Q. What inspired you to become a researcher?
A. As a child I liked making things, and I was a great fan of the Usborne series of ‘KnowHow’ books. I particularly liked the electrical experiments, so it was inevitable I would end up as an electrical engineer.

Q. How did you get started in your academic career?
A. I really enjoyed the electronics and physical electronics aspects of my undergraduate degree. I did a PhD under Haroon Ahmed who by then was in the Cavendish labs at Cambridge, although he was himself an engineer. His lab was a great environment for an engineering student with a physics bent. When I finished my PhD I wanted to get industrial experience and worked as a VLSI design engineer with STMicroelectronics, but after a year or so I realised that research was my first love, so I returned to academia as a postdoc at Glasgow University.

Q. When did you start working in the biomedical field?
A. I didn’t seriously start working in the biomedical field until I took up a lectureship at Glasgow University in 1999. When I started there was a lot of excitement about lab-on-a-chip and system-on-chip technologies, and talk about how these two fields might be combined. The key was to find a compelling research driver that would need miniaturisation and lots of sensors, and I realised that the sensor pill had all the necessary attributes. The first major project was Integrated Diagnostics for Environmental and Analytical Systems (IDEAS) that I was lucky enough to lead. Working with colleagues in Glasgow and Edinburgh Universities, and the Institute for System Level Integration, we were able to demonstrate many of the basic concepts of wireless sensor devices and created a lab-in-a-pill.

Q. Has the biomedical field developed as you might have expected?
A. It has developed at a terrific speed. When we first got involved there weren’t many components so we had to do a lot of things for ourselves. Now there are a lot more chips out there that really simplify product development. The speed of development of large arrays of CMOS sensors has been astonishing. It was always known that basic research prototypes in CMOS work are demonstrators for massively scalable technology, but as with DRAM or camera chips, I am always staggered by just how much technology can be squeezed onto a small chip.

Q. Tell us a little bit about your current research activities.
A. I am working increasingly on the integration of CMOS and photonics technologies. Electronics and optics have both revolutionised communications, sensing and diagnostics, and further integration will almost certainly generate enormous rewards. I also want to look at combining the virtues of electronics and optics with types of sensor technology, e.g. ISFETs, but that might be a little further in the future.

Q. Within your area, what are the key challenges?
A. It is very tough to go from a research prototype to a safe working technology that can be taken towards medical trials. For this reason I think progress in devices that are used in the lab will be faster, but the great challenge is to make devices for internal or implanted use. This needs stronger collaboration between engineering and medicine.

Q. What are the potential applications that you find the most exciting?
A. Something like X-ray vision, but for all types of sensor modalities. X-ray specs are science fiction still, but the same idea applies to future sensors of all types – a device that is very handy and easy to use that can be relied on to make a range of measurements, be it chemical or biological. These devices actually might be closer than X-ray specs. Also, the X Prize Foundation are offering a prize for a Star Trek-style tricorder – that would be fun.

Q. What do you see as the prospects for exploiting semiconductors for use in personalised medicine, and what are the key barriers?
A. More personalised healthcare and better tools in the hands of first responders and general practitioners. The mobile phone is the ideal vehicle of integrating capability – the handheld surgery perhaps?

Q. What one key thing would transform the healthcare field?
A. It is now possible to make extremely sophisticated sensors and electronics on only a few millimetres of silicon, but the battery technology has not scaled. The arrival of energy sourced with 10 to 100 times that of currently available power sources would make a big difference.

On another tack – improved and highly specific diagnosis and hence treatment will be increasingly important. For example, we know antibiotics are becoming less effective and sometimes it can take a few attempts to find a treatment that can work for a particular bacterial strain. Next-generation sequencing technology was shown in the recent German E. coli break out to rapidly identify the bacterial strain and therefore assist doctors in prescribing appropriate treatment. The Ion Torrent ISFET-based system is one such sequencing tool. A major transformation would be to make sequencing technologies that worked in minutes and were sufficiently cheap and convenient to be used by the GP or at the pharmacist. We are still some way off doing this, but I think it will come.

Q. What are the potential applications that you find the most exciting?
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