

Dairy, Digital and Drones – Innovations Creating our Future

Sir Paul Reeves Memorial Lecture 2014

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Tēnā koutou katoa kua hui mei nei

He honore māku ki te korero i tēnei wā

Hei maumahara i a Tā Paora Reeves

He rangatira rongonui

He rangatira rangimarie – nō Te Ati Awa

Kei te mihi ki a ia; kei te mihi ki a koutou hoki

I runga i te kaupapa – ara, ko te rangatiratanga auaha

It is an honour for me to be here with you this evening, an occasion which commemorates the memory of Sir Paul Reeves.

I have lived most of my adult life as a KEA – a Kiwi Expatriate Abroad – so I never had the opportunity to meet Sir Paul. As a result of the invitation to speak this evening I have been able to discover this extraordinary leader and learn something of his immeasurable contributions to justice, reconciliation and peace in Aotearoa New Zealand.

I have learned he was a man of great renown, a man of peace. In words spoken at Sir Paul's obituary in Parliament in 2011 he was described as giving us "a different vision of leadership... a refined, softer leadership that appealed to our better selves ... a type of leadership rare in this land where our leaders tend to be of the rugged, individualist type".

These words remind us that there are many ways to lead and all of us are called upon to be leaders at different times and situations. This year Leadership New Zealand is exploring and teaching the meaning of creative leadership, the kind of leadership that finds new ways to solve intractable, complex or long standing issues; the kind of leadership that Sir Paul exemplified in his many roles whether as bishop, Governor General, Chancellor, or guiding the work of commissions and delegations both in New Zealand and in the global arena.

In thinking about the origins of leadership and how our lives follow the paths that they do, I found myself looking back through the pages of a scrapbook I kept in the 1970s during my high school and

undergraduate days – looking for clues as to what might have foretold my future career and prospects for leadership.

I came across a letter dated 3rd November, 1970. It was from the Manager of the Woolworths store on Broadway in Palmerston North. In 1970 I was finishing sixth form and taking the exams for University Entrance and Bursary. The letter concerned my application for holiday employment over the summer:

Dear Mary

I am sorry to advise you that your application has NOT been successful (NOT was in capital letters to be sure I understood). May I take this opportunity to thank you for coming in to apply. The standard of applicants was very high and there were a great number of them, which made our choice a difficult one.

Kind regards. Yours faithfully, (signed by the Manager).

My career thus started inauspiciously, turned down for a sales job at the Woolworths store in my home town because the standard of applicants was so high I didn't make the cut. I recall there was an arithmetic test as part of the application – I don't think that was the problem.

Fortunately things picked up. Further on in my scrap book I came across a letter from Associated Motor Industries Ltd on the Western Hutt Road in Petone. By then I was in my third year of a Physics and Math Honours degree at Canterbury. This letter, dated 31 October 1974, said:

Dear Miss Quin

Thank you for your letter of the 24th. We are able to confirm employment for you during the summer vacation. You would be employed in our Trim or Paint Departments. We can offer a commencing rate of \$1.82 per hour. Yours faithfully, (signed by the Assistant Personnel Officer).

I was extremely excited about getting \$1.82 per hour for working on an assembly line, because the University of Canterbury only paid me \$1.10 an hour as a physics research assistant. Thus began my first exposure to working in a manufacturing company – installing the wiper blades on Austin Maxis and putting the brand decal on the back of each car as it came off the assembly line.

That factory in Petone closed just ten years later in 1984 and by 1998 the last auto assembly plants in New Zealand also closed. How good was the leadership of those plants? I don't know ... they could have been outstanding leaders and managers but they could not withstand the tidal wave of fully assembled imported cars once the sea walls of protectionist tariffs were removed. Sometimes creative leadership means recognizing sooner than others do that the world is changing and it's time to abandon strategies which are no longer relevant. Very often those tidal waves of change are powered by changing technology.

Industries and technologies are not static - new technologies are constantly emerging that change the way goods are produced or create entirely new goods and services. Processes and products are swept away as better or cheaper alternatives take their place.

