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Revolution not evolution

May Chiao

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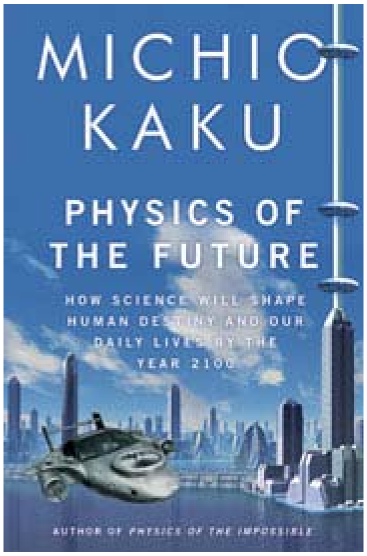

Physics of the Future: How Science Will Shape Human Destiny and Our Daily Lives by the Year 2100
Michio Kaku
ALLEN LANE: 2011.
389 pp. £22

Is there any point in trying to predict the future? For instance, 21 May 2011 came and went the same as all previously trumpeted dates for 'the rapture' in Christianity: the world did not end and the believers did not suddenly find themselves in Heaven. When it comes to technology, however, predictions have been more successful. Take Leonardo da Vinci, for example. In the fifteenth century he designed a helicopter, an adding machine, a tank and even thought about solar power — many of his machines actually work. Similarly, Jules Verne was ahead of his time. His 1863 book *Paris in the Twentieth Century* (lost but eventually published in 1994) described subways, glass skyscrapers and even the Eiffel Tower. But let's not lose sight of their less-publicized failures, as well as those of legions of prophets, philosophers, futurists and science-fiction writers throughout history.

Taking inspiration from da Vinci and Verne, theoretical physicist Michio Kaku wonders whether using a firmer scientific basis to glimpse the future would be more successful. To that end, he interviewed three hundred scientists and visited laboratories to see working prototypes from which he temporally projects our collective destiny in *Physics of the Future*, and is careful not to break any laws of physics in the process. Each chapter describes the state-of-the-art of a given technology and then extrapolates to the near future (present to 2030), midcentury (2030–2070) and far future (2070–2100). This approach is conservative by design, and although Kaku acknowledges that such predictions, “with few exceptions, have always underestimated the pace of technological progress”, he uses “reasoned estimates of when the prototype technologies of today will finally reach maturity”. Still, that is how engineering advances, not science.

Somehow, I found this framework too limited and too far-fetched at the same time. If we consider the cutting-edge experiments one hundred years ago, Ernest Rutherford was conducting his scattering experiments from which he deduced that the atom has a concentrated nucleus with positive charge surrounded by orbiting electrons. But despite being the father of nuclear physics, Rutherford was quoted as saying in 1933: “The energy produced by the breaking down of the atom is a very poor kind of thing. Anyone who expects a source of power from the transformation of these atoms is talking moonshine.” He didn't think much of nuclear power, though he was the first to knowingly split the nucleus in 1919. An extrapolation of the early work on nuclear physics certainly would not have led to nuclear weapons.

Contemporaneously, in 1911, Kamerlingh Onnes was cooling down mercury, which went on to become the first superconductor. The phenomenon remained unexplained until 1957, but even then the highly successful Bardeen–Cooper–Schrieffer theory predicted a maximum transition temperature of 30 K or so. Hence, nobody was prepared for the high-temperature superconductors discovered in the late 1980's, which are superconducting below 100 K. But even now, most applications take place at 4 K, including the thousands of magnets in the Large Hadron Collider.

“We have never lost touch with our inner caveman, which explains why certain predictions in the past have gone badly wrong.”

In his book, Kaku relies on there being a room-temperature superconductor for technologies such as dissipationless cables and magnetically levitated cars that are computer controlled. And although the idea of room-temperature superconductivity itself is not implausible, it is far from clear whether a room-temperature superconductor would be useful. Superconductivity is a macroscopic quantum state. There is some 'coherence length' over which two electrons can pair up. For the elemental superconductors with low transition temperatures, such as Pb or Sn, the coherence length is on the order of 100 nm. However, in the cuprates, it is closer to 1–2 nm. This small coherence length means that in cables made of high-temperature superconductors the individual crystalline grains need to be very well aligned, because misaligned grain boundaries would quickly reduce the current that can be carried. Thus, for even higher transition-temperature superconductors of the future, it is likely that the coherence lengths may be too tiny for the practical applications imagined by Kaku.

I also have my doubts regarding the section on space travel, particularly concerning the space elevator and colonization of the moon or Mars. Although the author stresses the obvious problems associated with these goals, he nonetheless ploughs ahead and describes them. A mid-century project to terraform Mars involves a string of rather preposterous projects. First, we need to warm it up. Well, the introduction of a greenhouse gas such as methane into the Martian atmosphere could start the process. Then, once the permafrost starts to melt, carbon dioxide would be released, which would speed up the warming process. But how to add water to the atmosphere? A comet! Yes, we could crash a comet into Mars. Now all we need is life, so some Antarctic algae could do several jobs at once: convert carbon dioxide to oxygen, help the surface absorb more sunlight by changing the surface colour and provide food for higher life-forms. Each step seems wildly uncontrolled, and given our own track record on Earth, I would caution against messing about with another planet.

Does the book have any redeeming features? Actually, quite a few. For each of the technologies covered, the description of what can be done at present is interesting and broad, spanning computation, artificial intelligence, medicine, nanotechnology, energy, space travel, wealth and humanity itself. And the author excels at explaining technical terms in an engaging way. That said, I would rather he didn't use certain adjectives as verbs. One recurring example, which also lends a pompous tone — deliberately or not, I cannot say — can be found in the following: “I keynoted a major conference...” Honestly, where was his editor?

I also like his “Cave Man Principle”. The idea is that we have never lost touch with our inner caveman, which explains why certain predictions in the past have gone badly wrong. For instance, hearsay is not enough when it comes to news of a fresh food source; our ancestors wanted evidence. Could this be why we insist on printing out e-mails and not having paperless offices? Or why the internet has not killed television and radio? (Or, likewise, why television and radio have not killed theatre and live concerts?) Or why university campuses are filled with students when they could be getting an online diploma instead? We're naturally “high touch” rather than “high tech” individuals.

I had high hopes for this book, but unusually, it took me a month to read it — including a brief hiatus during which I devoured Stephen Fry's autobiography in just a couple of evenings. Possibly I am too in touch with my inner cavewoman to believe in the future. My feeling is that there will be several disruptive changes in our near future because our planet is unable to sustain our growing population. Many of these changes will be driven by science, but we can't predict the revolutions that will surely happen.

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