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**HOUSE OF
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STANDING COMMITTEE ON SCIENCE AND INNOVATION

Reference: Pathways to technological innovation

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HOUSE OF REPRESENTATIVES
STANDING COMMITTEE ON SCIENCE AND INNOVATION

Monday, 30 May 2005

Members: Mr Georgiou (*Chair*), Mr Quick (*Deputy Chair*), Mr Hayes, Mr Jenkins, Dr Jensen, Miss Jackie Kelly, Mr Price, Mr Tollner, Mrs Vale and Dr Washer

Members in attendance: Mr Georgiou, Mr Hayes, Dr Jensen, Miss Jackie Kelly, Mr Quick, Mr Tollner, Mrs Vale and Dr Washer

Terms of reference for the inquiry:

To inquire into and report on:

Australian technological innovation and pathways to commercialisation, with particular reference to examples of successful Australian technological innovations that demonstrate strategies to overcome potential impediments and factors determining success.

To assist in its inquiry, the Committee seeks to compile a series of case studies of successful technological innovations, and the pathways to commercialisation. Submissions are sought detailing successful examples of Australian technological innovations.

Submissions are also sought with particular reference to successful innovations, on issues such as:

- pathways to commercialisation;
- intellectual property and patents;
- skills and business knowledge;
- capital and risk investment;
- business and scientific regulatory issues;
- research and market linkages;
- factors determining success; and
- strategies in other countries that may be of instruction to Australia.

WITNESSES

BATTERHAM, Dr Robin John, Chief Scientist, Department of Education, Science and Training 1

Committee met at 4.37 pm**BATTERHAM, Dr Robin John, Chief Scientist, Department of Education, Science and Training**

CHAIR (Mr Georgiou)—I declare open this public hearing of the House of Representatives Standing Committee on Science and Innovation in its inquiry into pathways to technological innovation. Written submissions have been called for and 77 have been received to date. The committee is now conducting a series of public hearings and this is the third public hearing for the inquiry. Welcome, Dr Batterham. Is there anything you would like to say about the capacity in which you appear today?

Dr Batterham—I am the Chief Scientist of Australia for one more day.

CHAIR—Is that good or bad?

Dr Batterham—Others will judge that.

CHAIR—I am glad we have caught you before you leave. Thank you for coming. The committee does not require you to give evidence under oath but I should advise you that these proceedings are formal proceedings of the House of Representatives and consequently they require the same respect as the proceedings of the House. It is customary to remind witnesses that giving false or misleading evidence is a serious matter and may be regarded as a contempt of parliament. Would you like to make a statement in respect of your submission or would you care to make some introductory remarks?

Dr Batterham—Thank you, Chair. I am delighted to have the chance near the end of my second term as Chief Scientist—and I will not be taking another, as I have indicated—to make some comments because I think the area you are looking at here is just so important. I will make three broad comments but I am happy to answer questions or go into discussion as you like. The first one is about skills for innovation. It seems to me that we really spent quite a lot of money in research in research training, and you can look at this as training people just for the sake of doing research, and to the extent that we need researchers in the community that is right and appropriate. But it seems to me that research training per se is actually equipping people for innovation and equipping them rather well. I do not think we have focused enough on that in the past. The sort of thing I have in mind is that those who are undertaking research in higher degrees, for example, are learning about where the leading edge is. They are learning about how you choose between various alternatives which are essentially technically based and understanding the risks associated with different particular paths by pursuing them and getting their hands dirty, so to speak, and then moving on.

When you consider that in fact the majority of people trained either via research project in their final year or by doing higher degrees are actually not going to end up in full-time research jobs—they are going to end up in the wider community—one can see the reason for this interest in skills for innovation side to research training and perhaps put more emphasis on it rather than less. This could come about, for example, by formally recognising in however we look at research training—and there is half a billion dollars spent per annum on research training in this country as a separate line item—that we look at it being as much about innovation as about

research and look at the process and the measures we put on it accordingly. That is the first point that I would like to make: a lot of the skills for innovation are picked up in research training.

The second point that I would like to make about technological innovation is that I sense our universities and, to some extent, our public funded research agencies at the moment are not fully legitimised for the functions that they perform and could perform. The less than helpful way would be to say that we have a bunch of illegitimate institutions. But the point that I make is that their strongly legitimised functions at the moment are research and teaching. I will not get into technical arguments about scholarship and its commonality across all fields, but nobody disputes those two. There are arguments as to the degree and whether you can have teaching only or research only. I am not addressing that issue in this point.

The point that I am making is that there is a further activity, which you can call outreach or third arm—you can give it all sorts of names—which is about moving knowledge out of that framework, out of the university, and into end use, be that industry or be it public end use. I call it third arm, for want of a better name. It is the passing on of knowledge, which may be your own research but which can just as likely be other people's research, into the SME or industry that is down the road. It is the special training course that might be very tailored because you have the equipment or the capabilities in some leading edge area which is not available elsewhere, at least in that geographic area. I do note, by the way, the innovation survey that showed that, in innovation in Australia, something over 60 per cent—I think that was the figure—of the source of innovation for firms operating in Australia comes from within a 100-kilometre radius of where those firms are domiciled. I think this notion of feet on the ground and legitimate purpose in outreach is one that has not had enough attention. So I am fairly supportive of third-arm activities as somewhat of a new way of thinking of legitimising wider outreach than we have at the moment. I think it could make quite a difference.

The third point I want to make is in a totally different area. If I look at technological innovation in this country, and we do not do too badly of course—it is not as if we have a poor base; we have a very good base—international competition says that we just have to keep getting better and better. So the questions come as to what we do that is new, what we accelerate and so on. I think that in this country one of the things that is fairly hard to organise is a major change, a step change, in the way a company or an industry, for that matter, goes about things. Step changes always require significant piloting of one sort or another, significant trials of one sort or another.

