Annual Report 2018

Another year has crawled into the shadows of the past and, as usual, we are facing a myriad of new – well, not new, but improved – challenges and opportunities. We are in a period that has a different background to the demands of the past. The reasonably tech-savvy Baby Boomers are retiring (10,000 a day in the USA alone) and the new workforce has been brought up in a totally different world with a totally different market alignment. This is reflected in Silicon Valley where gadgets are left to the wider community and more serious effort is being placed on community needs and powerful computing methods.

Take one community need – health care for the aged. Retirement residential care is a booming and very profitable business, but is expensive, so if the retiree's life at home can be extended with monitoring superior to that in most retirement facilities, then that is brilliant. Personal monitors are old hat, but the level and span of monitoring with instant diagnosis of problems, plus automatic calls for help, giving the patient's exact location and nature of the problem has taken the risk of home care away. This may seem like a small matter, but for hundreds of thousands of users it is the most important factor in their lives. The computing power in a necessarily small device is amazing. Even an Apple watch can give better monitoring than a care home, so a dedicated device can be far superior.

Going to the other end of computing power, the theory of qubit computing has been around for some time, but now Intel has managed to produce actual working processors. In November last year they delivered a 17-qubit processor, and now, as I write this in January, they have produced a 49-qubit superconducting quantum test chip. An interesting aside is that they named the 17-qubit "Tangle Lake" after a chain of lakes in Alaska, referring to the extreme cold temperatures and the entangled state that quantum bits require to function.

Intel predict that quantum computing will solve problems that today may take our best supercomputers months or years to solve – drug development, finance problems, even the correlation of SKA data - something New Zealand is very much involved in as a prime mover (and I was fortunate enough to be a hanger-on in some years ago). For commercial relevance, though, it will probably require a million or more qubits.

Intel also is working on neuromorphic computing – a new computing paradigm based on how the brain works. It could unlock exponential gains in performance and power efficiency to allow huge advances in AI. They already have a fully functioning research chip, code-named "Loihi", which mimics a brain's operation in learning not only by example, but by inference. It will be a big step where real-world data needs to be processed in evolving real-time environments. This does not mean just fancy highly technical applications, but also in the mundane world of security cameras, and smart-city infrastructure for real-time communication with autonomous vehicles (avoiding heavy traffic, accidents, etc). Intel will actually be sharing the Loihi technology with major universities and research institutions to hasten the applications of this powerful system.

Obviously, to handle the research and development of these technologies, we will need a whole new breed of computer-savvy engineers. To this end Clark Radio have developed a Root Robot that is capable of teaching 4- and 5-year-olds the process of basic coding. To make it more attractive to this age group, it has a face with two eyes and a nose, plus a definite personality. It has been tested with success on such children (and with success on adults also).

On the subject of robots, with the newer micro-techniques available now many new applications have been made possible. For example there is tissue regeneration through a robotic implant. Two examples are esophageal atresia (esophagus does not reach the stomach) and short bowel syndrome – both birth defects. The internal robot gently stretches the tissue over a lengthy period, monitoring many factors all the time and so allowing more tissue to be grown naturally. In a test with a large animal, it lengthed the esophagus 75% whilst the animal lived a normal life.

Batteries are another field of huge interest, for every device must be powered by some means. There are 110 million possible known combinations of materials that can be used to create a cell, but so far only 30 are in practical use. With the advent of practical capacitor storage with its advantage of high capacity and recharging in less than a minute (can even be used to drive trams, with almost instantaneous charge at each stop), battery manufacturers have been looking for new techniques in conventional cells.

The most promising material is old-faithful Lithium, but the research is directed on how it is used. Lithium-sulphur and lithium-air look very promising for capacity and weight. Coating the lithium anode with polymer or ceramic film gives longer life. The electrolyte has a huge bearing on the suitability for each individual application. No longer will we have batteries like the old lead-acid that was used for everything. At Cambridge University they have developed a Lithium-Oxygen cell that has ten times the energy density of Li-ion, more than 90% efficient and capable of a large number of cycles.

The electric eel has inspired some to develop self-powered batteries for biological use – e.g. pacemakers. Others looking for more energy per unit volume are looking at solid-state cells.

Now here is a melding of the advances in computing power referred to above with battery research. There are millions of potential cell chemistries that remain untested due to the extended periods necessary to check out all the myriad variations of construction and life cycles. For example, there are more than 12,000 lithium-containing compounds that could be used and 21 solid electrolytes. Toyota is working with Stanford using intuitive computing to model many new architectures, with the computer learning with each test.

I have only talked briefly about two fundamental areas of our profession with the game-changing advances being made at an exponential rate. Electronics and computing are now an integral part of practically every aspect of our lives, so the fields of advancement are almost unlimited. We are fortunate in being part of the creation of the basic building blocks of our whole society. Never treat your chosen path in life as “just another job”. Every one of you has the opportunity to make a change, you are limited only by where you set your personal horizon.

Ross Muir

National President