive. You can imagine a robot arm in a factory that automatically remanufactures itself when the object that it is putting into boxes changes shape. Every sector is changing and even the lines between industry sectors are becoming blurred, as 3D-printing and machine learning come together for example; as manufacturing and information; or manufacturing and the body come together.

## What needs to be done to ensure that their benefits are maximized and the associated risks kept under control?

If you think about the future of computing as a convergence of the biological, the physical and the digital (and the post-digital quantum), using as examples 3D-printing, biotechnology, robotics for prosthetics, the internet of things, autonomous vehicles, other kinds of artificial intelligence, you can see the extent of how life will change. We need to make sure that these developments benefit all of society, not just the most wealthy members of society who might want these prosthetics, but every person who needs them.

One of our first questions in the Council is going to be, how do we establish governance for equitable innovation? How do we foster the equitable benefits of these technologies for every nation and every person in every nation? And, is top-down governance the right model for controlling the use of these technologies, or is bottom-up ethical education of those that engage in the development of the technologies and their distribution, a better way to think about how to ensure equitable use?

I believe that all technologists need to keep in mind a multi-level, multi-part model of technology that takes into account the technological but also the social, the cultural, the legal, all of these aspects of development. All technologists need to be trained in the human as well as the technological so that they understand uses to which their technology could be put and reflect on the uses they want it to be put to.

**What will computing look like in 2030?**

We have no idea yet because change is happening so quickly. We know that quantum computing – the introduction of physics into the field of computer science – is going to be extremely important; that computers are going to become really, very tiny, the size of an atom. That’s going to make a huge difference; nano-computing, very small computers that you might swallow inside a pill and that will then learn about your illness and set about curing it; that brings together biological computing as well, where we can print parts of the body. So I think we’re going to see the increasing infusing of computing into all aspects of our lives. If our Council has its way, we’re going to see an increasing sense of responsibility on the part of technologists to ensure that those developments are for good.

**What technology or gadget would you most like to see by 2030?**

In my own work, I’m committed to ensuring that technology brings people together rather than separating them. There’s been some fear that having everybody stare at their cellphone all day long is separating us from one another; that we are no longer building bonds with other people. My own work goes towards ensuring that social bonds and the relationships amongst people, and even the relationship between us and our technology, supports a social infrastructure, so that we never forget those values that make us human.

To my mind it’s not a particular gadget that I want to see, it’s gadgets that ensure the bond between people is not only continued but strengthened, that the understanding amongst nations and amongst individuals is improved by virtue of the technologies that we encounter.