You can argue that the route to technological innovation, particularly from the research end, always involves piloting of some description, and this is a matter of degree. But I am particularly focusing on step change technologies here and asking, 'What can we do to make this easier?' Because, in the long run, the lesson of history is that incremental innovation is always welcome and always worth while. In fact, without innovation you are dead in any marketplace. But the big changes are equally worth while, yet the risks associated with big changes are much greater—to state the obvious—and they are fewer and further between. What can enable them are, firstly, having people with a really good grounding in the science base, and making them available. As I described for the research training, they are the people who can help evaluate risk. So something like the third arm can start to feed into that.

Secondly—and this is the core of this particular point—I think we need to look at the incentives that we have around that help share the risk of major changes. An example which would not be to everyone's liking, but nevertheless is the right direction, is coming out of the energy portfolio at the moment; that is, to look at the low-emission technology fund. I have perhaps got its name slightly wrong, but it is the low emission fund. It has got a couple of interesting characteristics. First, it is some government funding—and, I think, twice as much industry funding; second, it is leaving it to the marketplace to decide what gets pursued. It is not trying to dictate from any other source what the best technology is going to be. Third, it is really very cleverly targeted to large step changes, because it has put the rule that says, 'If you want to be eligible for this fund, you have got to be demonstrating something which is potentially going to take Australia's emissions down by two per cent, in and of itself.' That is quite a major ask.

So I look at that and say: this is the sort of thing we need—and not just for energy. We need to be seeing more step changes. How do we add considerably more value to our commodity exports? It does not matter whether it is looking at biologically what is possible out of some of the products at the farm gate or whether we are looking at a world titanium industry or whatever. The logic still applies. So whether this is the business of accelerated depreciation on major demonstrations or whether it is something like this low energy fund—or whatever outside my realm of expertise to dream up—I just point to this need and say that with technological innovation in Australia we really want to see more of the step change as well, and I think that is going to require special attention.

CHAIR—If could start at the end: was cloud seeding a step change?

Dr Batterham—Cloud seeding is potentially a step change. By raising that one, you raise the very interesting point that says one has to be careful that, whatever the venture is, it is not a licence to consume money for a long period of time. I do not suggest Australia gets into nuclear fusion as the future of the world's energy equation—although there are plenty of people working on it—because I think it has been a perpetual infant for 50 years and that anyone treading down that path ought to put the restriction on, as you would for anything in this area that says that the prototype or pilot works within a sensible time frame—two years, five years or whatever—and thereafter, whatever the encouragement is stops.

CHAIR—So you can punt a lot, but only over a short period of time.

Dr Batterham—Correct.

CHAIR—Could you just go back to your point about physical proximity? You say that physical proximity is really important to interaction and innovation. Doesn't that put us at a huge disadvantage in terms of our physical lack of proximity to major markets and so on? It is something that I have never understood.

Dr Batterham—The physical proximity thing is clearly a disadvantage. When you get down to the market end, we are a long way from most of the markets where we see ourselves dealing. There are a very limited number of ways that you can get around that. The notion of having the joint venture with somebody who is already in the marketplace is common enough. It seems to me that it is dangerous to say, 'Yes, but we can get it going on the Australian market and then we'll see how we go.' You have to think global and move global. When it comes to generating

the innovation, I think our remoteness is also a disadvantage. But I do point out that in Australia overall in the innovation scene you are seeing some very large centres in terms of population and the capabilities within them—and that is largely things like the Group of Eight universities and where they are—and this regionalisation where the very thin population in rural areas is being concentrated more into regional centres.

Just a small example of that is in Warragul. I am not quite sure exactly what direction it is on the map—somewhere in the east of Victoria and not that far east because it was only an hour and a bit on the train. One of the universities has an outpost there and they have some very active innovation going on, in this case, in the dairy industry. It struck me that they are actually able to get quite a reasonable act together. They are hardly the world cluster for innovation in the dairy industry; that would be overstating it by a long way. It does not bother me too much as long as we see that we are getting the connections, literally, on the ground. To rely on the fact that we all have pagers, mobiles and emails and so forth, I think is helpful but does not get over the fact that credibility is often essential in interactions and that is best established still by face-to-face work at some stage of the game.

CHAIR—You spoke about legitimacy of research and teaching for academic institutions. Can you tell us a little more about the illegitimacy of outreach activities?

Dr Batterham—It is interesting because, depending on who you are talking to, as is so often the case, you get very different takes on this one. There is no doubt that some universities do very well on the outreach side, and when we talk to almost any of them they can rehearse a pretty impressive list of their activities. But I look at it and say, ‘Okay, but now I’ll go and talk to the academics and I’ll see a pecking order of what they regard as important in life.’ Helping an SME—for example, getting up to speed with whatever the latest kit is in some measurement area—does not tend to feature too highly on that list. I do not want to tar all with the same brush, I might add. I am just saying there is, of course, good intent at the top, but if you look at what drives academics, by and large—what they get paid for, what their promotions are predicated on and so on—you will find that outreach activities do not feature too highly. That is just the reality of it, and to me that is relatively simple. It is a case of legitimising it and the easiest way of doing that is by having a small, appropriate sized pot of money. This tends to make people respond.

CHAIR—If their incentive systems are different, are the really good people going to respond to this?

Dr Batterham—The short answer I think is yes, because you have a system which is clearly under some pressure, as all parts of the system are. There are ever increasing demands on the public purse and so legitimately they are under pressure. Nobody is owed a living in the style to which they would like to be accustomed—knights and all, as the term might be. My understanding is, yes.

Dr WASHER—Thank you, Dr Batterham. I found that fascinating. Another idea regarding outreach in a slightly different way is that the federal government should fund a proportion of post-doctoral employment with industry. The idea is that getting these people who had come through a very academic system out into the industry region of that post-doctoral specialty would help innovation. The idea was to help educate them in the practicalities of business and at

the same time give the business some of their better innovative thoughts out of university. Could you comment on that?

