FASTS Federation of Australian Scientific and Technological Societies

Transcript

Science Meets Parliament Breakfast Forum

Strategic Leadership In Science

Senate Alcove, Parliament House, Canberra
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Participants

Dr Megan Clark – CEO, CSIRO
Baroness Susan Greenfield – scientist and member of the UK House of Lords
Professor Mary O'Kane - Chief Scientist and Scientific Engineer Of NSW
Professor Penny Sackett – Chief Scientist for Australia

Facilitator: Dr Cathy Foley, CSIRO and President-elect of FASTS

DR CATHY FOLEY: Welcome to the Strategic Leadership in Science Forum, which is the first forum of this year's *Science meets Parliament*, which is run by FASTS. My name's Cathy Foley and I am the President-elect of FASTS. We thought it would be good to get some of the leaders of science together to look at this important question of strategic leadership in science.

When we talk about science leadership we often think of things like worrying about budgets and making sure that projects are developed and working a way forward, but we want to go a level above that and look at the strategic leadership that science needs and this is more about why do we do science – is it just to let people allow their imaginations and follow their nose? There's some importance in that, and that's where some of our new and great ideas come from, but there's also a demand side which is saying, especially in Science meets Parliament we're seeing this well and truly that science today is seen as something which is crucial and needed to solve many of the major global challenges, whether it's climate change, trying to boost our manufacturing industries, say in Australia, whether it's being able to manage major health issues and having that expectation of modern science in Australia and in most developed nations means that we also have to think 'what is it that we supply to meet that demand?'

And so the three core issues that we're going to be looking at today for strategic leadership in science are: What is the demand? What is the supply side and the capability providing for that demand?; and, are they well connected, and if not, what should we be doing about it?

So I'm going to introduce our panellists. We've got first of all welcome to Professor Penny Sackett who's the Chief Scientist, then we have Professor Mary O'Kane, at the end, who is the NSW Chief Scientist and Scientific Engineer – so that's an important differentiation because it's beginning to touch on this connection between science and moving into technology, and then we've got Dr Megan Clark who's the CEO of CSIRO, and finally Baroness Susan Greenfield, who's a UK scientist, science communicator and member of the House of Lords. So we're very pleased to have you all today, and thank you.

The way we're going to run today's breakfast forum is first of all invite each panellist to start off with a little three to five minutes introductory comments to have the chance to take the floor and get their view of what is it that makes strategic leadership in science able to manage the demand and the supply side and what we need to connect them, and then we'll have some discussion amongst ourselves and then we'll have some closing comments. Just before we finish at 8.30 so everyone can go off to their important appointments with the parliamentarians today. So I thought that we might first of all start off with our Chief Scientist, Penny Sackett.

PROFESSOR PENNY SACKETT: Thank you. Thank you all. Well these are very important questions. In some sense I think asking the question of how much science we need is a little bit like asking how long is a piece of string. There are pieces where one can partially answer, and then there are other pieces where one needs to think of science in the larger context of society. So if I try to explain what I mean, I think that there are at least three main ways that science benefits society. One of those is in providing evidence on which people can make informed decisions. The other is being an engine for innovation that produces new changes in our lives that benefit either the commercial industrial sector and therefore indirectly in the workplace the populace at large or public good benefits – I'm thinking now particularly of advances in health and things of this nature. And the third area is in increasing our knowledge and understanding about the world. And I think it's that latter one you could say is a variable piece of string. How much do we want to know about the world in which we live? We're human beings, we're curious; we really want to understand the world. And often in doing that pure blue-sky research we actually learn things that have implications for the first two areas that I spoke about.

But if we ask the question: How much science do we need in the policy and benefit areas? That is not an easy question to answer. Certainly we know that the need for scientists in Australia, the domestic demand, is driven primarily by needs in government, the university sector and industry and we know that in university the workforce is ageing and I'm very pleased to see so many young faces here, that's very encouraging, but we do know that between one-fifth and one third of academic staff at Australian universities are expected to retire in the next decade, so this should give us pause, particularly when we know that the number of domestic students undertaking PhDs is declining. This very past year there might be a slight uptick there, and we certainly hope that continues, but the trend is very much downward, and so I think that should give us quite pause.

And I also think that we need to be a little bit careful about trying to tune the supply side too much to the demand side. I think we need to be a little bit cautious about thinking that we can track those things and figure out how many chemists we need this year, how many

physicists we need this year, in particular because when you're thinking about innovation and you're thinking about new ideas, how can you possibly predict where they will come from?

And so the important thing I think is to always maintain a large base of diverse scientists and cross-disciplinary scientists that can work together to create new things that we cannot in fact predict. Maybe I'll just stop there.