Familiar products that have served us for decades are disappearing even now – the landline phone, the checkbook and the fax machine, to name a few that are already becoming more endangered than the kakapo.

While some products and technologies are disappearing new technologies being invented today are already defining how life will be in the future.

Technologies already in existence are being combined in innovative ways to create new products and services that will shape economic outcomes and daily lives all over the world.

Based on the sheer size of other countries' populations and economies many of these technology advances are occurring overseas, but their impact is and will be felt in New Zealand.

Though our population and total science budget are small compared to countries in North America, Europe and Asia, this does not mean we cannot be actively engaged in, benefiting from and contributing to the technology advances and the economic growth that are driving progress around the world.

Indeed we have no choice but to run with the big dogs or get left behind. As the saying goes in the dog sledding world of Alaska, where I lived for the past 14 years, if you are not the lead dog then the view never changes!

In 2009 another extraordinary Sir Paul - Sir Paul Callaghan - published his influential book *Wool to Weta*, which was a call to action for New Zealand to expand its economic base beyond an historical dependence on agriculture and tourism. Sir Paul Callaghan was an esteemed scientist, academic and entrepreneur who saw that New Zealand must invest in science and technology, and encourage and support the formation and growth of high tech companies to remain among the world's advanced economies. Callaghan Innovation, a Crown agency whose mission is to accelerate the commercialisation of innovation by businesses in New Zealand, was named in his honour when it was launched in 2013, the year after his death.

The title *Wool to Weta* suggests moving away from primary industries such as wool, dairy, beef, fisheries and forestry towards high tech and digital industries such as software, medical devices, robots and unmanned aerial vehicles. However, I believe the future for New Zealand must be to continue growing our primary sector as fast as we safely can, while simultaneously expanding our emerging high value manufacturing and services sectors.

The future must be Dairy, Digital AND Drones – an economy equally balanced between our natural resources sector, our digital and data driven industries, and the companies producing technically sophisticated manufactured goods.

While wool has declined from 30% of exports to just 2% in the past forty years the dramatic increase in world demand for dairy products, and New Zealand's successful response to that demand, means that primary industry exports have actually increased from 59% of all New Zealand's exports to 71% in the past decade. As our digital and manufacturing sectors have not kept pace with that growth, we have become more, not less, dependent on the primary sector. Just as a financial portfolio needs rebalancing when success in one class of investment outstrips all others, New Zealand's economic portfolio also needs rebalancing.

Let's consider for a moment what new technologies are emerging. At Callaghan Innovation we have identified seven broad enabling technologies that underpin innovation and product development in multiple industries. These seven technologies are:

1. Information and Communications
2. Advanced Materials
3. Sensing and Automation
4. Biotechnologies
5. Food Technologies
6. Design and Manufacturing
7. Standards and Compliance

Now you could argue that Design and Manufacturing, and Standards and Compliance, are not strictly technologies but they certainly are important fields of technical expertise so, for convenience, I'm calling them technologies.

Taking an innovative idea and turning it into a product ready to sell often calls on several of these areas of technology. Let's take Unmanned Aerial Vehicles (UAVs) or drones as an example. A drone is in effect a miniature remote controlled aircraft which can be either fixed wing or rotating wing like a helicopter. Various devices can then be attached to the UAV ranging from video cameras to thermal sensing devices to a boom for spraying crops.

Designing, building and operating a drone relies on:

- advanced materials selected for their optimal weight, strength and corrosion characteristics;
- sensing technologies needed to send out and receive back signals in the relevant electromagnetic wavelength range;
- the signals require digital processing to convert them to meaningful images or data;
- control of the drone requires communications technology.
- expertise in manufacturing processes
- standards on where, when and how the drone operates vary by country and must be strictly adhered to when operating the device.

Advances in all these areas of technology, and in the definition of standards, have made possible the rapid growth in use of UAVs now taking place. Technological progress achieved by scientists and engineers in university, institute and industry laboratories have made drones more affordable, easier to build and operate, and readily customised to a growing range of applications. Recent market research has forecast the economic impact of UAV technology in the USA alone, to be \$82 billion dollars by 2025.

