Speech: The Language of Science – Massey University Research Awards Programme
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Tonight is not just about honouring researchers, it is also about honouring teachers, in both the sciences and the humanities. I applaud Massey on recognising its intellectual heroes, it is important that we all do so, and I congratulate all the winners.

This has left me cogitating on what I should speak about, as I want to speak to all those here tonight, not just the scientists amongst you.

This year marks 50 years since CP Snow famously wrote about the two cultures: two cultures that universities at times can struggle to marry, but I think tonight you see a University that is successfully doing so.

So in recognition of that anniversary, I thought tonight I would make my own attempt at bridging the gap and talk about the language of science.

There are many anniversaries this year. It is 200 years since Lamarck published his magnum opus *Philosophie Zoologique.* Jean-Baptiste Lamarck made many great contributions – he introduced the word biology, he was the first to advance a coherent theory of biology, to understand the role of learning and yet he is best remembered for something he never said, never discovered and never really emphasized in the way that we imagine he did – "the inheritance of acquired characteristics". Lamarck never used this phrase or anything like it – the concept of soft inheritance, that is the influence of environment on subsequent generations, was accepted in biology long before and well after his time and has never left biology; indeed it is now very much to the fore again. Yet his name has been used pejoratively for much of the last century. How ironic that in the post-genomic era soft inheritance has resurfaced in the concepts of maternal effects and epigenetics.

It is also 150 years since Darwin published his first great book: *The Origin of Species*. Darwin is best known for a word and a phrase. The word was "evolution": a word he did not use until much later in his life, indeed not until his second great book, *The Descent of Man*. The phrase was of course "the survival of the fittest": a phrase he did not invent and did not use in the earliest versions of his book and only used it under pressure from the co-discoverer of natural selection, Alfred Russell Wallace. Indeed it was the social philosopher Herbert Spencer who coined the phrase and Wallace suggested that Darwin should adopt it. But right from the outset the phrase has been misused in its inappropriate application to social Darwinism and its unfortunate offspring eugenics. Yet, ironically, if the phrase is interpreted in the modern evolutionary sense of the word fitness, which is now used as a measure of the number of surviving offspring, it is again remarkably accurate.

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It is 100 years since Wilhelm Johannsen introduced the word 'gene' into our language in 1909 – but it is a word full of ambiguity. What is a gene? It has two quite distinct meanings and we are always conflating them. Is a gene just a bit of DNA – a chemical substrate – or is a gene an instruction? This is been a rich area for biological philosophers such as the marvellous Evelyn Fox Keller.

And if we think about the last 50 years, what has happened in biology has been the phenomenon of science confounded by language. The molecular evolution which started in 1953 quickly became dominated by a deterministic language: genetic blueprint, genetic programming, genetic code are all words common in the molecular language. By the 1990s bold statements were being made – at least one Nobel laureate in molecular biology claimed that once the human genome was known we would be able to tell everything about the destiny of the individual. What naive hyperbole – hyperbole which science too often falls into – in the aim of getting funding for the human genome project. What hubris.

The medical literature became dominated by claims of the genes for this and the genes for that. If one was not doing research for the genes for diabetes or heart disease one would not get funded. Agriculture became similarly affected – soon the popular media was full of claims for genes for virtually every human trait. The failure of genome-wide association studies to show strong genetic determinants of disease has been quite a shock for the geneticists.

The manifest reality is that what we are is more than our genes – we are a product of what we inherit, how we live and how we develop. Indeed, the explosion of knowledge in epigenetics now means that we have mechanisms to understand soft inheritance – the inheritance of environmental memory as well as some explanations of the failure of genome-wide studies.

Scientists had become deceived by their language: Lenny Moss, the molecular biologist turned philosopher, put it so clearly: "The idiom of the language of the gene became written not by those whose hypotheses were successful but by those whose metaphors were successful."

There is a lesson in all of this – language can change our mindset, narrow our thinking.

I worry about the misuse of language in thinking about the science system – we have come to use words like 'blue skies' research and 'basic' research and put such research in a value-laden different category from 'applied' and 'translational' research. We have started to value one differently to the other. Indeed, 'basic' research is seen by some as worthless, not of value to the economy. Further the categorization implies a linear process from discovery to development to exploitation. Science is not like that – above all it is not linear, that is one thing that distinguishes science from technology. Science is a process – it is the process of gaining knowledge, of making observations, of attempting to put those into a conceptual framework, of modifying the framework and seeking more data. Nothing is proved, nothing is closed – the range of option is just narrowed. Because of that the process of research is not linear, it is not predictable – if the outcome is certain then it is not real research.