DR CATHY FOLEY: We'll move along then and invite Baroness Susan Greenfield to give her introduction.

BARONESS SUSAN GREENFIELD: Yes good morning everyone, I think the first thing I'd like to comment on is that all the panellists here are female, and I think that must send out some kind of signal, a very positive one. I work a bit with L'Oréal along the issues of women in science and they have a very good slogan which is 'the world needs science and science needs women', so please take note, especially the young women here, that we are fighting back, finally. My other observation is from Carl Sagan, a while ago, an astronomer now sadly dead; who said it is suicide to live in a society dependent on science and technology where no one understands anything about science and technology.

And if one takes that if you like as the starting text we've always known, well for the last 10 or 20 years, that finally the scientist is having to come in out of the cold. Previously we were the dysfunctional nerds in the ivory towers, we just communicated with each other in jargon-ridden peer-to-peer communications and grant applications and people rarely let us eccentric pointy heads, as it were, get on with it and we didn't really bother people too much. Now increasingly and even before the immediate problems that we're facing now we've had issues of climate change, nutrition, reproduction the kind of areas that strike at the heart of peoples' lives in ways that science can enlighten and give insights into, in ways which scare people and in ways therefore in which people need guidance and politicians need guidance.

I come from a place where you're going quite soon, which is one of great despair. I think England is probably about six months ahead of Australia in terms of the serious repercussions to the recession and it's not pretty. You go around towns where shops are closed, where day after day after day the press tells gloom and doom stories whether they're personal tragedies, whether they're worse upon worse predictions as to the unemployment rates and so on. And even Australia, which I know has more resilience and optimism than the UK, and I know that we are well known for our whingeing, nonetheless I think you will find nonetheless slightly, even in Australia, even a country of optimism, as to the outlook. So even more than before, where science was starting to come centre ground, I would now suggest to you that this is now no longer a 'nice-to-have', it's no longer some sort of utopian renaissance world that we're all striving for – and there's nothing wrong with that of course – what we are striving for now is a very pragmatic way out. We want a way out of a situation where there's no road map. And for once, I would suggest that the scientist has to be in the lead for this, it's no longer a question of us following the politicians, of us following the private sector. We are now going to be perhaps people who have the only answer, in terms of goods and services, in terms of innovation, that people are going to turn to for salvation. When your back's against the wall, you innovate. Since when have you had exciting new discoveries

come out of Fat City? Since when have you had a new way of thinking of something, radical, bold new thinking, come out of people who are sitting on the golf course or in the spa? You don't have that, yeah? So what you need, now, is, well you've got a choice. Either you can sit in despair that you can no longer afford to go on the golf course or the spa, and wonder what you're going to do, or you can start to think in a very new way and I find this very exciting, when I first came to Australia, to South Australia, that was my remit in 2005 was to think in new ways in South Australia how to do things and how science could help innovate and create wealth there. And one of the things we did was to set up this Science Media Centre which in turn has led now to the establishment of an RI – that's what I lead in London – it's going to serve the whole of Australia from October onwards, they're opening it in October, more of that anon if you wish. [1]

So already, science is starting to be central but I think particularly it can now actually help with some solutions. First, neuroscience, which is my area, one can actually help to explain risk, or recklessness and greed, which Obama only yesterday said, was responsible for the recession. If we understood that neuroscience could throw insights onto these puzzling new mindsets and frightening mindsets that have led us to where we are, then at least we won't repeat it and at least we might be able to do something about reversing it.

Moreover this puzzling new mindset, one dominated not just by technologies but also by a world where there's technologies not delivering happiness might be able to help us design goods and services that the consumer wants. It might help us design totally new technologies that are more appropriate for this new century, the 21st century. These are only a few introductory comments so I won't elaborate now, but we could do that in the Q&A.

So perhaps I should just wind up by saying that two weeks ago I gave a speech in the House of Lords on the impact of social networking sites on the brain and how that might be changing people's attitudes to relationship. The reason I say this is not to initiate a debate on that particularly, but just to say what that led to, was a world-wide media reaction to this issue, which is a very simple one to say that the brain is sensitive to the environment, the environment is changing, it's becoming two-dimensional for many people, and therefore, if the brain is sensitive to the environment, if the environment is novel, then the brain might become novel too. That was all I said. The reason I mention this is really to make the point that 10 or 20 years ago a scientist would not have had that outreach, would not have had that impact, would not have had people talking and thinking in that way. I'm not saying I'm right or wrong, whether it's valid or whatever, I'm simply saying that at last the time has come where people are listening to scientists and I think they're listening to scientists simply because they have no alternative and because they realise that whilst we may not have the answers we do have at least attempts and ways out of somewhere where nowhere else is providing answers. Thank you.