Dr Batterham—Certainly. I think there are quite a few specific proposals that one could come up with which are along this broad line. I will answer it by saying ‘tick’ to all of them but then one needs to look at the totality and the expenditure and do a bit of weighting here. I would put that specific one into a spectrum and say that when we look at competitive research grants we have discovery and we have linkage. If we look at research institutions, we have got CRCs, for example. The next level down is discovery grants and linkage grants. Linkage grants are paid for by industry as well as by the Australian Research Council.

With regard to PhDs, at the moment we do not have anything along the lines that you are suggesting but we do have APS grants for PhDs which now can be run under the linkage scheme so that it has got industry in it. So to some extent—not quite the same but it is fairly close—we have actually now got that built into the scheme of things. I look at it and say that, yes, we do actually need a spectrum of activities. I can go another step. Actually I can go two steps, if I may, further in this spectrum. I think that in any first degree, there is merit in considering, particularly in the sciences and engineering, some sandwich components to it, whether that be the full sandwich—that is, go off and do your year in industry after you have got to year 2 or year 3 level and then come back and do the final year when you can actually spell some of the words—or whether that be just vocation employment, not just highly recommended but mandatory before we will actually award the degree. There are various ways of tackling this. It could be a company running a summer school and they get an academic to come in perhaps with 10 undergraduates. I know companies that do this sort of thing. There are various ways of tackling this intermingling en route, so to speak.

The final point I would make on it, if I go down to one other level, is that I reckon that innovation training starts in kindergarten. It is probably not appropriate to call it innovation training at that stage but I would say that even in primary school we need to be teaching enterprise just as much as we need to be teaching sustainability for the environment and social responsibility because for a lot of people it comes naturally and for some people it does not. So I would put it in right through.

Dr JENSEN—Mentioning schools brings a point to mind—that is, the nexus that we have between secondary school and university as far as physical sciences, particularly, and mathematics are concerned. Both of those are very important enabling sciences yet, although ‘crisis’ might not be too strong a word, we are certainly facing significant problems in terms of attracting capable students from high school into those courses at university. In what way would you see that we could best address that problem?

Dr Batterham—Firstly, we are not alone. Unfortunately, it is quite common in a good few developed countries to see these trends, which does not mean we sit back and just wait for others to solve them for us.

Secondly, to share the experience, I have just had 12 months as President of the Institution of Chemical Engineers. Whilst it is world wide, it is about 60 per cent United Kingdom focused. In that country they have been running a campaign called ‘whynotchemeng’. All the words are in lower case and are run together as one word; it is an appalling use of English. Nevertheless,

chemical engineering is the only course out of engineering and all of the sciences that has showed a significant rise in enrolments in recent years compared to the decline in numbers that you refer to. I do not want to just say, 'All we need do is run a 'whynotchemeng' campaign,' but what I am pointing out is a focused delivery of information to schools, not yet another CD about how you could be a so and so and what the career paths are and what have you—there are too many of those around already. Perhaps one could use them as fashion labels or something.

But in a focused campaign of the type of the ambassador schemes, you have people who are current undergraduates or very recent graduates going back into schools and just talking about what they are doing, for example. They all have the same lack of grey hair or baldness and so on. It is useless—not totally useless—to send someone like me in for a job like that because you have a credibility gap—a 'How would you know what is current?' type of thing. So there are campaigns that you can mount that do not cost an arm and a leg and that use the most credible sources for getting information across that there are actually jobs, that they are interesting and that this is pretty good news stuff. So that is my second point.

The third point I make is about the content that is talked about in schools. I was somewhat interested to see a paper that Peter Fensham gave me. I am sorry but I cannot remember the title of it. It looked at the attitudes of students in years 11 and 12—the last couple of years in most countries of secondary schooling—towards straight sciences and maths, the very area that you raised there. In most countries there is some degree of choice when you get through to that level as to what you take, and you can start to drop the things that you do not like or find interesting. This was just targeting the students who were doing the straight two maths, physics and chemistry and asking, 'What do you think of the stuff you are doing?' There were more targeted questions than that but that was the gist of the thing.

The bulk of the responses—and this was from three countries of which Australia was one; the other two were European countries—was overwhelmingly, from over 90 per cent of students, things such as 'boring', 'cannot see the relevance of it' and 'just regurgitating whole loads of facts for examinations but we are doing it anyway because it is a prerequisite for medicine or something else'. That is from the students who have actively chosen to follow this path. I look at this and say, 'If this is as pervasive as that, it must tell us something about the fact that we are putting too much content in or we are not able to show the relevance of it, for whatever reason.' I do not think it is says that we have a bunch of drongo teachers. In fact, it is just the opposite. Every bit that I see of science teachers fills me with delight to see the enthusiasm that they maintain against what I think is something over the odds of having to teach a whole load of material without having the time to do it in a hands-on learning way and to show what is relevant to life now.

Miss JACKIE KELLY—You sound like Doreen Clark. Do you know Doreen?

Dr Batterham—No, I do not know Doreen Clark.

Miss JACKIE KELLY—She is on my case about children's discovery museums. They are very popular in the United States. Every city has a children's discovery museum. Canberra has Questacon. There is nothing similar in Sydney. We have the Powerhouse Museum and then we have the Australian Museum, which is just too far from where the children are at. Doreen is on about getting kids engaged in science early. She feels that there is disengagement in about year 6

or year 7, so when the kids are moving into high school there is a substantial turn-off in the sciences. And why not, given that *Australian Idol* is just so interesting?

In my view, gained from going around to the schools in my electorate in Western Sydney, the music classroom has gone from this crappy old piano with a recorder to CDs and karaoke. The music is quite switched on. The science labs, which used to be quite exciting with the Bunsen burners and really wowing experiments, have not changed at all. There are still the same pictures of anatomy on the walls. Nothing has changed in science. I would disagree with you in terms of teaching, because a lot of the teachers are actually not science teachers. They have been forced to do the science because somebody has to do it.

Dr Batterham—Yes, in primary schools.

