



**Innovation through science: the pathway to economic prosperity
A conversation with Auckland**

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5 December 2011

I do not think there is any strategic thinker who does not accept that science and science-based innovation is central to a much better and more prosperous New Zealand, be it through growing our industry and exports, improving our services, improving our urban environment, protecting our natural environment or improving our society and social environment. But we need to get beyond such statements and think about what that might mean.

New Zealand stands out as a country that until recently has been rather passive in relation to the increased focus upon knowledge generation and innovation that has characterised other small advanced nations such as the Nordics, Israel and Singapore. I think most commentators including the OECD would say that this is at least a partial explanation of the increasing divergence in GDP per capita and in productivity that has occurred between New Zealand and those countries. It is interesting that these are the very countries that are withstanding the current global economic gyrations better than other advanced countries. Put simply – for a variety of reasons, New Zealand's public and private sectors have over a very long time poorly under-invested in science, research, development and knowledge-based innovation compared to other countries.

It has only been recently that there has developed a broad acceptance of the need to address this gap and really only from 2008 onwards that science investment has started to rise in absolute terms. Let me use Denmark as a comparator. It was a dairy based economy and still is a country of SMEs. In 1980 we were on a par with Denmark, investing about 1% of GDP on research split 50:50 with the private sector. But since, Denmark has doubled its public sector spend and almost quadrupled its private sector spend. Similar figures could be produced from nearly every other small developed nation.

In contrast New Zealand has really done little more than keep up with inflation until the last three years when expenditure has started to increase, but even now we are probably still at 60 to 70% of what appears to be an international consensus on the appropriate level of public expenditure committed to research by other small advanced nations. There is evidence that private sector spending only starts to increase when a critical mass of activity flows from the public sector.

As I said it is only in the last few years we have seen a number of steps taken to start addressing these issues. I am not going to reiterate the very positive steps taken in the last government to start shifting the agenda. In the rather strange electoral period we have just been through, it was interesting to see all the major parties give some emphasis to a science and innovation policy.

Before going any further I think I need to define what I mean by innovation. It is important that I do so, given that it is a word with very different meanings to different people. I am going to use it in this talk as a short-hand for science and research based innovation. Innovation can occur in other ways – changes in managerial practices or organisational structure, in marketing and so forth. Science and knowledge based innovation is about using knowledge, research and experimental data to generate a product or service which has impact, generally by way of producing something to sell.

There are a couple of myths we need to first deal with:

The first myth is the problem created by the number 8 fencing wire myth; that is, that innovation is achieved by individuals working as backyard inventors. OK that might happen particularly in the digital world, but the bulk of innovation arises from multidisciplinary interactions – I emphasise multidisciplinary because innovation by its very nature is often about doing it differently and that requires a shift from reductionist linear thinking and that generally happens when disciplinary boundaries are crossed. I emphasise this because if we want to create an innovative environment we need to recognise this critical fact. Indeed one of the attractions of big science projects like the large hadron collider and hopefully for us, the Square Kilometre Array, is that they create a focus for disciplines to work together and this can lead to quite remarkable new ideas. Both the World Wide Web and wireless broadband arose directly from such big science projects rather than from some company planning intentionally to develop such products.

The second myth is the simplistic view that there is a linear process from basic research to applied research to development to sales that is predictable in direction and time and readily divisible into these four categories. It is not like that at all. In science-based innovation, at least half the products that are developed and sold originate in research in an area of activity well away from that that started it. Perhaps the most famous example is that of Viagra – no one set out to invent a drug for erectile dysfunction, they were developing a drug for hypertension.

Rather the reality is quite different – scientists and engineers either in the public sector or the private sector, but more likely the former, might be engaged in a variety of research endeavours. Out of that activity bubbles up ideas. Some may be exploitable in their own right, others coalesce with others. In either case at some point someone recognises the idea as potentially exploitable, a new wave of directed research arises and then, hopefully, development is started. By that time, potential utility is clear and the activity takes on an increasingly focused approach. Whether it starts in a university, in a Crown Research Institute or in the skunk-work lab of a private company it generally starts like this and market pull leads to an increasingly refined and focused development programme, itself often requiring much more research before a product emerges.