The significance of standards and compliance with respect to standards cannot be overlooked. Currently the USA does not allow the commercial use of drones. Although this policy is being re-examined it means that New Zealand has been able to surge ahead with designing products and gaining real world experience with operating them, potentially making our products more competitive for when the US market does open up.

While the use of drones by the US military in the War on Terror is the most widely reported and dramatic use of UAVs, in fact their single biggest application is in agriculture. UAVs are used to monitor the condition of crops, the impact of droughts or floods, the location of livestock, and requirements for fertilisation and irrigation. By compiling and digitally analysing records from multiple flights and multiple farms over time, new insights can be gained regarding climate change, water resource management, and rates of soil erosion. In New Zealand, with our rugged landscape, UAVs may become an integral part of monitoring our dairy herds and pastures.

Massachusetts Institute of Technology's publication, MIT Technology Review, recently ranked agricultural drones as the number one breakthrough technology for 2014 and the Association for Unmanned Vehicle Systems International predicts that 80% of the commercial market for UAVs will eventually be for agricultural uses.

Several New Zealand businesses have now taken the lead in UAV technologies and several of these companies are located in smaller regional communities. Aeronavics is a small business based in Raglan, producing high quality multi-rotor UAV products that are sold around the world for aerial photography, filmmaking and industrial applications. Palmerston North-based Hawkeye UAV have also developed a UAV for farm mapping, pasture measurement, survey and imagery that are now used in nine countries around the world. Tauranga's GPS-it are using UAVs to map and audit Zespri kiwifruit orchards including monitoring the spread of PSA disease. Use of drones in agriculture illustrates how science and engineering breakthroughs across multiple technologies enable entirely new industries to form and these new high tech products can in turn benefit other industries, including our primary sector.

Dairy, Digital and Drones - primary industries, digital industries, and manufacturing industries all intersect. Advances in one directly impact innovation and economic opportunity in the other two. New Zealand needs all three.

Perhaps the most far reaching technologies creating our future are those which are enabling the capture, analysis and linking of vast amounts of data – what is referred to as big data. It is estimated that more data is now generated every day than had been compiled by the entire human race up to the year 2000.

As technologies are developed to analyse and draw meaning from this data it will lead to products and services we cannot yet begin to envision. But's let think about some of the impacts we can envision.

The consequences of big data for the future fall into two broad categories – (1) understanding issues and trends affecting a population at large and (2) capability to customize products to suit individual needs and preferences. Health data is a great way to illustrate this although the principles apply as well to education, entertainment, safety - almost any aspect of our lives.

Information about various aspects of our health have historically been highly fragmented – hand written notes about a patient taken in a doctor's office; electronic records of drug subscriptions at a pharmacy chain store; results of clinical trials for a medical device with a few hundred patients at a hospital; tests of a new drug conducted by a multinational pharmaceutical company. All of this information has been in separate silos, some of it not even in digital form and what is digital is spread across incompatible files and software applications.

As countries establish new laws and protocols allowing or even requiring the standardisation and sharing of this health related data, the potential is huge to see patterns and outcomes which were previously invisible. Insights into cause and effect and variations across populations (for example that women may react differently from men to the same drug or treatment) will greatly speed up knowledge of what works and what doesn't and why it doesn't. Overall community health will improve more quickly and the cost of continuing less effective treatments or programmes will be reduced.

At the same time the personal data of each individual from disparate health provider sources will also come together into a holistic view of the patient's genetic profile, medical history, lifestyle, allergies, accident-related injuries, and response to past treatments. This analysis of highly individual data means that "one size fits all" health solutions are being replaced with healthcare which is highly customised to each person, greatly improving prospects for treatment to be successful. The merging of all the individual data, in turn provides better data inputs across entire populations allowing more accurate modelling, forecasts and public health interventions.