Miss JACKIE KELLY—So she is really pushing federal funding for a children's discovery program through Australian cities, starting out in Sydney, obviously. I saw an expansion of that into a Western Sydney science park, so you have got the children's discovery. I find that my children will stay interested in something that I am interested in. So if I am going to take them to sport, gymnastics or dance or something, they will think: 'Wow, Mummy's come to watch. Mummy's involved. This must be important.' There is nowhere parents—and let's face it, I could not tell you the speed of gravity if I tried or what pi equals, although my husband did on the weekend—

Dr Batterham—It is 3.1415926535—

Miss JACKIE KELLY—Yeah, yeah.

CHAIR—Don't show off!

Dr Batterham—to 10 decimal places.

Miss JACKIE KELLY—But suddenly your kids are asking you these very hard questions, and I would like a place where I could, say, go on a Saturday and Sunday and do a quick catch-up. Even Questacon displays are not really made to help the parent stay ahead of the kid—because you want to be this all-knowing being to your children. They get quite disillusioned if you do not know something and they get quite dismissive of things. This centre is linked into the K-12 curriculum within cities, so it is linked into New South Wales education, and it is linked by ISDN, broadband or whatever to each school, each classroom. Through heavy involvement in that program you can really start jazzing up the school programs. The schools and parents can actually refer to the centre on a weekend to catch-up or to get ahead. It is linked up with clubs after school, such as geography or astronomy clubs. It is also linked to a university, so you have a lot of university research happening in the labs which kids can be involved in outside of school. It is also linked in the middle of an industrial park where the kids can see jobs, so it is a very clear pathway to jobs. Do you think something like that is some sort of solution in terms of retaining interest in science or do you think Doreen is whistling Dixie?

Dr Batterham—No. My only caveat before wholehearted support for that is the one that you need an integrated approach. If, for example, science teaching in schools was seen to be a turn-off rather than a turn-on, then the question one has to ask is: is one extra item like this going to

make enough of a difference without also addressing the turn-off that we actually see in schools? That is my only caveat on it.

Miss JACKIE KELLY—Yes, you would need the New South Wales education department on side.

Dr Batterham—Exactly. Otherwise I look at that sort of thing and say: ‘Full marks.’ When you walk into a science classroom these days, unfortunately, I tend to agree with you. They could have up on the wall every pupil T-wave scanned in the way that is coming into airports now. By the way, the T-wave scans two frequencies. It effectively then puts a picture on a screen of you without any clothes on but with every protuberance that you have got—the frame in your glasses, the clip in your hair and all that sort of thing; very visible, but you without clothes on also very visible. Dual T-wave scanning is a piece of cake. The whole bit of the interest in the science is: mathematically, how do you represent a body so that it is reasonably true to what you are seeing without being too true? Because otherwise it just becomes too much of a distraction—that is the fact of the matter.

CHAIR—I certainly hope so.

Miss JACKIE KELLY—But to do every single classroom is way too expensive, so this is sort of a centralised way of doing it.

Dr Batterham—To come back and answer your point more directly, I am saying there are all sorts of reasons why you see the turn-off in the schools. The lack of current things is one. The reduction of the risk factor is another. I can remember lighting a Bunsen burner by charging myself up on a static electricity machine, standing on paraffin blocks and going, ‘Zoop!’ The thing lights up and you do not feel a thing.

Miss JACKIE KELLY—Now all the fun is gone from it.

Dr Batterham—But when you shake somebody’s hand—which is very naughty—of course they feel plenty and, depending on certain factors which I will not go into, you might also get a shocking experience out of it. But you are not allowed to do that sort of thing now, because what if the poor kid has got a congenital heart defect or something? You can just imagine the trouble the school ends up in. Fortunately no-one I shook hands with had a heart problem.

Returning to your point, Questacon, in some of their travelling circus work, have done follow-up surveys when they have visited remote areas, and found that their one-week visit—it is of that sort of order—results in about seven per cent more students choosing to do the science-maths pathway than in places which they have not visited. So those are the sorts of runs on the board or numbers you can find from that sort of program, and you can then put that into the overall context and say, ‘What are we doing in schools anyway and how much do you spend in these relative areas?’ So full marks for the area. By the way, it also informs people about jobs. Students can go to Questacon and muck around in front of a blue screen. They can go home with a video which shows them doing some outrageous things, whereas in fact they are standing on the ground just clowning around. If Questacon choose to, they can be an enormous driver in telling people there are jobs in that area. They can say that this is an innovation that started in Australia and there are now post-processing studios in North Ryde and South Melbourne that are

world class, that work for the world et cetera. And what is the message? 'There are jobs in this; this is interesting stuff.'

Miss JACKIE KELLY—That is why the co-location with the industrial—

Dr Batterham—Full marks. But I do put the proviso on it that it has to be seen in terms of the totality of what you can change and what you are spending.

Mr QUICK—How do we develop a national approach? I am an ex-primary school teacher. It used to worry me that I would get the kids all enthused and then I would send them up to the local high school. If they were lucky, in the state system, they might get good maths and science teachers. In most cases that was not the case. Their enthusiasm would wane and they wandered off to mediocrity. How do we ensure that all the state and territory systems are such that when kids do go to high school they get a good music teacher, a good science teacher and a good maths teacher? As soon as the good teachers put their hands up, the private schools nab them. So there is this shift away by parents, who say, 'We want the best for our children.'

I am lucky that in one of my local high schools we have one of the best science teachers in Tasmania, who is so enthusiastic that he is regularly poached by principals. Just about every kid in his science class is a member of the Double Helix Science Club, and kids in grades 9 and 10 in Tasmania are getting gold medals for some really innovative science work. But he is the exception to the rule. I have been to Taiwan and have seen how they value education. They pour the resources into it. Should we say to potential maths and science teachers, 'We will forgo your HECS; we will pay that so that you can do it'? Unless we ensure that every child who has the capacity for and the interest in science is catered for and challenged, we are going to short-change our innovative future.

The other side of that is: how do we then force the PhDs and people like you to go back into the primary schools and challenge some of the teachers? We need to have that circular route so that you can say, 'I went to Hampton Primary School in Victoria and I struggled through the state system but I had a love of science and I am now the Chief Scientist of Australia. I want to come back; this is where my roots are. I went to Hampton High school,' or wherever it was. How do we do that? One day a year the scientists come along and bombard us with a whole heap of stuff, and we never see them again until the next year.