Of course, a more linear process can occur where a company sets out to make a new product to fulfil a clear goal. That too can be highly innovative but when one looks under the surface a surprising number of characteristics remain the same. Think of the iPad – it was not the first tablet computer, but what made it is a series of design based innovations that led to something that captured the market appeal. We will come back to the issue of design presently.

So science based innovation must have at least two components – a sufficiency of ideas flow and an ecosystem that allows the market and the scientist to get close together. The Israelis believe that they need to evaluate at least 100 ideas that are thought to be of value to see one that justifies investment. That gives you an idea of the ecosystem we have to build. And yet the Israelis have no more researchers than we do, just a better linked up system.

But there are further components to this ecosystem – the generation of bright young minds. I was talking last week to the CEO of Orion Health, our most successful software company, with an annual turnover of about \$100 million, with about 500 staff spread in many countries but with all the R&D done in New Zealand. It sees a pathway to be a billion dollar company, and what it needs to get there are systems engineers, software writers and operations researchers and mathematicians – but where are they? Technology is not popular at school and is still trades focused, our universities are not well directed towards New Zealand's needs, at least in this area.

But there are other components to a complete innovation ecosystem – access to capital, to professional expertise in capital raising, in IP management, experts in dealing with regulatory affairs, particularly in the food, health and med-tech areas. And then when the product is in the hands of the private sector there are other issues. Managing an innovation company is not the same as running a property investment company – in fact the skills needed are very different to those needed to run the bulk of the SMEs in New Zealand. One of the issues I see is that many good ideas fail not because the idea is not good but because of failure of governance and management or inadequate capitalisation.

Then we have to sell to the world. New Zealand is very good at selling food and tourism but let us realise that that is very different to selling advanced high technology goods. I suspect that in many cases it will be crazy to pretend we will do it on our own – we are only four and a half million people, we have a limited number of knowledge generators and our business sector has difficulties absorbing the demands of high technology – in many cases strategic partnerships with other players off shore may be a more effective way to sell our knowledge. We are starting to see examples of that kind of partnership emerge.

Before moving in to a constructive mode, I want to go back to one issue – how have we ended up in this situation? We need to understand this to move ahead. I think our failure to move as far as other small countries in developing a knowledge economy is in part a function of our cultural history. We have been a lucky country, able to live off our farming, although we forget that that has actually been a highly innovative industry – think of new sheep breeds, of golden kiwi fruit, of electric fences, of artificial insemination in the dairy industry, of sophisticated pasture management – all research based innovation. So the lack of a sense of crisis and urgency together with our inbred egalitarianism undervalued the role of intellectual activity and science. Contrast that with Israel or Singapore where a sense of crisis led those countries to invest in knowledge and science and science based innovation. To use the only natural resource they really had – the combined intellectual horsepower of their well-educated populations.

We do not yet have a sense of acute crisis but things are starting to change. We cannot get rich by carrying on doing what we do now, and yet there are enormous demands for a better social system, for higher wages, for a cleaner environment. Clearly we have to be richer to achieve these things. And what is our unexploited asset – the very asset other small countries have recognised – we have a good education system and we have clever people, we have a stable society, we are corruption free – we are a good place from which to make new knowledge, protect it, exploit it and export it. Even if we were in better shape that we are, there is another reason to invest more in the knowledge economy – we need to diversify, since diversified economies are more robust.

We can see that in Israel, in Singapore, in Norway, in Denmark, in Switzerland – all countries of about our size. It has been the hi-technology sector that has protected them and allowed them to flourish while we have languished. Even here the high-technology sector has started to grow – it is difficult to be absolute about its size but, excluding the food sector (which

does indeed produce some very high technology products such as Tatuá's lactoferrin), the sector exported several billion dollars of products and services last year. This hi-tech sector is growing faster than any other component of our economy. It is complex to analyse because it is not one sector – it is advanced componentry as in Rakon, it is medical technology such as Fisher & Paykel Healthcare, it is software as in Orion Healthcare, it is services such as engineering from Beca, it is generic drugs from Douglas, engineering design from Opus, it is new products emerging in healthcare from companies and extraordinary new uses of biological information in companies such as Lanzatech, it is software through gaming, it is digital through Weta workshop and so on. It is clear that we can see several niches emerging – in advanced foods, in software, in medical technologies both hardware and software, in advanced manufacturing – but only if we give greater emphasis to design. This country needs a school in industrial design really badly.

