Maori and the 'McScience" of new technologies

Biotechnology and nanotechnology research and development

By Dr Jessica Hutchings and Dr Paul Reynolds

Abstract

Many Maori and other Indigenous peoples have opposed genetic modification, and other new technologies in both indigenous and non-indigenous forums. Part of the resistance to new technologies is the impact they have on cultural values and the environment.

This paper presents a critical response to the "McScience" of new technologies, in particular biotechnology and nanotechnology. Within this paper we build on the previous work of other key writers and commentators in this field and discuss some of the critical issues emerging from the platform of new technologies with relevance to Maori and other indigenous peoples. Specifically we discuss the reductionist and mechanist nature of western science and examine the manipulative framing and use of language within this scientific paradigm. We also consider the implications of the western science paradigm for Maori and other Indigenous peoples.

To overlook a Maori analysis of new technologies is to limit the intellectual analysis of nano and other new technologies. In fact, it is our Treaty right to provide a Maori analysis to inform the decisions on how this technology proceeds.

Key words: maori, nanotechnology, biotechnology, indigenous, genetic engineering, science, reductionist, Treaty of Waitangi.

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Introduction

In February 2005, the authors of this paper attended a symposium entitled "Nanotechnologies in New Zealand: Opportunities and Challenges" hosted by the Foundation for Research, Science & Technology. The symposium presented the opportunity for a range of 'stakeholders' to discuss the future potential of nanotechnology. We were asked to present a paper on Maori and nanotechnology. Although we had not specifically worked with Maori communities on nanotechnology our presentation was based on our active involvement with our communities over the last eight years with regard to new technologies, in particular genetic modificaiton.

The purpose of this paper is to speak with Maori communities and other social scientists working in the area of new technologies on some of the issues that may arise for Maori concerning nanotechnology. This paper presents some of the epistemological issues that may arise for Maori when developing analyses about new technologies.

Within this paper we identify current nanotechnology activities taking place in Aotearoa/ New Zealand. We build on current Maori discourses with regard to genetic modification, to explore some of the issues Maori may face with regard to nanotechnology. In particular, we provide commentary on nanotechnology as it relates to Papatuanuku and Te Tiriti o Waitangi. The second part of this paper discusses some of the epistemological difficulties that arise for Maori when being asked to develop analysis in the 'western' scientific paradigm. Specifically we discuss the reductionist and mechanistic nature of western science and examine the manipulative framing and uses of language within this scientific paradigm. We also consider the implications of the western science paradigm for Maori and other Indigenous peoples. We argue, that to over-look an indigenous analyses of new technologies is to limit the intellectual analyses of nanotechnology and other new

technologies. In fact, we believe it is our Treaty right to provide a Maori analysis to inform the decisions on how new technologies proceed.

He aha nanotechnology? What is Nanotechnology?

Nanotechnology is defined by the Ministry for Research Science and Technology as "the design, characterisation, production and amplification of structures, devices and systems by controlling shape and size at nanometre scale" (MORST 2005,3). Basically, nano refers to a scale and nanotechnology is the manipulation of matter atomic/nano-scale. The applications of this type of technology are broad and are purported to include:

- new forms of manufacturing (such as self-assembling materials)
- development of new materials (eg, new composite materials of high strength/low weight, new conducting materials, "smart" materials that retain their shape or are self-cleaning such as self cleaning glass)
- new or more efficient electronic components and energy storage devices
- medical applications (eg, therapies, diagnostic devices, bioengineering)
- environmental applications (eg, water purification, clearing of contaminated sites, sensors)
- military applications (eg, weapons, armour, sensors) (MORST 2005).

Nanoscience is the study of phenomena and manipulation of materials at atomic, molecular and macromolecular scales, where properties differ significantly from those at the larger scale (ibid). The majority of nano-based research undertaken in Aotearoa/New Zealand is concerned with developing understanding of the nanoscience as opposed to developing nano-based technology.

Nanotechnology in Aotearoa/New Zealand

New Zealand's nanotechnology sector is slowly blooming with rising investment by industry and government. The New Zealand Government clearly sees nanotechnology as a new market arena with promise and potential and has accordingly marked it as a priority area for funding research.