Dr Batterham—Firstly, Federation is a wonderful thing but it was dreamt up at a time when competitive pressures and a few other reasons for change were not as great as they are now. So we do struggle with the fact that the responsibilities in this area sit between the Australian government and the state and territory governments. And 'struggle' is the operative word. We were talking before about syllabus and content. If you look at how long it takes to get agreement in that area, it takes several years for relatively small changes to occur, let alone the notion of turning it on its head.

But to be more specific, rather than just duck behind the fact that we are a federation and we do not have all our power in one area—to which many would say, 'Fine'—I think it is absolutely essential that you have good quality science and maths teachers. How do you get that? We do have an ageing population in that area, so you have to turn around and ask, 'Do we need special incentives to get more in?' I think the answer is: probably, yes. There are many possibilities, I

am sure—and you covered the ground, for example, on whether there should be HECS-free entry through that area. It is worth serious consideration. Should there perhaps be a bit of a return to the system that we used to have, which was that you became a teacher with a science degree and then there was an education add-on? I now get more of an impression, perhaps incorrectly, that you get an education degree with perhaps a science add-on. That actually does not stand you all that well, I would argue, for year 12 physics and maths these days. So I think there are a few things there. But the notion of having teachers that are inspirational is well worth while, and all sorts of incentives could be looked at in terms of how you get them in. Finally, in that area it is well established that a lot of people make their choices in school based on even just one inspirational teacher. So that is worth hanging in there.

We should be targeting that everyone who goes through school—and we have much higher retention rates now to year 12, which is a good thing—should at least be scientifically literate. The Hon. Jackie Kelly was mentioning her own view of science and so forth, reflecting no doubt the path that she has come on. I think everyone should get through to year 12 at least being what I call scientifically literate. By that I mean having some appreciation of what the scientific paradigm is. It is not the truth business; it is about observation, hypotheses and coming up with some useful prediction, because otherwise it is just hot air. We can use it and it can help us in our life—we check it out and we check the observations again and, as soon as it does not work, we throw the hypothesis away and we get on with it. That is what scientific literacy is about. If you understand that process and you have had some hands-on learning in it, then when a debate on stem cells or GM foods or BSE or whatever comes up you do not just recoil in horror and say, ‘Thank goodness that is not my bailiwick’ or ‘I’ll vote against it anyway, because I don’t understand it.’ Instead, you will say, ‘What are the hypotheses they are pushing here, guys? How good are the observations?’ So literacy is needed.

CHAIR—We are lucky to catch you on your last day. Can you reflect on your career as Chief Scientist and tell us the three things that you would like to have done or that you would like to do, if you could have your time again—not specifically in increasing innovation and commercialisation? Given that we are also talking about a Chief Scientist role, are you happy with the powers and functions? In brief—you have experienced it and you are out of there—how would you change it for your successor?

Dr Batterham—Firstly, it has been a great privilege and also a marvellously stimulating position. It is a fun job—full stop. I have thoroughly enjoyed it. When I look back over the six years the fact of seeing something like the BAA package come through just says that, six years on—and I am not claiming authorship of it of course in the slightest; I just happen to have been there at the time when all these things have been happening—science and innovation have been put on a much sounder footing and a much more accepted footing than they were previously. I could highlight some of the things that happened out of that—the new directions that CSIRO is facing.

That said, science and innovation is not at the top of Treasury’s priority list as it is in the UK. I do not say that all good things come out of the UK; I just point out that they have stated that this is the one area of government that will increase in real terms for the next 10 years. That is their forward estimate on the topic. You can say, ‘Well, they’re starting from a lower base and they’ve got a long way to catch up.’ But to explain a fact does not change it, in this particular case. So I see that we still have more to go.

I look at the innovation survey that was recently done. There are lots of you-beaut things in it: the 100-kilometre distance thing, the fact that a lot of firms do innovate and so forth. But I think that it takes our eye off the ball a little bit when we look at our level of industry R&D and our level of patenting, just as a couple of measures—very gross, of course—by which we can make some comparisons. I think we see room for improvement. Hence I home in on something like the third arm and say that I would hope that gets a run, whoever takes on this job in the future. I would look at something like step changes, as I mentioned, and I would look at the whole science in schools, science awareness and science literacy bit as three clear areas that need more in the future.

To finish with your question there—and I hope I am covering it all—I think the way the role has been structured has been quite effective and I thoroughly endorse it. There is the notion that one is not driving a significant part of the bureaucracy one way or another—unlike, for example, the UK counterpart. It has a staff of 100 people but the UK Chief Scientist effectively sits on top of the science-spend part of every ministry's budget spend; it has to get ticked off by their Chief Scientist. That is one way of making sure you have a whole-of-government approach. But it takes 100 support people just to run that lot. I look at what you have here—a somewhat independent figure who nevertheless has the credibility to be able to talk to inquiries, to ministers directly or to secretaries of departments and the like—and I say that, providing there are the hours in the day, that is actually quite a good model to have.

I think if you have a full-time Chief Scientist, while you can argue that more is better, there are downsides. The downsides are, quite clearly, firstly the temptation to get the finger into too many pies. Energetic and inventive people tend to have no trouble filling all their time. So I am not necessarily sure the UK model is necessarily advantageous. But the other part of what I have brought to this job is a currency of knowledge about how at least the big end of town—and SMEs, I might add—operate. It is quite interesting to look over the six years and say, quite frankly, that what drives them and what is important has changed quite markedly over that six-year period. Having currency of exposure is, I think, quite an asset for the job. If you have a full-time one, you are in deep trouble there, of course, because every day you have a Chief Scientist they are one day further out of date with what is current.

