

## The Future of Higher Education

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Good morning. I was asked to talk about the future of research and development in the context of the future of higher education in Australia and I decided that I would not talk about the IQF because it is about the future and since we've this is a CEDA forum I actually thought I'll exercise my imagination and really look at what is some of the structural problems facing the funding of research and where the opportunities are.

What I will do is I'll talk about some global research trends because they're very important. We cannot escape them and then I will look at where does research funding come from in Australian universities and we will see that there are some surprising facts there, and we will find that one area where we can do a lot of work is in actually getting industry and universities to work together or the end users to work together with industry. In that setting I'll talk about competitive advantage. I will talk about innovation and services because that's the sector of the economy that is growing the fastest and that's also the sector of the economy that the universities do the least amount of research. And then I'll talk about some of the challenges to better university industry interaction. And finally if we really look at long term, the developments of China and India to where our R and D future life becomes very apparent. China and India are just a way of looking at it. It is actually the Asian region that we inhabit.

Of course the, the global research trends over the last two decades there has been a consistent trend away from basic curiosity within research to end user research. End user research is not necessarily applied research. It actually is research that is outcome focussed. If outcomes require one to do basic research it involves basic research. It might require applied research or it might require experimental research. So the shift that has happened is that we have moved from curiosity driven research to outcome driven research.

Why is this shift happening? Well the main reason is that the most mature economies in the Western world, the tax payer dollars are under stress. We essentially have to fund the retirement of the baby boomers and the health care needs of the baby boomers and until they gracefully exit we are stuck with the fact that most research will have to address solving society's problems or creating economic opportunity. Now when you look at research that is solving society's problems or creating economic opportunities they do not compact it as a problem in a single discipline like physics or chemistry or mathematics or economics. They often have interdisciplinary angles and that is another reason that we are finding the shift from discipline based research to inter discipline research. Because we are doing outcome based research.

Now that's where academic research has shifted. Also something interesting has happened over the last two decades. The nature of clockwork research have changed. When I graduated from my PhD the best thing you could hope for was to get a 10 year track position at MIT or Stanford and if you didn't get into these 2 or 3 institutions, the next best thing was that you tried to get a job at Bell Labs or IBM \*3.31 Watson Research Centre or David \*3.32 Research Centres, these corporate giant labs. They did basic research. They did pure research and they produced Nobel Prize winners in physics and material science and electrical engineering. But they were also very interesting organisations. You went into these places. You convinced your manager that you wanted to do this curiosity based research. You did not have to apply for funding and went to conferences, presented your papers and never have to worry about undergraduate students. It was academic heaven.

But somehow during the 1990s it all shifted. And the Bell \*4.11 does not exist as we knew it. IBM \*4.14 Watson is a shadow of its former self. What happened was all corporate research, that funded long term research was actually funded by monopoly. And as the monopolies disappeared the shareholders did not allow the corporate sector to do anything that did not look at the results next year or the 2 years from now. And because of that, that shift has meant the better opportunities for universities. Now there is actually a corporate lab where you can spend your curiosity \*4.48 research and that's Microsoft Research. That was the closest to a monopoly that we had.

What has happened is that the need for long term research for corporations hasn't gone away. It's just that they cannot persuade Wall Street that they actually have to do this research. So they have started working closely with universities. Take the example of Intel. It has opened lablets at Berkley, University of Washington, Carnegie Mellon and Cambridge. Look at a company like \*5.17. It paid \$25m over 5 years to a department at Berkley for the right to have the first look at every intellectual property that came out of their department for the 5 year period. Look at gigantic companies like Cisco. They have no R and DR, but what they have done is created an equal system of innovation where university researchers do start ups and they acquire them, and that's the way, that's their R and D basis. Which means that the opportunity for us to work with industry is significantly higher but in Australia it hasn't translated yet.

Another trend is the revenue from services is increasing but research is still focussed on products and I'll come to that a bit later. So lets look at funding for research in Australian universities. We report funding in four categories \*6.14. One is the category one which is the National \*6.16 Grant, the Australian Research Council, \*6.18, Rural Development Corporations. Category two is public sector and users. So it's public sector money but it could be the Department of Main Roads. It could be some public sector institution that actually wants a focus research done. Category three is industry and international and category four, other corporate and research centres.