Internationally, expenditure in nanotechnology was estimated in 2005 at US$8.6 billion. The United States alone has set aside US$3.8 billion for nanotechnology projects. Furthermore, nanotechnology funding is enshrined in United States law with

the passing of President Bush's 21st Century Nanotechnology Research and Development Act which guarantees funding and support for nanotechnology research. By 2015 worldwide expenditure is projected to be US$1 trillion.

Table One outlines the increasing level of public investment in nanotechnology. As is evident there was a 503% increase in nanotechnology investment from 1997 -2002 (Arnall 2003,18).

Table 1: World-wide government funding for nanotechnologies research and development (US million).

Area	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
US	116	190	255	270	422	604	710
Western Europe	126	151	179	200	225	400	NA
Japan	120	135	157	245	465	650	NA
Others[i]	70	83	96	110	380	520	NA
Total	432	559	687	825	1502	2147	NA
(% of 1997)	100	129	159	191	348	503	NA

It is estimated that Australia invests about A$100 million (US$76 million) annually in research and commercialisation associated with nanoscience and nanotechnologies. Furthermore the United Kingdom government in 2003 allocated £90 million over six years to assist industry to harness the commercial opportunities associated with nanotechnologies.

In New Zealand there is a variety of research associated with nanoscience and nanotechnologies. The focus of New Zealand research is concerned with nanoscience rather than the commercial developments. The Ministry of Research, Science and Technology estimates the New Zealand Governments investment in nanotechnologies to be no more than NZ$15 million (US$10.5 million) (MORST 2005).

The MacDiarmid Institute for Advanced Materials and Nanotechnology, which works in collaboration with a range of Universities and research organisations, undertakes most of the nano-scale research in New Zealand. Currently, New Zealand is starting to develop its own nanotech based companies. The first, nanotechnology company Nano Cluster Devices Limited, was established in 2003 from self-assembly research undertaken at the University of Canterbury. The Ministry for Research Science and Technology reports that the current focus of New Zealand's research is on studying and producing nanomaterials, particularly those with electronic applications. They believe the nano research in New Zealand is more closely aligned to nanoscience than nanotechnologies, as it is directed towards developing reliable methods for creating nano-scale structures and understanding the properties of nanostructures. Given this, the current research and development in New Zealand is likely to be of most immediate use to other researchers rather than rapidly leading to commercial applications of nanotechnologies.

Internationally, and in New Zealand, government sectors are leading the research and development in nanotechnology. The motivation for government support in the research and development of nanotechnology is the desire to hold advantageous positions should nanotech applications begin to have a significant effect in the world economy, hence these governments and countries are able to fully exploit these opportunities. Harper (in Arnall 2003,18) describes this current situation as a global arms race; "You only have to look at how IT made a huge difference to both the US economy, and to US military strength to see how crucial technology is. Nanotechnology is an even more fundamental technology than IT. Not only has it the ability to shift the balance of military power, but also to affect the global balance of power in the energy markets."

With the existing and projected national and international investment in nanotechnologies, we know with certainty that the applications of this technology will have worldwide impact. The impact of nanotechnologies is considered by the Ministry of Research, Science & Technology to be enormous, as is indicated by their statement that; "Nanotechnologies could be applied in a very broad range of areas – chemical, biological, electronic and engineering – and the range and types of

applications envisaged indicate that nanotechnologies are likely to have much greater implications and impacts on society than biotechnologies." (MORST 2005,8)

Maori and Nanotechnology

Developed from the epistemology of western reductionist mechanistic science, nanotechnology does not recognise or respect the interconnected and holistic nature of the environment but rather seeks to manipulate matter at the atomic level to achieve 'development' and 'progressive' advancements. The epistemology of western science is markedly different from the interconnected and holistic worldview of the environment held by Maori and many other Indigenous cultures, and will be discussed further in this article.