Mr TOLLNER—Certainly when I went to school manual arts teachers were ex-tradesmen who physically were not up to the job in industry anymore. They went into a school to put into the community, as they saw it. I think there was a lot more desire by kids at the time to get into trades. It is possibly what you were talking about, Harry, in regard to your science teachers: we do not have science teachers anymore; we have teachers who are—

Dr Batterham—Teaching science.

Mr TOLLNER—teaching science. But what about when you progress that on into university? I can only speak parochially as far as my electorate, which is in Darwin, is concerned. Our university up there really seems to have died in terms of its technical school. They cannot do it. There is a view that they are robbing the technical school to pay for higher education and research. I am very interested in your third arm and your step-change technology. How do you put something like that into a university where that culture is not there, you do not have that enterprising commercialised culture? They are not the sort of people who run

universities. You do not have tradesmen running universities, so the trade schools tend not to do so well.

Dr Batterham—Mind you, you have a vice-chancellor running that university who was running something. They were making medical isotopes worth \$20 million for Australia.

Mr TOLLNER—We won't go down that line. Do you have a model that you think would work?

Dr Batterham—It is an interesting one. I know the university concerned and, obviously, the vice-chancellor of it. I am also aware of some of the research around there. For example, the Menzies institute there has done some excellent work. I think the model for a regional university like that—I do not like using the word 'regional' because some of our smaller universities are actually in Sydney and other quite large cities—or a smaller tertiary institution is fairly clear cut in my mind. Firstly, they do teaching that is relevant for that area. So, you do not base a course on Antarctic tourism in Darwin, to state the obvious. So the first point is that the teaching role is No. 1 for an institution like that. Secondly is a little bit of research. But I argue that any research you do you must always be world class. We are too small a country to muck around spreading the Vegemite too thinly, so always go for world class. You can do that by becoming the centre for tropical whatever and having the critical mass of people there. That is the sort of thing that James Cook University has done in marine science, just as an example. Or you make darn sure that you are part of a network and collaboration which is world class. The three northern states/territories—Northern Territory, Queensland and WA—have banded together in tropical science and signed a deal that says that they are really looking for ways to collaborate. That has to be part of the way to go. So for the research bit, you have to be really focused and say: 'I know we would like to be researching in 20 areas but we are only going to do it in three because we want to have a reasonable critical mass in each one of them. And with each one of those we're going to network out like crazy with the world's best so that we're on the map.' Then people start beating a path to the door, apart from the fact you are doing good research and it informs the training and so on.

Thirdly, you legitimise third-arm type activity like it is going out of fashion. So, if the tanks do not work or whatever it is, there are people on the ground there who are prepared to pitch in—and get rewarded for it, I might add. They can get grants to do it and can be held up on a pedestal: 'So and so got the world prize for XYZ in tropical medicine or whatever, and so and so got the tanks going.' They should be on the same sort of pedestal—not a one, two, three type of thing. To me, it is very clear cut. That is not necessarily how it is happening.

Mr HAYES—This follows on from Dave's question. My background is one of being in industry and having to use R&D. But R&D has always been on the basis of potential commerciality of the project. Unfortunately we have seen many projects disappear as a consequence of, I suppose, putting a value on the research role. That is why I was interested in your view about the R&D component, as well as your step-change approach. One of the last projects that unfortunately did disappear was a solid waste to energy project—a pyrolytic conversion process. Dr John Wright from CSIRO said that it would have been very good for a government agency like that to be involved not because of the commerciality but in terms of the R&D aspects.

Having regard to the way the conversation has flowed so far, is there a role for a greater involvement of a government utility—apart from being involved in the R&D—in terms of providing some opportunity in the sciences? It seems to me that, as much as we want to talk about kids at school and at university, the facts are that kids leave university and they will not get paid any more than their science teacher for a long while. If we had a proactive role from a government agency, whether it be CSIRO or something equivalent, that could actually work in and lend support on a higher commercial basis, particularly on R&D, with industry and retain some of these ideas. Projects like we lost now go offshore.

Dr Batterham—I am aware of that area and John Wright's activities in it from way back. I can see the promise in it. I will make a general point and then a specific one for CSIRO. The general point is that the business of innovation is inevitably, whichever way you look at it, something where you start with a few ideas about how you are going to make a change, you hone them down to a handful and ultimately you actually try one or two of them in an early stage or take them a little bit out to the marketplace and see where they are or, in the case that you mentioned there, actually build a pilot plant and run it and so on. At some point it stands in the marketplace as an innovation. It is actually out there and it has made a change. Typically, this so-called stage gate process runs with numbers like this: 1,000 ideas become 100 good ones, which become 10 that you actually do serious work on and so on down to one. You have something like a 20 per cent chance of success at each point of that stage gate process.

A consequence of having an 80 per cent failure rate is that being able to evaluate risk at any one stage is very good news and having people more skilled at that is very good news. The tools that are available these days get better and better in that area. You can do, in that particular area, a whole lot of modelling work without actually having to build the kit in the first place. You could not do that to the same extent 10 years ago. So something that reduces failure rate is worth while, but at the end of the day we have to accept that not everything is going to make it through to the marketplace. So we have to be, in some ways, just as good at killing things—actually we have to be four times as good at killing things—as we are at taking some of them through, based on the statistics of it. Not too many people run around with language that says, 'Innovation is all about failure four times and success one time,' but those are the sorts of odds at each stage of the process. This is part of understanding what innovation is and being able to drive it.

Coming back to the CSIRO point: we have talked about universities and third arm and so forth. I think CSIRO has a special role as well. It is not to repeat the mantra that SMEs are the customers from hell—not that I have ever seen that in writing! That perception is for reasons of culture, ability to pay, ability to stay with something, ability to do something with it when it looks interesting and ability to get financing. There are all sorts of reasons why they are not the most straight ahead to deal with, and great efforts are being made. More significantly, large-scale strategic work is sort of the core of CSIRO, hence their flagship programs. Nobody else in the country, apart from DSTO, and they have a rather specialised brief, can pull those sorts of large-scale things together. But, if you have the skill base to do that, you also have the skill base to knock over quite a few more focused—I should not say more focused; the flagships are quite focused—more singular, smaller activities. I put the one that you described in that category. I think CSIRO should be encouraged to see it as perfectly legitimate that some of the hard-earned taxpayers' money that flows into it is seen as support for emerging companies, particularly if they are in the step change business like that one is. That would mean providing them with laboratory backup, pilot scale, a bit of modelling work, a bit of analytical support and so forth,

on some sensible collaboration. Probably not too much money would flow into CSIRO early on for it, but it might cut them into reasonable returns in the long run.