Now category two to four are clearly and user focussed research, and category one which is supposed to be the basic research is increasingly becoming end user focused. Rural Development Corporation funding is mostly end user driven. The growth in ARP linked grant is end user driven. You can say that NHMRC is more end user driven and if you look at the topics of discovery grants today they will remind you of topics of linkage grants from a decade ago. The entire world is shifting towards more outcome driven and end user focussed research.

If we look at the funding and this is from the \*7.22 Time Series data, Universities Australia now, category one over the 6 year period, there have been an increase of 79 per cent. No doubt these boosted by the backing of Australia's ability funding. In category two we have seen a surprising increase on public sector and user driven research that has been significant and some of it is because many straight Government departments have shut down their labs and they have shifted to universities in many states. Category three is industry and that hasn't seen a significant rise and category four is the CRC.

So if we look at the bulk of the research that happens in Australian universities is actually end user driven and category one is also end user driven. So the challenge is, how do we get, how do we get this, this thing to really benefit Australian universities? How do we increase the sense of, the sense of industrial driven research? Now to make sure that universities and industry work together we have to look at certain competitive advantages. Of course the best way to have company \*8.29 in a country is to have critical mass, and Australia has critical mass over sustained funding that it has done for medical research and agriculture and astronomy and that's great.

But the source of ultimate competitive advantage actually comes from a local context. If we want to work with industry we actually have to work on local problems because that's what's going to attract industry. And let me give you an example. It's a slightly humorous example. When I was a head of school of computer science and engineering at the University of New South Wales, we used to collaborate with NIDA, the National Institute of Drama Arts. NIDA actually employs American accent training coaches because the job prospects of a NIDA graduate increased tremendously if they can speak with an American accent. So they employed American accent training coaches. We had researchers in speech development \*9.20 and they started working together to actually come up with automotive tools for accent training in American accent. Now it's a very difficult problem and they haven't cracked it yet but think about the possibility that they crack this problem. This was a unique problem that happened in Australia, in NIDA which is unlikely to happen elsewhere, but if they are successful, think about all the call centres around the world that will require this technology.

So the idea here is that if you solve local problems you come up with unique innovation that actually acts as a source of competitive advantage that has wider applications. If we solve other people's problems we are actually starting on the back foot, because they have the domain knowledge to solve those problems faster than us. So we have to look at our, our problems. We have significant levels of competitive advantage if we have to worry about solving Australia's vastness. Our tropical and sub tropical context. Our domain knowledge and resources and logistics. The need to ensure the future of our coal industry. Australia will be the centre of green coal research over the next decade.

Now this, if we focus on our problems for innovation it not only engages our industry but it also is able to attract funding from overseas. Let me give you an example. Boeing Corporation has used the sparseness of Australia to actually look at solving the problem of sparsity, of technologies for sparsity in Australia. They have decided to make unmanned air \*11.00 research for civilian applications in Australia. Two reasons. In Australia we have need for this technology. You are on the right side of the politics. You want to keep the cost free from aliens. You're on the left side of politics, you want to monitor the environment. You want to detect bush fires. So another advantage is that the Australian civilian authorities allow experimentation in civilian air space. In America they do not allow experimentation in air space, in civilian air space. So Boeing saw that advantage and it has decided to invest its unmanned air \*11.34 research in Australia itself. Again it is our local context that becomes a source of competitive advantage.

Another opportunity in bringing universities and industry together is the growth and services. Most mature economies, 70 to 80 per cent of their economies are actually services orientated. If in a country like India the share of services in Indian economy is 52 per cent and increasing and China is also catching up. So if this is where growth is happening, this is where jobs are being created, somehow our research and mostly academic research is too product focussed. And what's the reason for that? And the reason is that it is very easy to \*12.32 the cost of product research over lots of copies of the product. Think about it. You come up with an intellectual property innovation. You patent it. You create products. If it's a physical product, you set up a factory in China and produce it cheaply and sell lots of copies of it and the entire cost of research is \*12.52 over lots of copies of product. If it's a software product. You simply run the copy command.

But what happens in services? You see I might come up with a, a clever piece of software that detects fraud in banking transactions. Now that software is fairly useless unless you actually have a highly paid consultant who actually can look at the actual context of funds, the actions in a bank and translate that into revenue. So what happens is, when you are coming up with services based innovation the only way you can translate that into revenue is by employing lots of consultants, and it is very difficult to \*13.35 the cost of that innovation, and that's one of the reasons that universities have shied away from doing a lot of service oriented research apart from some consulting.