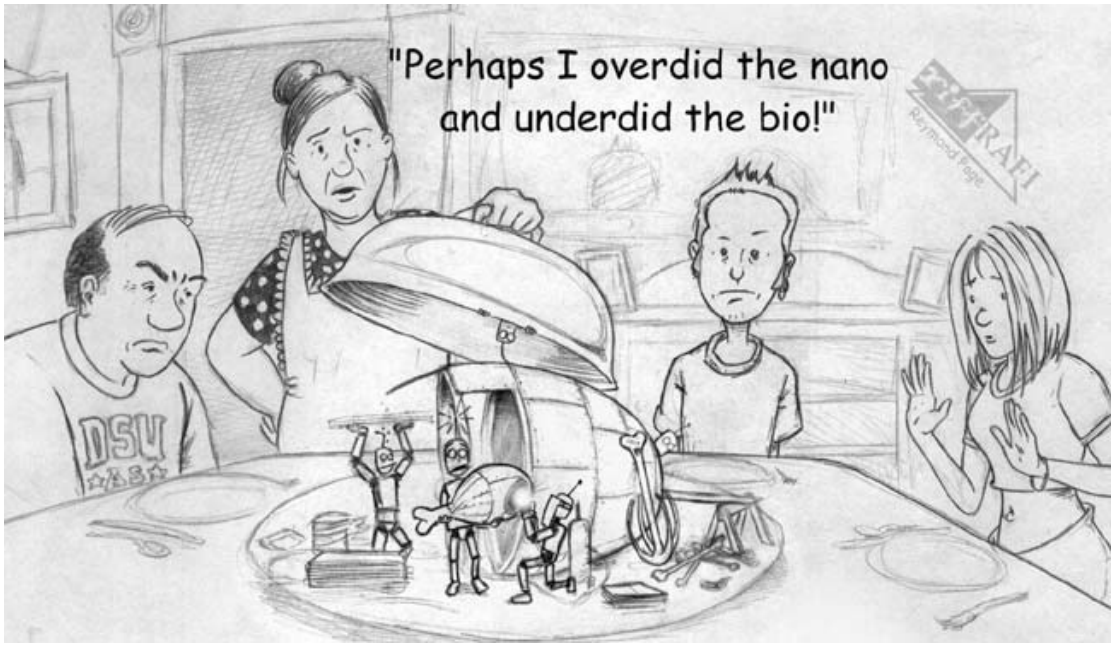
For Maori communities, nanotechnology is just another technology amongst a wide range of new technologies, such as; information technology, genetic engineering, biotechnologies, xenotransplant and reproductive technologies that have the potential to impact on tikanga and the environment.

The participation of Maori in the new technologies platform is as outside observers watching the machines of multinational science impact on our Maori communities and our tikanga. This position has relegated Maori to being non-decision making participants in the majority of debates around new technologies, as opposed to being active agenda-setting and decision making participants with regard to new technologies.

New technologies such as the biotechnologies, have been developed from the epistemologies of western science and the ideology of neo-liberal economics. It is from these dominant positions and spaces that the views of **'others'** such as Maori and Indigenous peoples are asked to provide; 'perspectives', 'views' and 'assessments' of these new technologies. After almost fifteen years of Maori making comment on the impact of new technologies our views are again sought, this time with regard to nanotechnologies. One could already be well versed on Maori and other Indigenous peoples concerns with regard to nanotechnology by engaging with the numerous reports, writings, academic papers and submissions made by Maori and

other Indigenous peoples with regard to biotechnology and in particular genetic modification[ii].

A critical issue with nanotechnology is its possible convergence with other new technologies. Maori and other Indigenous people have already voiced their deep concern around biotechnologies and genetic engineering, nevertheless we are facing the technological age where the convergence of these new technologies emerges as a highly technological new form of science, now known as convergence technologies. With nanotechnologies operating at the nano-scale level, with genetic engineering operating at the molecular level, and with the leaping advances in information technology, this convergence raises serious issues with regard to new initiatives in the fields of medicine, agriculture and food production, and the impacts on the environment in particular (ETC Group 2004). Some of the issues we are facing are outlined in the cartoon from ETC Group.



We believe these Indigenous 'perspectives' and 'views' concerning nanotechnology can also be applied to converging technologies. The US government refers to this convergence as NBIC (the integration of nanotechnology, biotechnology, information technology and cognitive science) and envisions that; "the mastery of the nano-scale

domain will ultimately amount to the mastery of all nature" (ETC Group 2004,5). The non-governmental group, ETC Group refer to these converging technologies as "BANG", an acronym derived from Bits, Atoms, Neurons and Genes, which they describe as the basic units of transformative technologies (ETC Group 2004,6). ETC Group also warn that "BANG" will profoundly affect human security and health as well as allowing cultural and genetic diversity to be placed firmly in the hands of the convergent technocracy.

