Introduction

From diabetes to heart failure, the world of health care is being transformed by technology. We now have a range of wearable health technologies and diagnostic devices that are transforming our lives. **Professor James Mclaughlin OBE**, one of our Archives interviewees, gave us an insight into his contribution to this transformation and some thoughts on the future.

James is the director of the Nanotechnology and Integrated Bioengineering Centre at the University of Ulster where he works on portable / wearable diagnostic devices with automatic monitoring of heart rates, blood sugar levels and the like, reporting the results and triggering alerts over mobile. He is also renowned as one of the team that developed the first external defibrillator. He holds over 30 patents including for the world's best-selling disposable medical electrode and has successfully co-founded a set of spin-off companies while raising over £100 million of research funding.

A Life Changing Temporary Decision

When it came to go to university, Jim chose to go to the University of Ulster over Manchester, in order to stay local after his father died at an early age. It was meant to be a temporary position just for a year, but it turned out to be life changing. Following his degree and PhD, Jim took a research job with Professor John Anderson in thin film electroluminescent display. John was the senior engineer and the innovator behind the portable defibrillator.

The portable defibrillator of 1966 was trialled and modified right up to 1973/'74, before it was properly used. It consisted of a handful of logic devices that basically measured impedance, arrhythmias et cetera, and tried to portray the results on a flat panel display, which was a fragile cathode ray tube - CRT at that stage.

Jim says: "It wasn't really portable. These displays were breaking all the time. John realised that this portable defibrillator wasn't really suitable for ambulances, so, he decided to get some research going

in Northern Ireland on proper flat panel display systems that were different to liquid crystal or anything else that was coming through, that had to emit light properly so that you could see them in all sorts of conditions, in sunlight et cetera. He asked me to start working on zinc sulphide and thin film zinc sulphide electroluminescent displays."

Patents Galore That Started with Serendipity

Today, Jim is the holder of 30 patents, however, he says it all started with his first project on defibrillator flat panel displays, serendipity, and his sister. He explains: "We had a problem with edge connectors, and I had read about a screen-printing method for putting silver inks on the edge of tin oxide on glass for flat panel display applications. As I was sitting wondering about screen printing, serendipity played its part and my sister called me to ask if I could help her in the art college with some graphic design screen printing. I met the technician who explained the whole process of screen printing, preparing a screen and photolithography."

Back in the lab, Jim bought a high-precision screen printer and started work on the flat panel display problem. He asked a colleague who was working on medical electrodes, if he could try printing what he was doing on polyester. He says: "I got some of these special silver inks formulated, tried screen printing it. Bingo, it worked. It was one of these eureka moments, when we did the impedance analysis, and then did ECG analysis, and it just all worked an absolute treat."

This was the breakthrough they needed and Jim, John and a colleague patented the design and licensed it to a company called Ludlow it went on to be the largest selling ECG electrode in the world from the patent using the same technique.

Jim adds: "Defibrillator pads are all screen printed, and without that eureka moment, we wouldn't have had some of the uniqueness that was required. That bit of serendipity in those early days, the fact that we had a multidisciplinary lab, was absolutely core."

Together John and Jim went on to establish a clean room, launch a bioengineering centre offering a biomedical degree within the School of Engineering to sustain their work, and created several spin-off companies.

John adds: "Establishing a thin film laboratory with some characterisation equipment, mainly focusing on electronic and medical devices, really opened the door for so many things after that that lead to a whole history of innovation that started to happen."

The Impact of Technology on Health Care in The Future

Looking towards future developments within healthcare over the next five years, Jim is clear that the healthcare 4.0 revolution will involve trying to digitise the healthcare system. However, this brings with it inevitable issues such as patient data security and patient data issues.

One key aspect to solve these and other issues is trust. He explains: “What is needed by the digital engineering world, academia, and industry, is trust from the regulatory bodies, MHRA, FDA, CE et cetera. We need trust that digital can fit into a system where both clinicians will totally trust the technology to help make decisions, and that hospitals and patients will benefit. There are multiple issues that slow innovation down, and that’s what the UK Government have promised to improve in their most recent spending review; they’ll spend the money on trying to get productivity in the innovation process right.”

On the positive side, Jim highlights the successes that are already helping to transform lives such as the continual monitoring of diabetes through a microneedle that’s worn for fourteen days and feeds data back to the patient. He says: “That’s been a life changer because of its ability to continuously monitor. We have the same sort of technology coming through in other areas. Cardiac monitoring is another opportunity where people want to continuously measure, for example, atrial fibrillation (AF) is a big worry in later life, it’s associated with heart failure and stroke, so, people will want to eventually measure that condition on an ongoing basis, if it’s getting worse, or better, depending on how you’re being medicated. This relieves anxiety when you can actually do proper monitoring pieces because it’s becoming more and more difficult to call on a doctor.”

He concludes: “What I would hope you will see in the future is the concept of clinically relevant diagnostic kits coming to the home enabling self-management of your own health, using electronic devices to record that information so that it’s a backup to electronic care record systems. In fact, the smartphone, has a lot to offer the medical world. There’s a CMOS camera that we can do a lot of image analysis with; eyes, fingers, et cetera. Analysis and AI gives us early warning systems, predictive analysis systems et cetera. The processing power, the miniaturisation of those CMOS imaging sensors are all adding up now to a platform that really allows us to move forward.”