DR CATHY FOLEY: I'd like to invite Megan Clark now to have her opening comments

DR MEGAN CLARK: Thank you very much and thank you for sparing some of your very early morning to join us. I think we appreciate it and I think this discussion is very timely.

[1] RI – Royal Institution. A UK organisation formed in 1799 to promote science education and research.

I wanted to really share a couple of things with you, given that this is an intimate gathering, really try and give you an up-to-date picture of what we're seeing, literally an up-to-the-minute picture of what we're seeing in the investment side in innovation. We deal with external investors in innovation across almost all of the scientific sectors from deep space right through to some of the materials work that Cathy herself is involved in. We're seeing first of all, you can't really call them forces; I would actually say we're at the maelstrom of three tempests. The first being the financial crisis, and as the baroness outlined I think that's really sobering in its proportion. The second we're seeing is clearly climate change. As Penny Sackett outlined last night, the new evidence coming in from Copenhagen that we really are tracking along the worst-case scenario for many of those metrics with the new science. The third one we're witnessing, and we're seeing driving a lot of the demand and innovation, is a much more silent one. And that is, the greatest migration of human kind since this species arrived on the planet. And last year we tipped over having more people in urban environments than outside urban environments. That's even more pronounced in the developing world, where we will see 81 per cent of the developing world move to urban environments.

What does that mean for innovation? It means that for the first time more people will be completely and utterly dependent both in the developed and developing nations for their food, their water, their livelihoods, the removal of their wastes, in the infrastructure related to urban environments so we're seeing that as being an incredibly important albeit silent tempest.

In terms of what we're seeing reflected in investment you might expect in that environment and you might expect in some of the environments of despair that innovation and R&D and investment in that area would actually diminish and be suffering. We're actually seeing something completely new emerge and I think it speaks to both of the previous speakers; we're starting to see the evidence of that. First of all we're certainly seeing governments in the US and Japan, in our own country and China, using their stimulus packages to really drive technology and innovation that will certainly provide us with a more sustainable environment. But secondly we're starting to see already and what I say is up to date - I would not have made these comments to you in January, I would not have made these comments to you in the first week of February – so this really is what we're seeing the last four or five weeks, that we're starting to see our external stakeholders, industry, they did a few things, first of all they stabilised their balance sheet, and quite frankly we didn't hear from them, innovation was the last thing on their mind, their bankers and shareholders were priority to them. The second thing once they'd stabilised their balance sheets was that they looked at their operating – they need to balance their costs and we saw and we've clearly seen, and you've outlined the job losses etc, as organisations had to bring their operating into balance. But the third thing and that's what we've started to see literally in the last six weeks, is they're coming out of that and the very next thing they're thinking about, their investment in innovation.

For a couple of reasons, one, they also need to reposition themselves in this new world. How are they going to be competitive in these new forces? How are they also going to reposition themselves in these emerging markets of energy security, of food security, how are they

going to take advantage of this urbanisation in terms of the enormous amount of innovation that act requires? So we've seen this across many sectors, we've seen the agricultural sector stay very solid in its investment, and go to two spectrums, one, actually feeding the world, the basic fundamentals of seaborne trade of protein, carbohydrates and fat. You know we think of fat as something not so food, believe me if you are trying to survive it's a wonderful source of calories. At the absolute other end we're seeing the developed world wanting to use food as a medicine in terms of health and how we support our ageing population. We're seeing investment in deep space, as the Chief Scientist would be pleased to note, actually increasing because it's really the forefront of our new wireless technologies, it's the forefront of our new computing and data-handling technologies, and in this country it's also leading the automation of our plants and the activities we undertake in remote Australia. Our space research is helping us to lead the way. We're certainly seeing energy security, we're seeing green energy, we're seeing hybrid vehicle investment, nanomaterials and as I mentioned health, all these areas increasing in their investment. So I just wanted to highlight with you in my opening remarks that we're already starting to see the evidence of some of the things that the previous speakers have talked about. I am an Australian, and I am positive, but I did want to share with you that there's some tangible evidence now coming through that society and that our stakeholders are truly wanting to come out of these new forces in a completely different way.

DR CATHY FOLEY: OK thanks Megan and I'd like to now invite Mary O'Kane to give her opening remarks.