From our perspective, Maori concerns and those of other Indigenous peoples with regard to nanotechnologies and convergent "BANG" technologies stem from the connection that Indigenous peoples have with the land and their environment, in particular for Maori, the obligation we have as kaitiaki of Papatuanuku. Within a Maori environmental worldview the land is passed to us from ancestors for us to care take and pass on to future generations. It is from this premise that any technology that impacts on the land and the environment is of relevance to us as kaitiaki of Papatuanuku.

There are many other issues that Maori may explore with regard to nano and "BANG" technologies that stem from our cultural paradigms and frameworks. For example nano and "BANG" technologies raise serious concerns with regard to our key cultural concepts, in particular the aspects of mauri, whakapapa, tino rangatiratanga, whenua, Papatuanuku, kaitiaki and ira as well as issues of the commodification of our knowledge or, in neo-liberal parlance, the appropriation of intellectual property.

It has been our observation through engaging with the GM debate in Aotearoa/New Zealand that the assessments of new technologies from our Maori paradigms are relegated and minimised as 'cultural or spiritual concerns' and are neither understood nor rated as relevant. Therefore it is not the purpose of this paper to explore the more complicated culturally based Maori concerns of nano and "BANG" technologies as we believe those discussions are for Maori, and Indigenous peoples to have in our own spaces with our own cultural protocols guiding the discussion. This will ensure that the space for critically discussing our cultural values is protected from 'outsiders' and their (mis)interpretation of our concerns. What is relevant for the purpose of this paper is to signal the impact nanotechnologies and "BANG" technologies will have

on *Papatuanuku* and to examine some of the epistemological underpinnings of western reductionist science

Nantechnology and Nano-Agriculture on *Papatuanuku*

According to the new nano-vision by the United Sates Department of Agriculture in 2002, agriculture needs to be; "…more uniform, further automated, industrialized and reduced to simple functions. In our molecular future, the farm will be a wide area biofactory that can be monitored and managed from a laptop and food will be crafted from designer substances delivering nutrients efficiently to the body" (ETC Group 2004, 8).

The re-organising of natural processes is not a new idea. The Green Revolution was science based agricultural change that had far reaching ecological, social and political effects. The Green Revolution's purported advantages were not only outweighed but destroyed by the damages it brought about. The "Miracle Seeds" central to the Green Revolution, for example, were touted as instruments of economic progress in developing countries. In most cases, however, their use led to poverty, discontent, and violence amongst the rural, predominately agricultural societies who they were suppose to benefit (Shiva 1991). It is concerning that the Green Revolution with all its detrimental effects has recently mutated into the Biotechnological Revolution which has again mutated into the Nanotechnological / Nano-agricultural Revolution.

The new technologies platform and their associated 'Revolutions' fail to support the biological diversity of the environment. Rather these new technologies promote an agricultural relationship mediated by mechanistic reductionist technology. The new technology platform fails to account for the relationship Maori and other Indigenous peoples have with the land, who most refer to as their Earth Mother. Furthermore they fail to recognise and respect the interconnected self-ordering and self-reproducing capacity of the environment.

Of great concern to the protection of Papatuanuku and the environment is the potential impact of nano-structured particles and devices on the environment. Nano-particles and other throw away devices may constitute whole new classes of non-biodegradable pollutants that scientists have very little understanding of. Although

nano-particles are mini-versions of particles that have been produced for a long time, the larger versions have undergone testing while research into the impact of nano-waste and nano-particles on the environment is lacking.