Earlier I mention the iPad – that is the classic example of design adding enormous value to technology. In many areas of technology, there are multiple ways to address the challenge. But the market will often respond by selecting between competing products – think of the Betamax versus VHS. Human factors and particularly design factors come into play. We think we have highly creative people in New Zealand, we have tended to think of the creative arts and technologies as being two different worlds separated by a gulf – but the reality is both science and the creative arts require the talent of the mind. We have not brought these two domains together and we need to. Design is what really sells, be it in software or in gadgets. We need a world class school of industrial design embedded in our science and technology ecosystem.

Let me focus briefly on another of these niches where we could have advantage – advanced foods for health. The world faces an epidemic of diseases such as diabetes which cannot simply be managed by advanced healthcare. These diseases are estimated by the World Economic Forum to cost the world at least 60 trillion dollars over the next decade – that is 4 times the national debt of the USA. There is growing evidence that foods could be developed that slow the development of this epidemic. What is required is very advanced biological research of the type carried out by AgResearch and the Liggins Institute jointly in Auckland, then married with good clinical research, again possible in Auckland, and connected with an improved regulatory framework and food science development targeted at Asian tastes and markets, for that is where the burden falls. We are starting to develop plans to take us in such a direction. It may take 15 years, but already I have chaired a meeting of stakeholders, governmental and institutional, public and private to identify what strategies might be needed. We hopefully will come out with a new industry – using advanced foods with market premiums to address unmet global needs. We have a unique competitive advantage to do so.

Throughout this talk I have used the term ecosystem repeatedly. I have done so very intentionally. We have had a habit in New Zealand of believing in single interventions rather than integrated system wide approaches. Every country that we have looked at as a comparator and has done well has recognised and acted on multiple points across the whole system simultaneously.

In Australia, State government takes a major lead in promoting innovation ecosystems. The same is true of local government in many small advanced nations – for example in Israel town corporations are major investors in incubators. Increasingly we are seeing the metropolitan areas of New Zealand recognise the need to also be active in promoting the regional economies. Christchurch has a very active innovation ecosystem, Wellington is developing one and Auckland must take a lead. With the formation of the supercity, we are seeing that something is starting to change.

Key to all of what I have been saying is the need to have a multi-layered innovation ecosystem. It has many components. It has to have local government committed to promoting, encouraging and if necessary, part-financing an “innovation city”. It needs the development of technology parks clustering academia and entrepreneurs along with support services. It needs the institutions – hospitals, universities, technical institutes – to cooperate rather than compete. It needs venture capital. It needs a commitment to work together and to attract the best and brightest to want to live in Auckland. We cannot leave it all to central government even though their role is critical – the evidence is clear, local government must play a role.

The Ministry of Economic Development released a report on Auckland’s knowledge economy in March this year. It was a discussion paper prepared by Arthur Grimes of MOTU and colleagues. It compares Auckland to other major cities in Australia and to some comparator cities in small European countries.

It notes that Auckland’s share of employment within knowledge intensive sectors has increased at a faster pace than other New Zealand cities and indeed faster than perhaps seen across the Tasman. The other cities in New Zealand tend to have clear foci of expertise while Auckland can be more broadly based, but given New Zealand’s size we will always have a few areas where we are more likely to succeed by developing critical mass – the challenge is what mix of bottom up and top down policies foster the development of such foci. This is a very difficult policy matter with very different views depending on where one stands. It is true in every small knowledge economy. Does government stand back and let some sectors emerge and then assist them to make it, or does government catalyse some areas? We are not starting from a zero base and in a sense both the academic and private markets have defined areas where we could do very well and be highly competitive. Advanced foods, some areas of advanced technology, medical technologies, the digital world are all areas where clustered expertise has started to form.

The other New Zealand cities have grown more slowly than the Australian comparators, highlighting the critical role of Auckland as the centre for knowledge based activity in New Zealand. To a large extent this is a result of agglomeration forces and we must act aggressively if knowledge based industries in Auckland are not to be pulled across the Tasman. Hence the importance of Auckland being very public, loud and credible in promoting itself as a knowledge based city. Hence the importance of the Wynyard quarter of celebrating our institutions, of promoting technology clusters, of the city being active rather than passive.