Several technologies are already directly contributing to gathering better individual health information. The embedding of sensors in clothing or on wristwatches is allowing data to be constantly gathered on everything from heart rate and blood pressure to exercise and nutrition. Some sensors can already be directly embedded in the body. Communications technologies then allow these sensor readings to be transmitted to a healthcare provider where data analysis can indicate progressive improvements or pending threats.

Fears about protecting privacy have of course been a significant factor holding back the collection and analysis of personal data, especially health data, but technology innovation is also coming to the rescue here with constant improvement in tools that can guarantee data privacy and control of personal information.

Combining video conferencing with health sensing allows patients to be examined remotely by doctors or specialists. This is called telemedicine. In Alaska, every clinic in the Native villages I frequently visited

had telemedicine capability so that a healthcare professional in Anchorage or Seattle could evaluate a patient in Kotzebue or Anaktuvuk Pass, often avoiding the major expense of a bush plane flight followed by a commercial flight to seek medical care in a town or city, or allowing for initial diagnosis and care to be provided when weather conditions prevented travel entirely.

Remote and tough geography can itself spur demand for innovation and receptive markets for testing new technologies. In 1925 a series of dog sled teams covered over 1,000 miles of largely uninhabited terrain in bitter winter conditions to bring a diphtheria serum to the city of Nome and prevent more lives being lost to an epidemic. This event is the origins of the now annual Iditarod race in which as many as 80 dog teams and mushers cover this same 1,000 mile route from Anchorage to Nome, the fastest now completing the race in under 9 days. It is a major tourism attraction for Alaska with teams competing from all over the world, including the occasional Kiwi competitor. I highly recommend it if you are ever able to be in Anchorage on the first Saturday in March when the race begins. In Alaska the top mushers and their lead dogs have the same status as the All Blacks do in New Zealand. It's actually a tougher sport than rugby since no All Black to my knowledge has been killed by a moose while competing.

One of Sir Paul Callaghan's key points was that to grow the economy and provide the standard of living we want, we need to make New Zealand a place where talent wants to live - a place where entrepreneurs choose to build great companies.

To do this, how should we position this country in the eyes of the world? The clean, green image is certainly positive and important but it is not enough. If we wish to be taken seriously in the business world we need to be seen as an entrepreneurial country with a highly skilled workforce producing technically advanced products. For the public at large the Lord of the Rings movies have made us better known for our scenery than for the amazing technology of companies like Weta Digital. I'm a big fan of Lord of the Rings and the New Zealand film industry in general, but a close friend of mine in the States has convinced his grand-daughter that the reason I'm short is because I'm from New Zealand and therefore I'm a hobbit! No doubt she thinks I shave the top of my feet. Not the image I or New Zealand really want when we are promoting our medical devices, software and industrial robots around the world.

It's time to move on from 100% Pure to Pure Genius. Because there really are some ingenious ideas coming out of New Zealand and part of that ingenuity is a culture of inventing on a shoe string budget. An Auckland company called Vend, which produces point of sale software solutions, has just been included in the TIN's 2014 Hot Emerging Companies list. Auckland based Rocket Lab is positioning itself as a leader in aerospace technology, recently unveiling a comparatively small, lightweight carbon composite rocket capable of sending satellites into space for a fraction of what it currently costs.

In Callaghan Innovation's Gracefield laboratories in Lower Hutt a company called Mesynthes made its start inventing and producing breakthrough products for healing serious wounds. Mesynthes' biotechnology products are based on tissue from sheep – another example of how our high tech industries can springboard from our primary industries.

Rocket science, software for retailing and exciting new methods to heal wounds – these are examples of diverse businesses that are using new technologies to create the future – a better future in terms of health, environment and communications.

There does not need to be a conflict or disconnect between positioning New Zealand as a beautiful, safe, friendly country and a smart, technology-driven, innovative country. In fact, establishing a reputation for both is essential for survival. We can and must be both high tech and high touch.

Let's think about dairy again as an example: synthetic milk, such as the product being developed by an American company called Muufri using research facilities in Ireland, may very well become a viable alternative to milk produced from cows. Perhaps not next year but very possibly within five years synthetic milks could be making inroads into the markets for natural milks. Synthetic milk could do to our dairy industry what polyester did to wool. Recall wool dropped from 30% of exports to 2% in four decades.