Nanotechnology and *Te Tiriti o Waitangi*

As with biotechnology, in particular genetic engineering, Te Tiriti o Waitangi provides an appropriate framework from which to assess nanotechnologies. The Treaty obligates the Crown not only to take into account the Maori world, but also to actively protect it. These obligations are clearly set out in Article Two, which states: That the Queen of England agrees and consents (to give) to the chiefs, hapu and all the people of New Zealand, the full chieftainship (Rangatiratanga) of their lands, their villages and all their possessions (taonga). It is from this premise that we argue that The Treaty should be the foundation for all processes regarding nanotechnology in Aotearoa/ New Zealand. We also argue that The Treaty guarantees Maori rights to be consulted, and to make decisions, about what comes into Aotearoa/ New Zealand. Many Maori stress that Te Tiriti o Waitangi guarantees rights to control what will impact on their well being, environment and culture (Cram 2000). Moana Jackson (cited in Cram 2000,70) illustrates this point with regard to GM: "…it [GM] is a Treaty issue, it is our right as sovereign people to make our decisions, it has nothing to do with the Crown's obligation to protect us. Therefore, if our people say, we have the right to discuss this [GM] and need the time to do it then the Crown simply has an obligation to acknowledge that call. Not in a sense of wanting to protect us, but because that is a recognition of our sovereign right. So it [GM] is a Treaty issue in that sense. But for me, it is an exercise of our sovereignty to say we have concerns about this, we need to korero [talk] about this, we will do that first".

Aroha Mead also discusses The Treaty with regard to GM. We believe that the arguments that she makes are relevant to a Treaty analysis of nanotechnology (Cram 2000, 72). She states:

> *How I see it is that the crown has guaranteed Maori certain rights under the Treaty, both Article 2 and Article 3 rights…How I interpret that in the field of genetic engineering is that, the crown has a responsibility to ensure that the programs that it offers to Maori, to reduce disparities, are safe ones. That the technologies and opportunities that they are bringing to Maori, to help Maori, are safe ones. That what they're doing now is not going to create a further detriment to Maori a further generation from now. Because what has been*

> *offered is not safe. So I take the view, and it's the view that we put forward in the work we do here at TPK [Te Puni Kokiri, The Government Ministry of Maori Development] is that, unless the crown can assure Maori that the products that come from genetic engineering are safe, and have no risks associated with them, then they are breaching the Treaty. In very simple terms they have an obligation not just to consult, but to look quite seriously at how this particular technology can assist, or become detrimental to Maori development. They need to have done that research, they need to have worked the issues out, they need to know what the issues are before they even venture into the field.*

The central notion within The Treaty is to ensure Maori control over areas of life that affect our destiny. Many Maori when discussing The Treaty in regard to GM, discussed the need for consideration and decision making to be based on processes that affirm and enact The Treaty. We believe the same would apply to nano and "BANG" technologies. Other areas of concern raised by Maori voices and authors with regard to GM and The Treaty included the right of participation. Angeline Greensill (Cram 2000) believes that Maori are being excluded from having a voice on GM, which she sees as in direct conflict with The Treaty.

The discussion to come from Maori concerning The Treaty and GM provides important information for scientists working in the nano and "BANG" technologies fields in New Zealand social scientists examining the socio-cultural impacts and Maori communities dialoguing about these new technologies. The fundamental lessons we can learn from the GM debate with regard to the Treaty are: decision making processes need to affirm and enact the Treaty as well as the Maori right to participate in the development of this technology. Furthermore a mana wahine conceptual framework to assess the impact of new technologies raises the following questions with regard to The Treaty, nanotechnology and other new technologies.

- Does the development and implementation of this technology endorse our Treaty rights?
    - Has this technology been developed with the full participation of Maori exercising their Treaty of Waitangi rights?
    - Is the treaty of Waitangi being used as one of the decision making tools in the development of this technology? (Hutchings 2004)

Nanotechnology raises some important Treaty issues concerning decision making, participation and the protection of the environment. We suggest that scientists working in the fields of nanotechnology and "BANG" technologies become familiar with these concerns and issues that Maori, Pacific and other Indigenous communities will inevitably raises with regard to this technology. Furthermore we also strongly advise that scientists learn from the GM debate that new technologies raise issues and concerns for Maori and begin to ask what the Article 1,2 and 3 Treaty issues are with regard to nano and "BANG" technologies.