In terms of the notion of having growth partnerships or whatever you want to call them, and perhaps even funding them in the same way as a separate third arm for universities, as I was talking about, an equivalent for CSIRO might be some extra money for something like growth partnerships. I think that makes excellent sense because it is utilising the skill base that you have, which is there for a major purpose—in the university it is its research and teaching thing, and in CSIRO it is major strategic programs—for additional purposes which are just going to facilitate innovation. So, yes, full marks on that one! Sorry, that is poor language. ‘I totally agree’ would be more careful language.

Mrs VALE—I apologise that I was here late. It is nice to see you again. I met you years ago at a huge uranium mine in the Northern Territory—

Dr Batterham—Yes.

Mrs VALE—and I am very pleased to know that you are looking after Dr Helen Garnett, who was our CEO at Lucas Heights, which is actually in my electorate. I am very proud: I like to think that I have the smartest people in Australia living in my electorate.

Dr Batterham—Even if you export them all over the place!

Mrs VALE—Excuse me if this question has been asked before, but I want to ask: if we accept the recommendation from the Senate that the next Chief Scientist should have a full-time position under the Public Service rule, do you actually see that that would impact in any way on the next Chief Scientist’s ability to assist in innovation?

Dr Batterham—There are two bits to that. On the full-time/part-time issue I have commented that there are pluses and minuses, and I think that the part-time model is a good one. In terms of the perceived conflicts of interest and so on, the suggestion was that you need to be employed under the Public Service Act, because then the same conditions apply to all and sundry. I do not see any restrictions in that. I think the only thing that you have to watch with the Chief Scientist is that it seems to me that, at the moment, one of the principal benefits of the position is its independence so that, when you rock in to see Minister X, Y or Z or whoever, you are not representing a department or even a string of departments for that matter. You are coming along with quite independent advice. That you should be giving that advice against an ethical framework which is implied by the Public Service Act and conditions, I totally agree with. I see nothing wrong with it being a public servant per se, as long as the element of independence is there, because I think that is half the benefit of the position.

CHAIR—You spoke passionately about incentives—at least, I think you spoke passionately. If you take a university departmental structure, how do you inject incentives into that to make people reach out and push things out? Say you are given a department and you have carte blanche. How do you actually do it?

Dr Batterham—A significant portion of funding is competitive. I would see the base funding for research as being informed by a quality framework such as is being investigated at the

moment and that quality framework informing the funding—so that is quite a degree of competition—plus competitive grants per se. So competition drives that. When you look at the teaching side, that is likewise competitive. It depends on the number of foreign students you can get in, the number of courses you can teach and the number of faculties that will let you teach, say, first-year mathematics, on account of the fact that, if they teach it within their own faculty as ‘mathematics for engineers’ or something, instead of letting the science faculty do it then it counts as full-time equivalency in engineering rather than science. So there are a few gives and takes there.

What I am suggesting is that, if all of the research funding is largely competitively driven, those that can win it and establish, whether it is at Darwin or wherever, world-class research, are going to win the competition. Those that cannot will have no option but to go for the third arm. I do not want to hold it up as a second prize, because I do not see it that way. I see it as increasing the choices of how people can attract funding and what they can do with the hours of the day. I think that should be enough to drive it. A key element is that there would have to be funds on the table. You cannot just wave a magic wand and say, ‘Outreach is fine; please do it.’

CHAIR—Is there anything written on this? I do not want to take up the committee’s time, but it is very important, and I am afraid I have not quite grasped it.

Dr Batterham—There is a UK scheme which has some elements of it. I think it is called third stream funding there. It is relatively new. In the UK stream, if you are a researcher, you can apply for funds for research, you can apply for funds for teaching and you can apply for third-arm funds for outreach type work. Their scheme is a bit more restricted than what I would go for. I am sure the department can send you some details of the UK outreach scheme. My suggestion is that it is worth thinking of it as a base and then going further.

Dr JENSEN—I am going to go back to education again. I note that in high school education there is a real problem once again with the level of technical expertise that the kids are getting, even if they are doing theoretically advanced physics, maths et cetera. It is at the point now where they are going to university and having to do bridging courses. To what extent do you think that those sorts of things are acting as a disincentive to the kids? Allied to that, I guess, in having teachers who may not be as expert as they should be in those areas, is that they are teaching these subjects in such a way that it is clear to the kids that the teachers are finding it tough and they are getting the message, ‘Hey, folks, this is tough stuff; you’ve got to be a real genius to want to go and do it further.’ To what extent do you think that those are acting as a disincentive to kids’ progression in the area?

Dr Batterham—We have a year 12 student in our household so I get some scuttlebutt and direct feedback from university and high school. It is pretty interesting. You hear comments that fit in with that view. You have to have well-trained and expert teachers. You have to have career development and progression for them. It has always struck me as fairly obvious that, if you want to change the way teachers are paid, you should encourage them to do further education and pay them for it. This can be continuing. I do not care if it is primary, secondary or whatever. Subject matter changes, particularly in the sciences. In mathematics perhaps it does not. Chaos theory has come in, and how you predict or do not predict share prices has also had a run. The world’s largest hedge fund employs two Nobel laureates in mathematics. Expert teachers have to

be there, but I keep coming back also to the content. If the content is such that it is a bit of a turn-off or perceived as too hard, let us address that.

