# Science Under Threat?

## Why and what can be done[1] by Dr D C Edmeades



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AgKnowledge Ltd is a science-based company which Dr Edmeades established in 2000 to provide farmers and farm consultants with independent information on soils, soil fertility, fertiliser and nutrient management. The company currently has 7 staff.

Dr Edmeades was educated at Auckland and Canterbury Universities. In 1976 he joined the staff at the Ruakura Agricultural Research Centre, Hamilton, becoming, in 1990, the National Science Leader (Soils and Fertiliser). Concerned about the effects of the science reforms which commenced in early 1990s, he left institutional science in 1997 to study management at Auckland University, a consequence of which was his seminal paper, "Is the Commercial Model Appropriate for Science?" published in the New Zealand Science Review. Subsequently, he has become an outspoken critic of the current structure and management of government funded science in New Zealand.

**Abstract** Science is under threat world-wide. This paper explores several possible reasons for this touching on modern philosophies (political correctness and New Age fades), politics (monetarism and the 'free market'), and their impact on science funding policies and the current standards of journalism. He will argue that all of these factors contribute to undermining the importance and value of science in modern society. Scientists, he asserts, must recognise these dangers and become proactive in explaining and, if necessary defending, the importance of science to society.

## Introduction

John Ziman an English physicist (died 2005), is best known for his writings on the social dimensions of science and science management. In his 1994 book 'Prometheus Bound' he makes the point that science activity has increased exponentially for the last 300 years since its birth, approximately doubling every 15 years since the eighteenth century. This is perhaps not surprising because science has been, based on the evidence, very successful. We just need to consider the numbers: human longevity: middle ages, 30; 1900, 47; 2000, 77, projection, 85; crop production 1850 to 2000 between 300-500% increase. These figures reflect the formidable development and application of science and technology.

What is surprising is that, despite its success, growth in science has, since about 1970's stalled; as Ziman puts it, we are now in a steady state which, for most of the OECD countries, is about 2-3 % of GDP, c.f. Australia, 1.6% and New Zealand, 1.1%.

To deal with this steady-state situation, governments around the globe have implemented various policies designed either, to make the limited science dollars go further, and/or, to supplement government's

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contribution to R & D by attracting private research dollars, sadly with profound effects.

For example, agResearch Ltd, NZ's largest crown owned science organisation (now a limited liability company owned by the crown), is required to undertake public good research, pay taxes and generate a profit plus a return as a dividend to its owner. Government funding has been cut from $130m to $75m (1992 to 2008) offset to some degree by private-sector research. Needless to say they are still shedding staff to meet their financial goals.

The consequences of these policies are that science is becoming increasingly commercialised and commoditised, and management theories and practices, developed from the private sector, are being applied to science. These policy-twins are having, in my view, a disastrous effect on science, not just in NZ, but worldwide.

Underlying these changes there is, I think, a more sinister hand at play: the emergence of a strong anti-science 'ideology' in developed societies. Science is no longer respected and valued by society. I do not think that this is the cause of the changes discussed above, but it certainly aids and abets them, at least in the minds of the politicians and bureaucrats who set the parameters for science governance.

This paper explores some of the reasons why we find ourselves in this situation and some of the implications of this for modern science management.

## What is science?

To make sense of what is to follow it is first necessary to define what science is and for this I am relying on people far more thoughtful and wise than I.

According to Edward Wilson, an American biologist, (quoted by Robert Park, an American physicist, in his book 'Voodoo Science: from Foolishness to Fraud' 2000):

"Science is the systematic enterprise of gathering knowledge about the world and organizing and condensing that knowledge into testable laws and theories"

Park builds on this definition setting out two rules which are at the heart of successful and credibility of science:

i. Expose new ideas and results to independent testing and replication

ii. Abandon or modify accepted facts of theories in the light of more complete or reliable experimental evidence.

Ziman develops this further into a list of essential requirements for any science organisation:

i. Social space for personal initiative and creativity;

ii. Time for ideas to grow and mature;

iii. Openness to debate and criticism;

iv. Hospitality towards novelty;

v. Respect for specialised expertise.

The other point, which must be added, and which is frequently overlooked, especially by those who wish to adopt into science management theories and practices designed for commercial activities (see Edmeades 2004), is that, of all the professions, science is very different.