But to what extent does the Auckland plan encapsulate all of this? We need a very explicit strategy encapsulating both central and local government working together and engaging institutions, public and private, business people and entrepreneurs. The University of Auckland is a world ranked university, it is an enormous contributor to the local economy but has this asset really been incorporated properly into our thinking? And Massey, AUT, MIT and UniTec all have major contributions to make. We have said a lot about education but have we focused education to produce what a high technology economy needs? Unfortunately a number of incentives in play in the tertiary sector can be counter-productive and drive an over-emphasis on individualistic institutional behaviour. This is a particular risk in a small country like New Zealand. So can we get beyond the focus on individualistic activity to create knowledge based precincts and parks that will demonstrate to investors from around the world what we might be? Could we take advantage of the Eurozone’s troubles to attract more knowledge industry players to the best country on the planet?

We have several academic precincts and we need to work out how to integrate and use each to maximal advantage without destroying their individuality. The recent decision to develop Wynyard precinct is an enormously positive idea but what will be put there – it is worthy of a lot of reflection. A technology precinct has to be genuinely that. How will we build off the precincts around Auckland University and AUT, at Massey, at Tamaki and in South Auckland? For example should we be thinking of a science museum at Wynyard? What bits of CRIs and universities, what kinds of incubators, what private sector services need to be there? Should we be developing new models of incubator jointly with the Crown, what sort of core facilities should Auckland develop to attract high technology business and who should manage them? Often it is hardware that limits development and one of the features of effective ecosystems is that to ensure capital efficiency the private sector often takes greater advantage of the high level of capital available within public sector institutions.

And we need to look not only from a national level but from a local level at what we can do to cross the cultural divide – the divide between science and business. How many of our boards have scientific and academic expertise?

But what will drive more innovation? If one talks to Israeli experts, and they are the most successful country at knowledge based industry, even excluding their defence industry, they will say four things matter: education, basic research, a holistic approach and a risk-taking attitude. Until there is a good ideas flow and until there are clever people trained to develop that ideas flow and then exploit it, an innovation community cannot thrive. I hear local bodies talk a lot about social equity and about matters like transport – it is time for them also to realise that knowledge generation is their business too. It is exciting to see this city starting to talk about innovation – but we have a long way to go. We do not have an established forum to discuss innovation but one is in formation. We have many institutional rivalries, and the town and gown are too far apart.

How many businesses look inside the universities and polytechnics for ideas they might exploit or turn to them for problem solving? We tend to blame the universities for not pushing outwards, and of course there are blockages and issues, but look at Auckland Uniservices, it is one of the most successful knowledge transfer companies in the world. The problem is that volumes are low and that our capital markets are more interested in property than in knowledge.

There are many experimental models we might consider – for example in Israel many incubators are owned jointly between investors and the local authority or between the local authority and the university. Such incubators work with large sums of both government and private money. But while we have some jointly owned incubators such as the Icehouse, their capacity and roles are much more limited. The Israeli model is based on a high ideas flow, an aggressive culling, high levels of investment and international management and technology input from the start. New ventures are supported with loans, not grants, to encourage entrepreneurial activity – written off if the product does not make it. Auckland has to work as “Auckland Inc” to attract more risk capital to Auckland. It is uniquely placed to create an environment for this type of innovation.

Central government has started to play its role – its partnership with Auckland in the Wynyard quarter, the commitment to reform Industrial Research Limited and develop an Advanced Technology Institute with a larger footprint in Auckland. Both these initiatives are critical. Understandably at this early stage in the planning of the initiatives which have only just been announced there are different views yet to be reconciled. What should be the shape of the Wynyard quarter, what activities should it encompass, what parties can commit to be there, how will it integrate with other knowledge precincts in Auckland.

I think there is a sense however that it is a brilliant place to make a statement about Auckland as a knowledge city and one can expect areas like industrial design, like the digital and media research to have a high presence there. I would hope both the private sector and some of our public sector institutions see the importance of building on this initiative. The intent to remould IRL into a larger more industry facing organisation was heralded in the election campaign. That inevitably will lead to a much larger footprint in Auckland, something that is welcomed – it has always seemed to me that a major flaw is that the one CRI committed to high technologies had such a small footprint in Auckland. Hopefully these developments will not occur in isolation. The restructuring of the CRIs has led to far more alliances between CRIs and the universities, but our universities and CRIs need more city support –we should be really taking pride in our educational and research institutions. They are much more important to Auckland than we generally recognise.