PROFESSOR MARY O'KANE: Thanks Cathy. One of the advantages of being last in a group of speakers is you can either disagree with them, which can be fun, or you can actually add to them. I actually think by and large they've got it right. Susan slightly got it wrong of course, she should have said *engineering* and science is starting to be the centre, but apart from that they're almost there. I'd like at the very start also as my second really opening comment is to congratulate FASTS on holding this session and looking at this issue. I think we don't spend enough time thinking about supply side and demand side issues in Australia. Other countries do, and I think we talk about it in very general terms but don't get down to the hard sharp end of it often. And it's interesting, Megan and I were last year on the Innovation Review and there we did talk about what I would think of as more the settings side and I would think they're very important. And Penny started by touching on the importance of not being too precise in matching up supply and demand, and I'd like to echo that. You'll notice if any of you bothered to read the great Green Paper, and it was nice to read it and it was in a nice typeface, you'll see that we actually chose the chapter headings carefully, and we chose the order carefully, and right up the front of course is human capital. And I think above all we all know that you have to have an extraordinarily good supply of human capital, well educated, lot of kids doing science and maths, people reaching high levels of educational attainment, getting through Year 12, going on to VET, going on to university, so the first thing you need before you start talking about demand and supply is that. You also, as we asserted quite early in that review, you need a very good R&D system. You just need extraordinarily good, well-funded, blue-sky research. And, I think a lot of the literature points to that and we've seen it in many countries, and I think we should always keep the primary emphasis on those two things.

But coming to the sharper side of issues, I think where we tend to get it wrong is in the next phase. And that's where I think the US has always struck me as particularly good. Most of you are far too young to remember the Man on the Moon project and before that the Cold War, and the incredible impact that had on our lives, not in terms of everyone feeling scared or everyone feeling excited when people jumped around on the moon, but what it did in terms of a push in terms of science and in terms of technology. And it's very interesting if you examine the detail of Obama's stimulus package and the enormous amounts going to R&D. To look at not just the money that's going into R&D, but the mechanisms they're using. And the mechanisms in particular reflect DARPA.[2] And the notion of very precise statement of the problems they want to solve. It's not just saying let's solve the climate change problem. It's actually going down and saying which precise pieces of the climate change problem you wish to solve, and then setting it up effectively as a challenge – the DARPA challenge model – and setting many well-funded teams going, running them against very strict measurement criteria, ruthlessly cutting off ones that aren't doing as well as the top group, and then getting through to a solution to the particular problems. It's been a very good model, used right through the Cold War and the man on the moon issues in the US and people see it as driven particularly by defence in the US but it's wider, and this time it's got slightly different titles, it's got shorter time lines, but it is the same model in use. And I think it's one we ought to think about very hard here. And because one of the things I've noted, in many years of serving on grant bodies in Australia, is just how great Australian scientists and engineers are at responding to challenges. If you put out challenges, if you put a pot of money on the table and are precise about what you are doing, Australians are incredibly inventive. I know we talk about stump jump ploughs and so on but there is more than a grain of truth in it, and I think we ought to think about that now when we face the enormous challenges that Megan spoke about. Thank you.

DR CATHY FOLEY: Well thank you very much for those introductory comments, I want to now pick up on the point that was relating, I guess Mary raised it specifically, looking at the demand side and saying Australia only does this, say the number is three per cent of the research in the world, and yet the problems we have to deal with are the same as every other major nation, how do we actually go about picking out which are the problems we're going to pick to work on, say using your challenge model, saying let's identify some of the challenges and go a bit deeper and then try and attract people to do that? Should we be actually picking the ones we're going to solve and then looking externally beyond Australian shores and saying that we'll rely on other people to provide the solutions in other areas, or is that not going to work?

PROFESSOR MARY O'KANE: Well I'll have a go, because in some ways it's easier for me, with a smaller remit. I think we do need to do that, and even though there might be solutions elsewhere in the world we might be competing, we might be solving locally, but actually that'll help it sell globally. And in NSW there are a couple of extremely clear problems: we're a very, very coal-dependent state. We need to be focusing on what's euphemistically called clean coal but we also need to completely change our power system because Australia of course is the highest emitter in the OECD countries and NSW is the highest emitter of all the

[2] Defense Advanced Research Projects Agency (DARPA) is the key research agency of the US Department of Defence and is renowned for its support of high risk, transformative research.

states. So we need to drastically change our power structure in NSW. Green to us absolutely means power. And whatever's happening in the world we need to be in there solving it and putting that challenge on the table very precisely in NSW. So at a very state-focused level we have to do something like that.

DR CATHY FOLEY: Penny would you like to comment from a national level?

PROFESSOR PENNY SACKETT: Well I think there are certain challenges that we need to clearly define and go after in a very big way. Actually I think there are areas where the economic crisis and the climate crisis are pushing us in the same direction and those are the ones that we can actually expect to get greatest return from quickly. So I think those ought to be some of the ones that we focus on. Some of the solutions will be local, they need to be local. We know that every place on the world is not going to be able to react to these crises in the same way. So there has to be a very strong Australian component in looking at the Australian situation and finding solutions for Australia. At the same time, we would really be foolish to not first understand what others have done and pick and choose the bits that seem to work or could work for Australia. So I think it's a combination of working with the very best overseas, actually something that in most areas Australia does well, working with international teams, but asking again the questions in the Australian context.