We also caution scientists and researchers in this area against the co-opting of selected Maori experts to provide this advice. Tikanga Maori and matauranga Maori provide clear guidelines for how Maori might conceptualise a set of culturally informed values, practices and knowledge for the issues associated with new technologies. Consultation over the controversial issue of genetic engineering has again exposed the traditional problems of reliance on 'selected' Maori experts. Research teams interested in promoting their research, universities conducting this research and government agencies promoting this research seek these "selected" Maori experts to legitimise their work. Yet over and over again consultation with the general Maori public has revealed the same concerns relating to genetic engineering and the use of traditional knowledge, flora and fauna. Dr Cherryl Smith believes there have been two main responses to such consultation with Maori (in Reynolds 2005, 12):

1. We have been told that we must need more education, especially about science. We are told that obviously we don't understand new things. More education of communities needs to happen and the science curriculum in schools needs to change, for example. This has been particularly evident as a response from ERMA representatives who told us at hui that more education was needed and who also submitted a paper to the incoming government to ask for a budget to educate us. (Within one Maori women's network I work with there are kuia (women elders), doctorate graduates, Masters graduates, lawyers, medical specialists and we have made representations to ERMA)
2. The ways we think, our philosophies, need to be changed. We have had our traditional stories re-told to fit the new scientific paradigm, we have had findings appearing re-translating and re-explaining their meanings to show that mixing of genetic material is ok, we have been told that the stories where our ancestor transformed into a bird was genetic engineering, that it was a traditional practice.

What we do advise is that scientists move from the laboratories out into Maori communities to begin to dialogue and to genuinely attempt to understand Maori perspectives with regard to new technologies. This requires the simple art of listening, as opposed to feigning listening.

Critical examination of the philosophical foundations of western science

A critical issue with emerging technologies such as nanotechnology and biotechnology is the philosophies and ideologies that they are built from. Ultimately, these emergent technologies are built from the foundations of reductionist mechanistic western science which see life, nature and biodiversity as largely consisting of separate and independent parts. This type of science has been referred to by some as the age of 'McScience', where science has been "captured by business and whose integrity is questioned" (Stevenson 2005).

For Maori, tikanga is one way we have articulated our worldview, values, beliefs, and epistemologies. Tikanga articulates Maori ways of doing things. Tikanga has specific applications in different areas and for different kaupapa. Aspects of new technologies, such as genetic engineering and the creation and use of transgenic organisms impinge on tikanga Maori. So in order to articulate Maori perspectives on the new technologies, we first need to differentiate between worldviews; a worldview which is informed by tikanga Maori knowledge and another which is not. In order to do this we have had to develop appropriate terminology that can adequately define, describe and differentiate between the worldviews. In this section we want to define what we mean by "tikanga Maori knowledge" and "Western reductionist science."

The term "science" is culturally bound; there are different interpretations of what science means for different peoples. For Indigenous peoples, the term "science" has had specific meaning. "Science" has been experienced as the handmaiden of colonialism. In the name of science, colonial (historic and contemporary) explorers have named, described, categorized and defined indigenous peoples and their knowledge. Indigenous people have been researched, experimented on, and samples of their genes have even been extracted, identified and then bought and sold.

“Science” then is a way of seeing and a way of doing things that a lot of Indigenous peoples are wary of.

Tikanga Maori is a term that encapsulates Maori ways of knowing and doing. Tikanga Maori has a long history and strong traditional foundations but is highly relevant in providing guidance in the contemporary context. Tikanga Maori knowledge incorporates Maori traditional teachings, values, beliefs and epistemologies. Tikanga Maori knowledge sees the world through a Maori epistemological lens. Central to the Maori worldview is the whakapapa (genealogical) link to and between all things. Tikanga Maori knowledge is based on relationships (whakapapa) and how we interrelate. It includes the respect and dignity and sacredness of all things, which require a reciprocal kaitiaki (guardian) relationship. This reciprocity manifests in every effort we make to respect all things. What we do to the earth, our environment, and peoples will impact on how the earth, environment and peoples interact with us. This holistic view of the world, which recognizes that our actions can have an impact on the world we live in, also acknowledges the fact that we are not alone on this earth. We do not own or control it. As part of our whakapapa and kaitiaki relationship with all things, Tikanga Maori knowledge recognises that we are connected to a particular place. There is a whakapapa relationship to the rohe (area) of our iwi (tribe), hapu (sub-tribe) and whanau (family) and all things that share that geographic area. Tikanga Maori knowledge is therefore based on whakapapa (genealogy and relationships), kaitiakitanga (guardianship), connection to place, and all of the values and beliefs that form and inform these relationships.