We need to encourage our private sector to recognise that it too has to contribute – by engaging better with academics and technologists, by recognising the need to have effective and appropriate governance and management, by seeking to be innovative in their business models. But Auckland is New Zealand’s international city and we need to build off that – we should be partnering more with other knowledge intensive cities like Singapore and Brisbane.

But there is one other challenge. We can build knowledge based business but we have to keep it here. Essential to doing that is to create an environment that keeps the R&D function in our city. As companies grow their markets will be overseas, and there will be a pull to shift executive functions and even manufacturing offshore. I think the only thing that can keep the companies anchored here will be an R&D function so embedded within the city that it cannot move. Apple manufactures a lot of its gear in Asia, but Apple is based in California because that is where the R&D function is best located. What do we have to do to keep these companies anchored here? We have to build a city and a country that really values knowledge and science and entrepreneurship. We need technology parks, we need an intertwining of researchers, in the public and private sector, we need a world class university sector, and a vibrant knowledge based ecosystem – without that I fear for the future. The time is now.

At the end of the day this is about environmental and cultural change – it starts at the bottom and it starts at the top. The city can encourage, but at the end what we need to recognise how important is better science and technology education in all our schools, how important are our universities and polytechnics; until we take as much pride in these as we do in our rugby teams we will not succeed. The Liggins Educational Network for Science, run from the institute I used to direct, is the kind of activity the whole city should be proud of. Even though always looking for funding, it is world famous for the model it has developed for introducing young people to science.

Our media love telling stories about science – but not about Auckland science. The *Herald* is full of science stories coming down the wire from overseas but where are our Auckland stories – stories about the young students from Tamaki College who have done research that has led to major changes in how we are attempting stop the death of kauri in the Waitakeres, or stories about companies like Photonz, a small start-up company in West Auckland with one of the most exciting technologies. It is looking at how to produce important ingredients normally only found in fish by culturing marine algae, leading to valuable products for the pharma and food sectors. If they are successful it will be the first sustainable source of these products – the other source being krill and anchovies from the Southern and Pacific oceans.

I can see the green shoots are starting to emerge. We have a collective responsibility to nurture them. It is not unrealistic to imagine that a decade from now Auckland will be genuinely known as a knowledge city. There will be vibrant technology parks, not only serving SMEs but attracting multinationals back to do the sort of R&D that New Zealand is best at. Again if we look at our small advanced comparator countries, a feature of all of them has been their capacity to attract multinationals to do research and development in them. It is not unrealistic to imagine they will come here.

The tyranny of distance is real but overstated when we consider the knowledge based industries. We have diverse populations in Auckland and this makes it attractive for many forms of product development – in food, in pharma and advanced electronics for example. Auckland has the attributes that could attract multinational activity. In Austria, 50% of the private sector R&D spend (which by the way is 4 times ours per capita) comes from 10 multinational companies.

That 0.9% of GDP from 10 companies approximates our total public and private sector spend on R&D. there is a lesson in this – what can we do to attract multinationals to base some of their R&D and perhaps even manufacturing in New Zealand. Singapore's wealth in no small part is based on attracting multinationals to base R&D and manufacturing there. Melbourne has attracted IBM to set up a services research centre there. Could we attract the big food industries or some of the digital companies to set up in Auckland? This should be a significant goal for the regional government. Overseas the experience has been that once one multinational moves in, others follow.

Local and central government, the public and private sectors need to work together to change the perception of New Zealand and Auckland in particular.

We are preparing to spend a lot on infrastructure to change Auckland into a world-class city that will attract people to live here. I would suggest that to make this truly a global city we also need to think about the knowledge infrastructure in the sciences and technologies that I have been talking about today. It needs as much attention as transport. The investment needed is partly fiscal, but so much more of it is psychological and motivational. Let us do the things that enable Auckland to brand itself as a city of innovation; a smart city in a smart nation.

Thank you.

ENDS