Yes, of course there are different types of science largely based on timelines and provability of outcomes and governments can and should make their allocations across the science system according to tactical needs and longer-term strategic imperatives – but let us not confuse that need with the value proposition.

Perhaps Michael Porter, the economist, put it better – in his view there are only two kinds of science: **applied research** and **not yet applied research.**

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The point Porter is making is worth reflecting on as we think about the future of the science system. If science is about developing new knowledge, then in Porter's view and in mine, in one way or another much if not most of that knowledge will be in time be applied to public or private good. The point he is making is that the time frame may be uncertain, the field of application may be uncertain, but the ultimate utility of the knowledge is not.

Let me give you a personal anecdote: in 2005 we reported that human newborn babies who had been brain damaged at birth could be successfully treated by cooling their brains for 3 days. This in modified form is now the universally used treatment for what was previously an untreatable disaster, but what was the origin of this highly utilitarian discovery. It lay in research I started some 15 years earlier – research that was unashamedly 'blue skies'. I wanted to know why the concentration of a hormone in fetal blood – a hormone that did absolutely nothing – was so high and fell at birth. I was doing experiments in sheep and I wondered whether the fall in temperature at birth had anything to do with the fall in the levels of this hormone.

Who would fund that? Fortunately the old MRC did. Well, over the next 10 years from that first interrogation of the effect of cooling on the fetus we worked our way progressively into the research and findings that would ultimately lead to human therapy. It is a worry to think that the chances of such research being funded 20 years later would be remote, and we need to reflect on why.

Does our language have anything to do with it? 'Basic' and 'applied' or 'not yet applied' and 'applied'?

There is of course another language of science and that is the jargon we use, the different expectations of science between those who understand it and those who do not. Most science is about complex systems, and science is about reducing uncertainty and probability. Yet many want a science of certainty, of finality. The media would rather have breakthrough stories and yet science is not like that. Science is not like that, not now and this creates an enormous cultural gap between science and society. And it does not suit the media. Complexity and uncertainty means they can cherry pick, and in the guise of moral equivalency they will give equal airtime to two views – and one of those views may represent the consensus of the global climate change community and the other is a person with an agenda or an outlier result. No wonder the community is confused. No wonder folate did not end up in our bread supply.

In December 1999, the sociologist Anthony Giddens wrote a paper in the millennial issue of *Nature* which has had the greatest influence on my thinking. He pointed out that what had been a good contract between science and society in the early 20th century had broken down at the end of the 20th century, as science moved without society coming with it. As a result, society had developed a cynical sceptical attitude to science and this was reflected in attitudes to developments, especially in biology. Giddens suggested that the key challenge for science was to rebuild that social contract.

What does that mean? Well, when I was a Fellow we used to say that the science is not done until the paper is published. But that is not enough – the science is not really done until the papers are published and the public understands its impact. This means that scientists must be more than technologists, they must be communicators too.

Conventional wisdom and folk understandings are often challenged by science. Science may produce results that are challenging, or counter-intuitive. Before science can be incorporated into policy, science must match conventional wisdom, it must be compatible with society's values and mores, and only then do the practical issues of money and political ideology come into play. Increasingly as we face the

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challenges of global warming, quality water, energy needs, pandemics and so forth, we scientists are going to have to learn to interact far better with the public.

New Zealand faces the challenge of remaining relevant in a world where knowledge will drive prosperity. How can we do that? It seems unlikely that simple incremental growth can do that – our assets are limited. So where does New Zealand go?

One way of distinguishing a first-world country from a developing country might be to consider that first-world countries are net generators of knowledge, whereas developing countries are primarily users of others' knowledge. Yet New Zealand has one of the lowest investments in RS&T of any OECD country. Why is that? It is often put down to the low investment of the private sector but the public sector investment is low too and it has been for decades. Is it that we have a young frontier culture – one that values brawn and money over intellectualism? We have only been awarding postgraduate degrees for about half a century.

To be relevant in this world we have to keep on punching above our weight. The rate of increase in knowledge is exponential and we risk the danger of becoming irrelevant. We are going to have to become much more ambitious as a country – ambitious to value knowledge, to use knowledge. Scientific process is in the end the only process we have that gains new knowledge about the world – and it is a process, not just a collection of factoids. I worry immensely – the quality of science understanding, the quality of science education, the commitment of this society to science is dangerously low for us to have a smooth path ahead.

A key part of my role is to help change the place of science in New Zealand society. But all academics and researchers, be it from the humanities, the social sciences or the natural or physical sciences, need to play a role.

Again, may I congratulate all the winners and Massey University for their commitment to a knowledge-empowered New Zealand.

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