We can either ignore and deny the threat of new food technology or we can invest in being world class at producing synthetic as well as natural milk, over time shifting natural milk to an upscale premium product with correspondingly higher margins and synthetic milk as a lower priced, every day, mass market product more competitively priced. Our goal should be to unequivocally dominate the world in milk regardless of whether it's from cows, yeast, soybeans or almonds.

The current pressures on our environment, especially our lakes and rivers, from dairy farms are a clear indication that there is a limit to the amount of cow milk we can produce. When a desirable item becomes scarce there is an opportunity to make it even more desirable, commanding higher prices. New Zealand has a limited amount of land. Let's generate the highest margins we can per hectare.

Today innovative NZ companies have re-positioned wool as the upscale or premium performance fabric. Icebreaker has demonstrated the power of great design and branding to position wool clothing for outdoor sports at a premium to synthetic fabrics. Armadillo Merino has demonstrated that wool has far superior properties compared to synthetics to minimize injury from burns. Wool can reach a much higher temperature before catching fire and does not melt into the skin, causing better protection to soldiers and firefighters whose jobs put them at risk of being severely injured by explosions and fire. As demand for these products reaches the land limits of merino wool production the value of these wool garments will increase, positioning wool, like natural cow milk, as a prestigious product generating premium prices in world markets. Again let's focus production on the products that generate the maximum value per hectare.

Technology is constantly advancing with discoveries and inventions. The most dangerous thing we can do is be unaware or dismissive of technologies that potentially threaten our existing exports. In 1988 after completing my MBA at Harvard Business School I took a job at Kodak, in a middle management marketing role with the copier division. I was keen to use my MBA to transition away from hands-on R&D and gain experience in other business functions.

The potential for emerging digital photography to replace silver halide film, the core of Kodak's huge profits, was a very visible risk even then to Kodak's board and management yet Kodak leadership failed to embrace this new photographic technology for fear of cannibalising its existing business. Of course other more innovative companies did that for them and a workforce of about 80,000 employees in Rochester, New York dwindled to 8,000 as digital completely replaced film. The company had developed a culture of discouraging frank discussions and shooting the messenger of bad news. When a company makes those mistakes it goes out of business and jobs are lost. If a country makes those mistakes it lowers the standard of living for its citizens, possibly for decades to come.

Creative leadership is not afraid of dissenting views or unconventional perspectives. In fact creative leaders actively seek out diversity of thought. That means having a diverse workforce around you – people who have experience from different cultures or come from different industries. It means encouraging and listening to both intuitive and analytical thought processes. In my own career I've had my share of good ideas but even my best ideas have always been improved upon by the input of my team or colleagues.

As Sir Ken Robinson notes in his TED lectures on creativity, creative leadership is not about leaders coming up with creative ideas themselves, it is about creating environments that unleash the creativity of the entire organisation. If we are to become a more creative and innovative nation we must tap the creativity of all New Zealand citizens and residents whether their family origins in New Zealand extend back hundreds of years or they arrived here as immigrants or students just a few months ago. Whether they live in New Zealand or offshore.

Creative leadership also means encouraging and allowing others to lead when their expertise best fits the situation. I experienced one such situation while president of a company in Alaska. The company was half owned by an Inupiat (Eskimo) tribe in Northwest Alaska and we were committed to creating employment opportunities for as many shareholders as possible.

One year I joined our small team who were recruiting in the remote Arctic villages where many shareholders live traditional subsistence lifestyles. With a local guide we traveled by snow machine from village to village. All went well until we came to a small river about ten miles from the next village. The first four of our five snow machines made it across the frozen ice but as the last one, on which I was a passenger, crossed the river the ice began to crack. I jumped off and leaped across broken chunks of ice to shore as the snow machine began to sink under its operator – one of my direct reports – who also jumped off, yelling at me to get clear. The techniques for recovering a snow machine which has tipped sideways and submerged in a metre or so of icy water was best left to the leadership of my Inupiat colleagues.