The corporate sector actually is beginning to look at it because this is where the revenues are coming from and I looked at some figures where 30 per cent of the berg, the business expenditure and R and D in Australia is actually in services oriented research. That's significantly more than where academic research happens. Now how we can address that and I think we have to first address the nature of commercialisation of services. Of course the first step in commercialising a service oriented IP is that you consult, but that is not the most optimal way to get the revenues back. Increasingly we are finding that we have consulting services companies coming out of universities which are like spin outs. So these companies, they rather than selling a product, they start employing people when they get contracts and they are actually consulting services company and that's a pretty good model of commercialisation.

But the other problem that happens in commercialisation of services is the mindset of how university commercialisation managers. They come from product oriented cultures. They actually want to have a piece of IP and exclusively licence to someone. Now when you're in the product business you can exclusively licence IP because a company will pay you the price for exclusively licensing it because they can actually address the entire global market by manufacturing lots of copies of the product. But no one is going to pay you the price for exclusively licensing a services oriented IP because it is simply cannot scale. If they had to look at the entire global demand they would have to employ hundreds of thousands of consultants. So the moral in services oriented IP commercialisation should be non exclusive licenses. As many as possible and that's a mindset that we have to get our university commercialisation managers onto and when we start doing that they will start taking us seriously. We will start attracting industry because that's where the revenue growth is happening.

What are some of the challenges? Suppose we have figured out exactly the area that we want to attract industry and we want to work at their services oriented problems. There are a couple of challenges that we have to address. One is the cost of end user research. Australian universities are chronically underestimating the cost of doing research. Earlier we saw Glen talking about costing education. You haven't seen anything when it comes to costing research. We underestimate the cost of overheads. We underestimate the cost of infrastructure and it has been made worse by a block grant funding calculation which actually is a very good thing, but what happens here is that universities are rewarded for attracting industry income in the block grant funding allocation. So if we attract more funding or we win more funding, we get more block grant. So universities compete with each other to charge as little overhead as possible. Now the block grant allocation for attracting income actually was good because block industry at universities closer together but it also has had a side effect where universities are not charging the full cost of research.

On the flip side industry has become used to highly subsidised research and trying to get them to change is a very difficult thing. You often find industry partners coming to us, paying a fraction of the cost of research, having unrealistic expectations of owning all IP and that's a situation that simply is not conducive to going ahead and I think the universities and the academia have to work together to address this. There has to be a better understanding on both sides and unless we solve this, our introductions will become optimal.

The second set of issues that arises from significant commercial presence is issues around conflict of interest. Now balancing academic freedom and commercial interest is a very significant issue.

Obviously if industry is paying for certain piece of research they want to ensure that their rights are protected. But often we find that industry insists on clauses and contracts that are overly restrictive of academia and this actually really compromises the universities ability to be independent proprietors of research. Now Derek [name \*18.06] the former president of Harvard has said, "The only way you can solve it, you cannot solve it by asking academics to look out for it." Academics will never look out for it. They just want to get the project done. They just want to sign the contract. They're not interested in what is there in the clause. What we have to do is get university business managers, their performance indicators is not just how much resource dollars they've processed. Not what kind of royalty streams they have brought to the university but also in successfully restricting the highly restrictive clauses in contracts and unless we do that, we are going to find that over time our independence is going to be compromised and the independence the community expects of us is also going to be compromised.

Another is the pressure to protect research very early. Increasingly we are finding that a small piece of research has been done, which has been done in collaboration with the industry and the industry says, "Protect it." Now the problem is that unfortunately commercialisation is like a relay, where the final leg, the athlete that runs the final leg has the disproportionate of glory, reward and recognition and the challenge is that if the athlete that runs the first leg does not pass the baton on, there is a sub optimal outcome for everyone. When you do research it's very embryonic and you protect it. No one else sees it. The way science happens is you do research. You put it out in the open. Someone else picks up the baton, does some work. Then someone else picks up the baton, does some work. And finally it's so close to commercialisation that someone makes all the money. Now this is a very unfair system but there is no other system that we know. But the insistence of protecting research early is leading to sub optimal outcomes and this is where the Australian Research Council has to be rewarded for going to an open access policy where universities should make a decision. Whether they are going to commercialise or not and if they decide that they are not going to commercialise they should make publicly funded research available for everyone else to build on, and I think that's something that we have to do.