The secondary thing is: what do universities need? I would argue that the school curriculum in science and maths needs to target the 90-plus per cent of students who are not going to go and read maths, physics or chemistry or do engineering at university—I might have my percentages a bit up the spout, but it is of that sort of order—with science, literacy, relevance, interest in it et cetera. If that means that, at university level they need to do remedial maths—I do not like to call it remedial maths, because some people get upset and say, ‘What are you doing to entrance standards?’—I would argue: so be it.

One of the things about university courses now is that they target so many mix and matches that entrance standards for bits of it can be all over the place and it puts some of the onus on the university system to say, ‘If you want to pick up that bit and that bit, woops, we are actually going to have to provide you with one bit in front of it to get you up to speed on it.’ People’s learning capabilities at that age when you go to university are so ferociously high—

CHAIR—I do not believe that. I once went to university!

Dr Batterham—It is just a matter of balancing that capability, because it is there. We are not seeing them so distracted that they have to spend all of their time in other pursuits.

CHAIR—If there was one thing that you could tell this committee to do to enhance commercialisation prospects that we could understand, what would it be?

Dr Batterham—Commercialisation largely out of the public funded sector. Quite simply, it is a consistency of approach in legitimising it. I am not harking back to third arm, it is just consistency of approach. For example, the Australian Research Council, the National Health and Medical Research Council and medical research institutes and a whole host of people all got together and agreed about intellectual property guidelines as to how intellectual property should be handled. I look at that and applaud it as a great step forward. But I look at it and say, ‘If we were totally consistent about our emphasis on commercialisation’—and there is some good work being done on measures of that recently—‘if we were totally consistent, wouldn’t we then turn around and say to those funding bodies, “How are you using people’s performance on commercialisation to inform funding decisions?”’ So you might say to an institution, ‘Show me that you can actually not only read the guidelines but that you have them in place and that you have resourced it appropriately. Then we will let you straight through for next year’s funding round. But if you are dragging the chain on it, we might put 10 demerit points out of whatever the scales are against you until you sharpen your act up.’

CHAIR—So is that evaluating past performance—

Dr Batterham—To inform future funding.

CHAIR—So if you have been good in the past on previous projects, that comes into play in the assessment of the next project.

Dr Batterham—Yes. We use people’s performance in research to help guide funding decisions in research: how many citations have you had, who thinks this work is terrific et cetera? Why shouldn’t we do the same thing with past performance in commercialisation? You have to aggregate it up somewhat, I might add, because you cannot say to every individual researcher, ‘Every bit of research is commercialisable and therefore we will measure you personally on the scale.’ But this is what I mean by consistency of approach. If we had a third arm system in encouraging outreach then you would want to look at the commercialisation parts of funding and say, ‘Are we actually requiring performance, not just encouraging it by saying we want to see it?’

Mr HAYES—Shouldn’t the steps going to commercialisation from the funding agent’s point of view be that you are meeting various criteria along the way, not so much on your past experience or your past track record on commercialisation, but that these are the things we want to start establishing out of this? To some extent the funding agent really should be taking some greater responsibility in allocating those funds on proof of performance and meeting targets.

Dr Batterham—I agree with you in principle and I make a comment on CSIRO, but there are some practicalities. One of the practicalities is that say you have got a three- to five-year funding arrangement for a whole host of little grants. It actually costs you money to get in and monitor things en route. There are some administrative levels here that say to lump it up to some extent, and as you start lumping up then you start having to be informed by past performance rather than the most recent. That is more at the administrative level.

In principle, what you say at the larger level applies. So you look at something like CSIRO’s flagship programs. One of the things that I really like about those programs is that they do not just have measures of how the research is going and whether they are succeeding there; they have measures of whether they are progressing the route to end use or the route to market use—whatever language you like.

Mr HAYES—It is almost a turnaround point: ‘This is not going to be commercialised, so we pull out.’

Dr Batterham—Correct: ‘This is not showing any progress en route to end use; it is time to pull the plug.’

CHAIR—If there are no further questions, would you like to say anything as closing words to us, given that you have understood the depths of our ignorance in this area?

Dr Batterham—I think I have covered the main points I wanted to make. I am just looking at my own notes because I had a few subsidiary things: step changes, which we have covered; IP on funding; and commercialising public sector IP. I have one last comment on commercialising public sector IP. The public sector legitimately generates a lot of intellectual property for its own purposes. A tax department might work up a system that helps them to decide who gets to have a tax audit. In fact, I am sure they have worked up a system; they have not gone down to Toys ‘R’ Us or something and bought it there. But the system that they have worked up has value in other marketplaces. For example, certain countries which until recently had been command economies are now running with taxation systems and are very much on learning paths there. I have just dreamed up the example. I might be using an example where the tax department has actually

gone out and sold systems to Poland or what have you; I do not know. But it would generally not be the tax department's legitimate role in life to commercialise that IP out in whatever marketplace.

I am aware of an example which the Australian Institute for Commercialisation made me aware of just recently where the corrective services department of a certain state government built up a system in house—they paid for it, of course—for tracking people on remand. It probably cost them of the order of \$1 million or \$2 million to do that. That system was then sold to the FBI and the royalties per year are of the order of 10 times what it cost to develop that system. That is of course a bonanza type pay-off. But the principle is that there is IP within government departments through which, if you look at some external body doing a commercialising role, might in fact generate quite a bit of income. As to whether you give it back it to the department or whether it goes straight to Treasury, there are all sorts of things you would have to consider.

Mr QUICK—To me, that is why a lot of it is not done: if it just goes back into the coffers, why bother?

Dr Batterham—Exactly. But the question of 'Why bother?' is probably answered best if there is a third party involved that can either make the connection, because it is immediately transferable, or contract somebody to do the work of modifying, rebadging, getting rid of the security bits and what have you and then take it out into the marketplace. It would be quite an interesting way of going.

CHAIR—Thank you very much, Dr Batterham; that was illuminating. Thank you for your contribution to Australia over the last six years. Good luck with your new job. We hope the contribution keeps on coming.

Resolved (on motion by **Mrs Vale**):

That this committee authorises publication of the transcript of the evidence given before it at public hearing this day.

Committee adjourned at 5.54 pm