DR CATHY FOLEY: Baroness or Megan, do you want to comment too?

BARONESS SUSAN GREENFIELD: Just for the sake of controversy, let me put a counter view, which is that sometimes you can't predict the end point or the implications of research that might at times seem quite blue skies. I'm thinking of quantum theory, for example, which when it was first explored in the late 1900s, the early part of the 20th century, no-one could have foreseen that that would lead to the development of the transistor, for example. So we have the same debate in the UK, which is on the one hand do you have a very focused, relatively short-term goal, where there are absolutely clear needs, that scientists technologists and engineers could deal with or do you let scientists have their head to a certain extent because it's only by doing that that you might have a truly innovative new insight into an issue. Both approaches are valid and I don't see why they should be mutually exclusive so long as we know that we are having a portfolio of different approaches to research. And the other perspective I'd like to say is that just because one has a small percentage of the world's research doesn't mean to say that one does it just on a quantitative basis, you know if that percentage is something that wins the Nobel Prize, you know or has some fantastic new discovery that it doesn't matter in terms of money or in terms of people that constitute the world the whole point is the quality of the research rather than the quantity of the money or the people.

DR CATHY FOLEY: Megan did you want to comment because CSIRO has a different charter to many other research organisations in Australia?

DR MEGAN CLARK: Yes we do and in fact we pick up both of those things. We believe you do need to do both. In terms of the national challenges CSIRO has really chosen nine major flagship areas not just for our research but where we catalyse a national response. In the area of water, water for this country's absolutely critical, in the area of new smart

manufacturing, in preventative health, to really help our population, just to name a few, so we use those focus areas to really catalyse a response of all of the players in Australia that need to come together to solve these problems and have defined targets. But secondly I think the Baroness is right, we also need to make sure that we have depth of understanding and capability for our people who are part of these teams and you don't quite know where that is going to lead and we do need to create the freedom for our young researchers to get depth in their science, to interact with the 97, 98 per cent of knowledge that's out there and not restrict that as well. From that magic they then of course can participate in these national challenges and bring that to the table. So we have worked very hard to organise our organisation to allow us to do those two things. It is not easy. There is no question that if you want to do both of those things well bring cross-disciplinary teams together on major challenges but also provide our young scientists with the absolute depth that gives them the international level training that they need, it's very difficult but I think it's absolutely essential because it is only the organisations and in some cases the nations that can manage to do this that I believe will own the future. So we can't shy away from that challenge I think of trying to balance both the comments of the Baroness and also we need to focus our intentions as Mary said.

BARONESS SUSAN GREENFIELD: Just a little quip that I'm sure a lot of you have heard, when someone asked Michael Faraday once what would be the use of electricity, and he said 'well one day you'll tax it'.

DR CATHY FOLEY: Or I think we'll only ever need three computers in the world.

DR MEGAN CLARK: Could I actually comment again, maybe I wasn't precise enough in my statement when I talked about challenge. I should've added the magic word of 'competition'. I think one of the things we don't do as well as we might, and this is more to be provocative although I personally believe it, is we tend to sometimes put up challenges, and I think CSIRO's done a great job with its flagships, but the missing element is we don't set multiple teams going on the same problem. And I think Australians, if you only look at us in the Olympics, we adore competition and we're very very good at competing against the very best in small areas. I mean we don't win the number of gold medals but we do quite well. But we do tend to I think go really well when there's several of us going at the same issue and I think that's what we ought to do more, set up precise challenges in the area, let's say of water or whatever and then put a bag of money on the table and let several groups go at it and then winnow it down to a couple. I really do think that the breakthroughs we got on the man on the moon, the transistor and so on came as by-blows to that phenomenon.

DR CATHY FOLEY: That's an interesting point because that actually goes against the expectations of creating more collaboration and interaction but anyway Penny I'd like to ask you to respond to that.

PROFESSOR PENNY SACKETT: Yes first of all one of the things I actually think you're probably hearing from this panel is that there is a mixed portfolio that needs to go forward I think we'd probably all agree on that point and as someone who did a thesis on quantum chromodynamics I can tell you that I have a special place in my heart for blue sky research so no-one should walk away from this room thinking that I don't. Quite the opposite in fact, but

I do think there are particular areas in which we need to set challenges and I do think that multiple approaches are good.