## Science Is Different

This difference arises because the results (the outputs) of science cannot be predicted in advance and the impacts of science (the outcomes) can only be known in retrospect. In all other professions including law, accounting, engineering, teaching and health, the task comes to an end or an end point can be defined. As Einstein put the case for science, "...if we knew what we were doing it would not be science"

Furthermore, all the other professions owe their ongoing existence to the laws of the land. They are required because there are laws requiring their input. Health is slightly different in this respect, but in any case, the compulsion for health professionals is obvious and motivated by the Hippocratic Oath.

Thus, science is the only profession which is:

i. Truly voluntary at a national level, and

ii. Its outputs and outcomes cannot be predicted.

For these reasons science and its management have unique and specific requirements.

Having defined science and its requirements, I now turn to examine some of the factors which undermine and undervalue science in contemporary society.

## Science is under threat

In my opinion there are a number of contemporary threats to science.

### Philosophy

Taking a very broad brush to the history of philosophy, and noting I am by no means an expert in this area, three very different belief systems have emerged over time. Prior to the Age of Enlightenment, the Church stood at the centre of society. The sole authority was the Church and the perceived wisdom for this authority was derived from faith in God. Deviation from this authority was not tolerated as Galileo and many others discovered.

Gradually this gave way to the power of reason, ushering in the age of enlightenment. Now evidence not faith was the authority. This was the birth of science as we know it and great progress was made, initially with the

industrial revolution. Ironically this association between science and industry is still seen by some today, e.g. the organic movement, as a dark source of evil.

Several world wars later and with the arrival of the nuclear bomb and DDT, faith in evidence-based science - not to be confused with faith in God - has been eroded, giving rise to what is called post-modernism. The "new age" with all its 'isms' had dawned which, in time, deconstructed itself into the belief that the only truth, and hence the only authority, was vested in oneself. If you believe "it" to be true, then "it" is true for you! Political Correctness has taken this further: criticism of other views and opinions must be suspended and hence all opinions, evidence based or otherwise, must be given equal weight.

**Such beliefs are, of course, anathema to science which requires open debate and criticism and which holds that the best opinion is the one that best reflects all the available evidence.** Ironically, the discipline of philosophy which had given birth to, and supported science initially, has now turned to devour its most productive child.

Thus we see in modern society this bizarre duality that allows "alternative" medicines – potions that do not require proof of efficacy - to sit on the same shelves as legitimate medicines for which evidence of efficacy is essential. It is this duality that sees scarce research dollars squandered on experiments investigating homeopathy and organic farming, e.g., movements and practices which are based on fundamental misunderstandings of the available evidence. Such movements are perpetuated by the authority of dogma.

## Social

While post-modernistic thinking has undermined science there is another force at play, at least in the layman's mind. Fed by stories of environmental catastrophes by the press, often based on little sound evidence, the public associate these problems with science, to the extent that they see science as part of the problem. Science, they reason, must be stopped. This is, of course, false reasoning, Many of the problems currently concerning the public arise, not because of science per se, but because of socio-economic circumstances, e.g. over population, poverty, poor nutrition and medical care, etc. These are political problems for which the only solution is more, not less, science.

Related to this, the public generally has a poor understanding of what science is. **This, I hasten to add, is not so much a criticism of society, rather it is up to science to educate and inform the public.** In this sense we do a very poor job. As Robert Park states, "Those who are fortunate enough to have chosen science as a career have an obligation to inform the public about voodoo science".

Some of the common misunderstandings are:

i. *Scientists are always arguing – who am I to believe?* We need to explain that this is normal, necessary and healthy for science to progress, although it may not be socially accepted in other areas of life. We scientists need to explain that most of the scientific arguments that spill into the public arena are in the emerging science fields, e.g., climate change, stem cell research. We need to explain that over time as more and more evidence is gathered scientists become more and more agreeable. For example, apart from people detached from reality, we all agree that the sun is the centre of our solar system and that the earth is not flat and that atoms are not solid.

ii. *If science is so good how come scientists do not know everything?* We need to explain that science will never know everything because every conceivable experiment has not been done. And, indeed, some questions go beyond the reach of scientific measurement at any particular time, c.f. the changing understanding of the atom over time.