Another issue is managing conflict of interest that is going to become increasingly important. We're all aware of situations where the researchers have done great work. A start up company has been formed. The researcher has a shareholding in the start up company. The start up company attracts venture capital funding. Sub contracts research back to the university. The researcher is doing the research. There are new negotiations on the new research that is happening. Which side is the researcher on? The company or the university? Often the university \*20.51 fund often at arms length distance, invest in the company. Which side is the university on? And we are entering into quagmires of conflict of interest. Now the solution is not to stop the researcher from doing the work because often the researcher is best suited to do the work and in some cases is the only person in the world that can do the research. But we as a sector have to come up with mechanisms that we confront these conflict of interest, manage them in a transparent way and only then we can actually work very effectively with industry but also maintain the confidence that society has come to expect of us.

And finally because it is long term I thought I will talk about the relevance of China and India. When I went to the United States as a graduate student in the mid 80s, there was a book by Paul Kennedy, the Yale historian, *The Rise and Fall of Great Powers*, and there was a fact there that sort of stuck in my mind and I didn't worry about it then, but now it has come back to me. In the 1850s China, India and Japan accounted for 52 per cent of the world's economic output and if things go as they're going, by 2050 they might be back to 52 per cent of the world's economic output. It just might be the case that 20th century was an aberration but our viewpoint of the world is always through the prism of 20<sup>th</sup> century and there are lessons for both sides. You lose a few technological trends, you lose your standard of living in a few generations and you make a few right calls, you might get your economic, like you know wellbeing back, and that's the kind of lesson that we have to learn from this.

We're living in a country that is endowed with resources. We have a very good standard of living but we are also challenged by how do we maintain the standard of living and this is where the opportunities that are arising in China and India, in our neighbourhood actually provide opportunities for us. The problems of China and India, surely we can solve them better than universities in North America and Europe. We share similar climatic conditions. We are in similar parts of the world. Environmental monitoring, infrastructure management, the diseases of the tropical and sub tropical climate. We should be able to compete and that's where our opportunities are but the most interesting thing that is going to happen which is going to get us engaged in China and India is not because the opportunities are there.

What is going to happen is many Australian companies will find that increasingly their revenue is being generated in China and India. When that majority of the revenue is being generated in these countries they will become interested in the end user problems in their market place and they will look at their research providers and get us engaged in these areas, and I think that's a great opportunity. But what else is going to happen. It is actually the source of talent. We're all aware of most American graduate programs would not have survived if it wasn't for the steady stream of PhD students coming out of China and India. Especially in life sciences, engineering and information technology. Now the reason why American universities, like you know one of the reasons why American universities have done exceedingly well compared to some of the European counterparts which are equally well funded if not better is because they have left their door open to the finest talent. As PhD students, as academic appointments anywhere in the world. The European Union is still only now coming to terms with making these academic positions open around the European Union. You cannot compete in today's world. A Germany cannot create a world class organisation by drawing its top class talent only from 80m population base and this is where Americans have done that.

Like in so many things Australia is somewhere between Europe and America. But I think where we have really failed is in attracting PhD students to Australia. Our level of funding for international PhD students is dismally low. Universities have used international PhD programs as a source of revenue. No one I know has gone to America to do a PhD and paid the cost of tuition for doing a PhD program but we still think that somehow PhD programs are going to make money and then we go and talk to cohorts in different countries and we come up with programs that provide a grade of skills to bureaucrats and we see that our PhD program is going well. We are missing out on the top talent out of [name\*25.57], out of the IITs which are invariably going to the United States. It's not that they don't want to come to us. We have world class expertise in many areas. They would like to work for us but the number of scholarships are definitely low and that's something that we have to look at in the sector.

So finally in conclusion, competing pressure on taxpayer funds will limit Government's ability to fund research. No matter how much we like Government to fund research more and more. We'll have to look at industry. We have to look at end users for expanding the research power, but in doing that we actually will stumble upon sources of innovation that will give us our global competitive edge. Australia is going to benefit from this and I think I'm very hopeful about it. There's something else about the baby boomers gracefully exiting and that is that Australia benefits from the fact that it is not going to be totally swayed in one direction. Our compulsory voting is going to protect us. In the United States the baby boomers have given themselves an entitlement but never paid the taxes for it, but they will vote en masse to make sure that all dollars go to their health care when time comes for it. Australia will be protected by the fact that everyone votes here and I think they would not be able to play an exceedingly, like you know powerful role there, and so I'm quite hopeful about Australia. Thank you very much.

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