Now the place where I hesitate just a little bit is pushing the competition word too strongly. It depends, I think, on what we mean by that, if it means competition of ideas then I'm all for it, in fact I don't know what science means unless we have competition of ideas. I think also that we need to be well resourced, I think in order for Mary's idea that the sort of model we're talking about, that has to be well resourced; it will fall on its face if it is not well resourced. If those teams are competing but none of them have enough money to do anything in the way they would like to do it then it will lead to an ugly sort of competition that one sometimes sees and we certainly want to avoid that. Rather the kind of competition we want is one in which sure you'd like your team to be doing something that is top of the line and hitting the front pages of the newspaper, but in fact you rather want the other teams to be doing well at the same time, because that lifts your game. And I think what we really want to do here is lift our game.

Certainly I have been an advocate of beginning many projects and then doing what Mary says, taking a hard look at them after a while and asking whether some really are doing better than others and then reinvesting. But I want to stress that this is an approach that I think would work for very specific targeted challenges where you can expect to have some results reasonably soon. And I might even mean ten years by that. I don't mean two years. But there is another area of science where I think you do have to let the scientists have their head and in fact if you don't do that you won't be preparing for the next 40 and 50 years that you can in fact be in no position to anticipate.

BARONESS SUSAN GREENFIELD: It's really just to endorse what Penny and Megan are saying, in my own view the biggest problem in the approach of having different diverse groups all tackling an issue, let's say my own area it's Alzheimer's disease, in different ways is that a certain dogma sets in and often what bedevils scientific research is there's an article of faith, let's Say in the case of Alzheimer's its this thing called ameloid, and that becomes a fashion, it becomes a dogma, this colours the decisions of the research councils, it sways the referees on the journals, because if you are subscribing to that broad conceptual dogma then you'll get any easy passage whereas if you challenge and come up with something that's quite different you'll have to work ten times as hard to try and prove your point. Which is fine, but it means that when you don't get a grant it's not fine, and it does mean that there can sometimes be a kind of institutional or collective prejudice. I just want to flag that in my own experience, inevitably I have a different view to everyone else about Alzheimer's disease, that it can be difficult, and it would be very nice if we were to have in place, and I agree we should have, a whole range of approaches to problems like Alzheimer's disease, a way of neutralising the dogma and trying to have a level playing field.

DR CATHY FOLEY: OK, I want to just now switch a little bit to the supply side because we touched on that in some of the opening comments and one of the things which was really interesting to hear was the idea of actually not having the supply and the demand absolutely mapped onto each other and I think it would be interesting to explore that a little bit because it's in some ways there's a bit of a mixed message I feel of what as people educating saying we're trying to develop new courses that actually are providing scientists for particular areas

because this is a big area we need into the future, when that happens when there's suddenly a rise in geophysics for example when there's a minerals boom or there's a rise in environmental science or whatever. I'm just wondering if you would like to turn to that and think well how do we actually get the balance right, what is needed to create the capability and the supply of Australian scientists and engineers so that we are able to make sure that we take on the right challenges or that we have the intellectual capacity to deal with some of these big challenges.

DR MEGAN CLARK: Let me cover that in I think two aspects: one, I think we need to start as early as possible on the supply side, and right at the primary school level where kids are curious about science. We absolutely have to get out and help our young science teachers. We have a program in this country called *Scientists In Schools*, the aim of which is to have 10,000 scientists interacting with a million young Australians every single year, personally and connected, with the science teachers really as a huge helping hand. I have my adopted science teacher in this program. I'm not sure whether they got the booby prize, but just last week it was just amazing to see this young science teacher who was really trying to stimulate stuff. She said "I used the word 'hypothesis' with my young kids. All the curricula people said you should never use such a big word, they can't understand the concept of scientific hypothesis." She said, "they *loved* the word hypothesis. They take it home, they think it's fantastic." So here was someone who absolutely excels. So I think at the supply side, this program we have, our understanding is it's somewhat unique in the world; we have to get and make those connections to make these young science teachers.

I think secondly there are some real dilemmas on the supply side and I see them as two ends. I've had the fortune of being able to work with scientists and be able to bring scientists from all over the world to work on problems and it taught me something. The most successful were the Russian and Columbian scientists and you might ask yourself the question why on earth was that? And there were two reasons; the Columbians of course know their country is facing enormous challenges. Their will, their enthusiasm, was so paramount that they simply overcame every obstacle and were successful. It's just extraordinary to see a young Columbian scientist in action. And I think it goes to your comment about the innate ability of a human being when they're back's against the wall, and believe me if you think our situation's bad, spend some time in Bogota.

The second was the Russians. And they simply were successful because they knew their stuff. Their mathematicians are so well trained in their maths. They're not exposed to as much as what we would be exposed to in the UK, the US, Europe or here, but they knew their stuff, which meant that when you put them in multi-disciplinary teams they simply functioned unbelievably well and they blossomed incredibly because of what they brought with them. So I think we have this dilemma, which is how do we teach our people to know their trade, to know their stuff. At the same time as you don't want to restrict them into disciplines too early. And the students have been telling us for many many years, if we had cared to listen, they did not want to go into those streams, they wanted more general broad, what I would call molecular-level science where it starts to all merge. So I think we have some enormous challenges to address the student needs.