Without the necessary effort from scientists to improve scientific literacy, we leave the public vulnerable to all sorts of dogma-driven ideas and concepts and to every new-age fashion passing across their mental sight-screens. **In a democracy, where each person has a vote, we are leaving science in very feeble hands.**

## Modern management theory

To cope with 'steady-state' science funding many management theories, ideas and concepts have been introduced into the management of science in the belief that this process would ensure that the limited funding was correctly aligned, efficiently allocated and then used. Thus, the science management lexicon now includes: funder-provider split, market forces, alignment, allocative efficiency, flexibility, contestability, appropriability, accountability, efficiency, transparency, contracts, performance indicators, milestones, and etc.

Much of this body of theory and practice has been developed from the management of privately owned (i.e. commercial) businesses; it is what Business Schools teach. In other words it was designed to improve the management and operation, and hence profitability of organisations, whose goods and services are largely tangible and for which there are measurable time-frames, inputs and outputs. For this reason such organisations can be defined and made accountable in the strictly financial sense, but it is very dangerous to apply this type of management to science - see Ziman 1966; Edmeades 2004, 2006.

The problem is inherent in the nature of science. Science inputs, outputs and outcomes can not be measured or predicted over short periods, and to do it, as modern accounting requires, in 12 monthly increments, is nonsense. Science time-frames are long (5-10 years minimum) and science is iterative. It builds over-time on many prior results while rejecting others. It cannot be known a priori which pieces will ultimately become useful and which will lead to 'dead ends'. And the ultimate value (financial benefit) of a piece of research is impossible to define in the short term.

Think of the examples of English physicist James Maxwell, late 19 century, playing around with electricity and magnets, whose pioneering work underpins our world of electricity. Or again, Albert Einstein, German Physicist, early 20 century, pondering what happens when thing move very fast, ultimately giving rise to the nuclear age.

And yet this is the accounting and management straight-jacket now imposed by society on modern science. Science cannot be accounted for in this way and hence all the management and accounting jargon being used today is a sham. Moreover, scientists are intelligent – that is one reason they are scientists – and most, sensing the charade they see, feel undervalued in the current system. The net result is that transaction costs (overheads) increase and science morale, and all that depends on it, is reduced, to yield a negative gain.

There is evidence to support this: NZ surveys in 1997 and 2002 suggested a "stunning level of dissatisfaction among scientists ...." and 75% of scientists would not recommend science careers to the next generation and 20% of NZ science graduates going overseas.

Note that I am not arguing that the scientist should be given free rein – of course, there must be accountability for the expenditure of public monies - but such systems should be based on the unique, inherent characteristics and requirements of science.

There is another pernicious problem which arises when science is commercialised, which could indeed prove fatal. Science as we have discussed must be open for discussion and debate. Competition and contestability and protection of IP act counter to this essential requirement. The gabardine cloak of secrecy does not fit well on the shoulders of science. This is magnified further when the need to raise research dollars compromises the objectivity and integrity of science. For example:

a) At the NZ Royal Commission on Genetic Modification, were the CRI scientists who gave evidence speaking as impartial observers (expert witnesses) or as spokesmen for the CRI required to raise money from IP?

b) AgResearch Ltd conducts research to develop pasture cultivars. But the same scientists are used by the seed merchants to promote specific cultivars. How does the public know when they are speaking as salesmen for the company or as objective impartial science undertaking public good research?

## The fourth estate

The media (in all it forms) is a vital component of the mechanism by which society is informed about issues and choices. To do this effectively requires that they, like science, is free from influences that might affect their ability to speak the truth without fear or favour. Analogous to science, the media has now been commercialised as never before resulting in a heavy dependence on advertising revenue and on 'stories' that sell. Sensationalism is rampant and what better stories to run than those from the doomsday prophets: people who invent tragedies to create markets for their dubious products and services, e.g. the extreme green fringe. Truth is, of course, a casualty and science is left putting the Humpty Dumpty of reason back together again.

There is another important aspect to journalism. The journalistic credo is to provide balance – what is the 'balance of opinion'. But this seems to reduce much science journalism to the same danger imposed by political correctness. What science needs, and I think what society generally would appreciate, is journalism based on the 'balance of the evidence'. But this is very difficult for journalists to articulate as most have little to no understanding of science.