When I meet business owners and leaders I always ask them "what is holding you back from growing your companies bigger, faster?" I can almost guarantee the answer will be one or both of (1) unable to hire enough skilled people or (2) unable to raise the capital needed. Just as we cannot afford to let out limited supply of land be used below its potential for producing premium products nor can we afford to waste any of our human resources – our limited population.

As the Māori proverb goes: he aha te mea nui o te ao? He tangata, he tangata, he tangata!

What is the most important thing in the world? It is people, it is people, it is people.

Making the most of our people means having a superb education system producing a wide variety of highly skilled graduates. Ours is among the best in the world, but technology advances are creating new possibilities. We need to constantly improve how we educate and train the workforce of tomorrow, which means embracing innovation.

There are two things that I would particularly like to see happen faster as a means to developing creativity and skills.

Firstly, developing a holistic view of lifelong learning, rather than the traditional model of primary, secondary and tertiary chunks of education followed by employment. We should see education as something we do throughout our lives, with a mix of learning, working and playing taking place in varying proportions at different stages of life. This approach enables us to constantly upgrade the relevance of our skills to our current career path or prepare us for a change in career. Or it might be learning in pursuit of a hobby or a personal interest or non-profit work.

Since moving back to New Zealand last year I have started to learn te reo Māori. An important part of the Callaghan Innovation mission is to ensure our services and strategies support the aspirations of Māori businesses. Developing some understanding of Māori language and culture allows me to be more effective in achieving that part of our organisation's mission but it is also a personal interest.

So far I am finding many more occasions to use my te reo lessons than I have found time to use the other course I took this year at Tawa College – a four session course on how and where to surfcast and rockfish on the coastline around the Wellington region. As they say, give a woman a fish and she will feed her family for a day; teach a woman to fish and, in my case at least, she becomes downright dangerous. I have an uncanny ability to get a fish hook caught in whatever or whoever is behind me!

We should also integrate the learning that takes place in educational institutions with the learning that takes place in the workplace or the community. Just as we are moving towards an integration of all the health information about an individual so too will we be able to integrate a person's entire learning and qualifications – not just high school attainment and university degree but the apprenticeship; the ten week training course in sales while employed at a multinational computer company; the online course to learn Japanese before a vacation trip; the bookkeeping course taken at the local college; the speaking skills gained at a Toastmasters club.

Secondly, in the digital age we all have access to the world's greatest teachers. We can now use technology to experience the best instructors on any topic, with students hearing and seeing subjects explained from wherever in the world the expert may be located and regardless of what decile school the student attends.

This will involve breaking down the various roles of today's classroom teacher and separating out what roles need to be done physically in the classroom, such as coaching and encouraging, maintaining

discipline, or conducting hands-on lab experiments, from roles that can be accomplished remotely from anywhere in the world. This can include the content of lectures, actual communication of material, taking tests, grading test results, and comparing students' performance against national and international standards.

As a compact country we have a fantastic opportunity to invent the education system of the future and use these breakthroughs to increase the export of education as a service sold to other countries. In doing so we can ensure all New Zealanders are ready for jobs of the future and our innovative businesses have the skilled employees they need.

As the first Chancellor of Auckland University of Technology, Sir Paul Reeves was certainly committed to leadership in education, and particularly education that teaches and advances technology. I am sure he would be encouraging us to embrace technologies which make world class learning available to all New Zealanders and which link our businesses to the skills they need anywhere in the world.

The future is one of unprecedented connectivity across different fields of science. Leaders must be willing to think about and engage with a wide variety of technologies and surround ourselves with diverse points of view.

In New Zealand we can run with the big dogs.

We can take our ideas to the world – a world that sees us as a centre of innovation uniquely blending dairy, digital and drones.

We can lead creatively and we can inspire creativity in the people around us.

The view will be constantly changing because we are helping create that view – a view of the future we want for ourselves, our grandchildren and generations of New Zealanders to come.