DR CATHY FOLEY: So can you just clarify? Are you saying the students are asking for more multi-disciplinary stuff?

DR MEGAN CLARK: The students have for a long time walked away from courses — they've voted with their feet — that led them into industries, jobs that led them too early into a career path. They've voted very clearly to go into quantum areas, to go into the biotechnology. They went into the platforms, what we would call the capability platform areas, you know, teach me about computational science, teach me about biosciences, but don't tell me what job I'm going to have. Don't tell me I'm going to go off into this industry. The students have been telling us that for 10 years. We started to listen 5 years ago. You know, they're very smart, these young people, and they know it intuitively. So that's a real challenge on the supply side. But just listen to the students; they've been getting it right for year after year. And they're voting and telling us exactly the pathway they want forward.

DR CATHY FOLEY: Mary did you want to comment?

PROFESSOR MARY O'KANE: Absolutely, a lot of my life's been on the education side of things and I want to make a few quick comments there. I agree with Megan you start early, but I'd start earlier, and believe it's kindergarten and training the mums. And the other comment about starting early is particularly about maths. The thing we have actually got very wrong in our schools is the whole issue of maths teaching. And often we have people teaching maths who themselves are terrified of symbolic reasoning in mathematics. And we need to change that. It's an issue of confidence, of building it up, and probably cutting back the actual curriculum of maths in schools but making what we teach extraordinarily good and taught by really confident people so kids want to do maths. Because I agree about the Russians issue, if you can get people with good maths the rest of the science tends to flow. That's a bit simplistic but it's not far off. The other thing I'd say is that if you pick up the most recent *Economist* there's a very interesting special report on entrepreneurs in the downturn and it makes the point that we've seen in Australia and many other immigrant countries, that you tend to get great impulse to science, you tend to get impulse to innovation and wealth creation, from migrants. And I think one of the really important things in building the human capital side is to have a very very open migration policy, particularly encouraging people from the very poorest countries. And you only have to look at what Singapore does, takes in the very brightest at Year 10 and takes their families in – gets them from around the world, doesn't matter what sort of country, and takes the whole family along and Singapore's got that group. There are lots of things to say about, I mean it's interesting looking at the response to Bradley for example, that's going, that is a totally demand-driven system. Is that fine? I think there's going to some real questions about where we need, some really tight points you know that we need nurses, doctors, engineers. And the very last comment I'd make, I think we need to free up our professional bodies. They're too hidebound by and large, and in terms of accrediting things, in medicine, particularly the specialty areas, engineering, several of the other fields, accounting and so on, we need very nimble professional accreditation so that people can move between fields very well off the good sort of base that Megan's talking about.

DR CATHY FOLEY: OK, Penny, you said you wanted to …

PROFESSOR PENNY SACKETT: Yes I'd like to first of all underscore very boldly the statement that Mary made about maths. I think it goes to the core of a lot of the difficulties that we're facing right now. And in fact it's quite worrying to me. So I just wanted to say that very strongly. Another thing I wanted to underscore was this, I think Megan stated it, the importance of knowing your stuff. I feel very strongly about cross-disciplinary research, I love cross-disciplinary research and so do the students, but the way they make it work is to really have people who know core disciplines well, and can speak across those boundaries. Mary mentioned maths teachers who don't feel comfortable with what they're teaching, and quite honestly a lot of us as disciplinarians don't feel comfortable crossing those boundaries. And that's not a good message when we're actually struggling and not doing a good job at all about cross-disciplinary research. So we need to identify people that know their stuff and feel comfortable talking across those boundaries and those are the ones that will really train the young people well. When we were setting up the planetary science institute at ANU some years ago and we had to talk across astronomy and geology one technique that we used were yellow cards and everyone had yellow cards so whenever there was a piece of jargon being used people would flash up their yellow cards and the conversation had to slow down until we could catch everybody up again and go forward again. So you know it can be a lot of fun but you have to be willing to admit that there are things that you don't know. So as the instructor you need to be holding up your yellow card as well to make it clear that there are things that you don't know and things that you want to know.