## Scientists

I sometimes think that scientists are the cause of their own demise as most are not good communicators in the public domain and when they do speak they often speak over the head of their audience. Thus, from the public's point of view they appear arrogant reinforcing a public perception that scientists believe they are a superior breed and would like to be 'a law unto themselves'. It is no surprise that lurking unspoken behind much of the recent science reforms is the implicit message: "we do not trust scientists", and hence the need for all this gooble-de-gook in terms of transparency and accountability.

In more mellow moments I realise that modern scientists are overloaded with work they despise: preparing proposals with all those make-believe costs and benefits, completing milestone reports, annual reports, reviews, etc. It is endless and there should be small wonder that there is little time or energy left to help the public.

But more profound in terms of its impact is the 'cone of silence' that most scientists must now operate under, or risk losing their funding, or jobs, or both. There was a time when the concept of intellectual freedom was sacrosanct. Alas, this principle is being stomped out by commercially and politically sensitive science

bureaucracies. PR, yes we can do that, but we no longer defend truth, objectivity and impartiality. Society is the loser and science will pay the price.

## Conclusion

John Ziman used the story of Prometheus as a metaphor for the plight of modern science: Science, he argued, has become a modern day Prometheus. Recall that Prometheus, a minor Greek god, came to earth against his seniors' wishes, to help mankind. He was successful, further exacerbating the wrath of the Gods who then bound him to render him useless.

But I would like to end on a more positive note. If science is to rid itself of the shackles which bind it then, I believe, in the first instance that we (science) should renegotiate our position with society (i.e. with government). **In that context the professional associations, which can be independent of political positions, have a responsibility to lobby governments and proactively present a pro-science case to the wider community.** On the one hand we must accept that we are in a steady-state world of funding with the limitations thereby imposed, but in return we ask:

- That our profession be accepted as crucial for the ongoing development and welfare of society.
- That science is respected as a unique profession and, accordingly, that management policies and practices, including accountability and transparency, are developed recognising this uniqueness.
- That science is returned to a normative occupation because society is best served if science is open, impartial and objective, based on the principle of intellectual freedom.
- We accept the need for a strong relationship between science and industry but to protect science and society, this interaction should never be controlled by industry or the profit motive.

For those interested I have attempted elsewhere (Edmeades 2004) to describe a model science organisation based on these principles.

## Further Reading

My own thinking on this topic has evolved slowly and been greatly influenced by many people, itself an expression of the scientific method. Listed below is a selection of papers and books that may be of interest:

1. The formative experience which started me thinking about these things can be found in: D. C. Edmeades. 2000: *'Science Friction: The Maxicrop Case and the Aftermath*. Out of print but can be obtained on interloan from Hamilton Public Library.
2. For my formal writings on the commercialisation of science: D C Edmeades. 2004: *Is the commercial model appropriate for science?* NZ Science Review 61: (3-4), and D C Edmeades. 2006: *A response to the MoRST sector engagement paper.* NZ Science Review 63: (1).
3. An excellent overview of science since its beginning can be found in: J Gribbin 2002: Science A History 1543-2001. Two recent books by Robert L. Park; *Voodoo Science: The Road from Foolishness to Fraud*. Oxford University Press 2000; and, Superstition: *Belief in the Age of Science*. Princeton University Press, 2008, beautifully demonstrate the application of science thinking to every day problems and issues. See also; J Roche and D.C. Edmeades 2005: *Fact of Fiction: How do I know who is telling the truth*. SIDE Conference, Invercargill, NZ.
4. For the general public trying to get its head around philosophy I found the following very helpful: James Mannion. 2002: *The Everything Philosophy Book*, F+W Publications Inc., and Bryan Magee 2001: *The Story of Philosophy*. DK Books, and Richard Appignanesi and Chris Garratt 2005: *Introducing Postmodernism*, Totem Books.

For some heady details about the dangers of the commercialisation of science in the biomedical arena go to: Sheldon Krinsky 2003: *Science in the Private Interest. Has the lure of profits corrupted biomedical research?* Rowman & Littlefield Publishers, and, Daniel S Greenberg, 2001: *Science, Money, and Politics. Political Triumph and Ethical Erosion*, University of Chicago Press. {Also see Book Review, The March of Unreason, Lord Taverne, this issue of *Agricultural Science*, Ed.}