I think another thing that I'd like to just throw out there as an idea, I very much like the idea of trying to solve two problems at once, wherever that's possible. And we're in an economic downturn, we know that there are people across all sorts of jobs and skills that are in fear of unemployment, we also know that we have a teacher shortage. We know that we want people that can teach science and math that are enthusiastic about it; we also know that that's not enough; there are skills to being a teacher that take years of training and expertise. I wonder if there is an opportunity here for some of the people that may be looking at unemployment but who are in fact absolutely expert and love mathematics and science, to be paired with teachers who are excellent in their pedagogical skills and understanding students and actually find a way to bring some of these people into the classroom, each of them mentoring the other. In a way, sort of like the pairing of the scientists and teachers, but now actually going one step further and trying to place these people in the classroom and supporting them through a program to do that. I just throw that out there as a an idea as possibly something that could

DR CATHY FOLEY: Baroness you said you want to – very quickly?

BARONESS SUSAN GREENFIELD: Yes just very briefly and from a UK perspective, which may or may not fit here. I think there are three issues, one is teaching, one is image and the other is women, if there's three pressure points.

Very briefly the way science is taught in the UK in a sense is the baby being thrown out with the bath water, and the attention is all on targets and ticking boxes and passing certain tests and exams rather than on whether the kid understands it or not. And increasingly it's very easy to download something, pass it onto the teacher and you're delivering the product but actually understanding something is more questionable. And of course that's at the very

heart of science because at the heart of understanding something twinned with that is curiosity and if you don't understand it and you're not curious and you're not therefore passionate you're not going to be very good at it and you're going to give it up as soon as you can. That's the first issue.

The second issue is image. And I think a lot of kids don't realise you don't have to stay at the bench in a white coat. That you can actually be welcomed into the political community, into the media, into law, and all those sectors which traditionally were antithetical to science now actually are very well informed by science and it's a wonderful market for any person with science credentials to go into those areas, I'm very proud in the House of Lords we have 10 per cent of people there now who have got some kind of claim to some kind of science credentials. I do stress some kind of.

I find that I'm going to end where I began, and I'm surprised that no-one else has mentioned this because this is the elephant in the room if you like and that's the issue of women. And it is a fact, and Penny and I were discussing this yesterday, it's lamentable, in terms of the recruitment and retention of women in science and we have to do something about that. And I know that that's an issue here as well. And we have to have it out there rather than pretending in some kind of politically correct way that it's not existing. It is existing. Girls and women are not doing science as much as men and boys are. We ought to explore why that's the case. We do have to make issues, and I say this emphatically and definitely because I've really looked into this, in terms of child care provision for women in their late 20s early 30s just at the formative time of their career when they're taking time off to have kids, that is an issue, it can be managed, but you do need resources. And finally there's the more senior level of the glass ceiling. Not just institutionalised sexism but representation of women on interview panels and above all the confidence of women to apply for high-powered jobs. Until we face up to these issues we will always be disenfranchised and science will be poorly served by not having the best possible brains there.

DR CATHY FOLEY: OK. Well just to wrap up I'm going to ask each of our panellists if they would be willing to come up with just a sentence or two to say what is the one things you think you would like to see happen or change or do in order to address the supply and demand issue in Australia?

BARONESS SUSAN GREENFIELD: Can I go first then, because while I was on my roll … it would be very simple, to have ring fence funds, but serious funds not just some token ten dollar, ring fence funds for anyone who's had primary child care for a year or two, and that would be widowers and men who've had primary custody of divorce, but primarily that would be women, ring fence funds for such individuals to have competitive fellowships, but when I say competitive it's not like winning the lottery, but competitive you do stand a reasonable chance of getting one, um, a let's say two-year pump priming fellowship that would enable you to get back into the fast track of science.

DR CATHY FOLEY: OK, who wants to go next?

PROFESSOR MARY O'KANE: Well I'll go and just repeat what I said, about I do think in Australia we ought to move, with really hard problems, to the combination of precise challenges done on a competitive model, with a very good bag of funding.

DR CATHY FOLEY: Megan?

DR MEGAN CLARK: I agree with Mary but I do believe we need to start early in terms of our training around science. We absolutely need the next generation to come through. They actually want to, I think what we do is suppress them and we suppress that natural curiosity and don't actually encourage what's there. I think if we bring that through that generation of course will be the next leaders, the next set of parliamentarians that we have and we absolutely need to nurture them through.

DR CATHY FOLEY: Penny …

PROFESSOR PENNY SACKETT: I think the thing that I would like to stress is, I'm going to sneak in two points, one is really trying to support teachers, this goes to Megan's point of starting early, I think we need to do as much as we can to support teaching and the other thing I would say is to, I'm a full fan of full cost of research being supported so that the scientists can get on with what they're doing and not make this invidious choice between spending time on teaching or spending time on their research.

DR CATHY FOLEY: Well I think it's been a really interesting and challenging set of ideas that we've come up with this morning. I'd like you to join me in thanking our panellists who got up bright and early (applause). And I'd like to end our forum.