Western reductionist science sets itself up as the pre-eminent model for all scientific endeavours and as the authority on what should be considered “truth” or “fact,” or scientific knowledge. Its claim to universalism is central to its monopoly position as a knowledge system. Professor Linda Tuhiwai Smith observes that ‘science’ is a site of tension for Indigenous people stating that; “the clash between science and Indigenous knowledge remains constructed around the interests of science” (Smith 1999, 105). Maori knowledge or science is not legitimised in the eyes of some Western scientists because it has not been through “rigorous,” “scientific” testing and is therefore not part of the academic and theoretical tradition on which Western science, and indeed Western reductionist science, is founded. In opposition to the holistic conception of

the world where the parts are seen as indivisible from the whole, Western reductionist science generally views the parts as autonomous[iii]. This view of science gives rise to the possibility for Western reductionist scientists to manipulate and modify the parts, for example research involving the modification of genes, in order to influence the whole. This reductionist conception operates on the mechanistic notion that by replacing or changing a part, the whole will be "fixed."

When life is viewed as machine, where a part can be changed or replaced in order to 'fix' the whole, "an ethical shift takes place – life is seen as having instrumental rather than intrinsic value" (Shiva 1997, 32). Indian physicist Vandana Shiva believes this results in two forms of violence; "First, life-forms are treated as if they are mere machines, thus denying their self-organizing capacity. Second, by allowing the patenting of future generations of plants and animals, the self-reproducing capacity of living organisms is denied" (Shiva 1997, 32).

This disrespect for life is fundamental to reductionist science. Furthermore biotechnology, nanotechnology and 'BANG' technologies are the ultimate expression of the commercialisation of science and the commodification of nature that began the scientific and industrial revolution. The rise of reductionist science has allowed Papatuanuku, nature and the environment to be declared dead, valueless and inert unless mediated by technology. Consequently this has provided western reductionist science with permission to exploit and dominate nature in total disregard for the social, cultural and ecological consequences. Vandana Shiva (1997) argues that the rise of reductionist science is strongly linked with the commercialisation of science and resulted in the domination of women, non-western and Indigenous peoples. This is clear with the marginalisation of Indigenous peoples interconnected and holistic ways of knowing. With commercialisation as the objective, reductionism became the criteria of scientific validity. Hence non-reductionist, holistic and interconnected ways of knowing ecosystems and environments were pushed out and marginalised. The result is that the new technologies paradigm (encompassing biotechnology, in particular genetic engineering, nanotechnology and 'BANG' technologies) is pushing out the last remains of interconnected ecological paradigms in science by redefining living organisms and biodiversity as 'man-made' phenomena valued by its potential

to return a profit. However, we argue that Western reductionist scientists are not fully prepared for unintended consequences resulting from the manipulation of the parts to influence the whole.

The framing and language of western reductionist science

Along with the philosophies and ideologies of western reductionist mechanistic science, the framing and language of science has been critical in the promotion of emerging technologies such as nanotechnology and biotechnology. The manipulative framing and use of language within this scientific paradigm has been working to ensure government and consumer "buy-in".

Scientists' use of language and their choice of terminology in articulating science is often highly strategic. According to Keller, scientists are language-bound. She states; "The words they use play a crucial (and, more often than not, indispensable) role in motivating them to act, in directing their attention, in framing their questions, and in guiding their experimental efforts. By their words, their very landscapes of possibility are shaped" (Keller 2000, 139). Keller describes here how scientists are themselves limited, directed, and guided by the words that they use to think, analyse and describe problems, processes and results of research. An illustration of this is the genetic modification arena which has fostered and been shaped by a new language. The discourse using this language privileges the gene because of its ascribed function. Genetic engineers seek and patent "functional" or "instrumental" knowledge, driven by the notion that knowing how things work will logically lead to ability to make them work more efficiently. This bio-technological goal has shaped molecular biology and transformed its scientists into engineers and entrepreneurs. Identifying and ascribing a function to a particular gene, no matter how faint or weak a connection, is a shrewd and strategic scientific endeavour that can lead to a new viable area of study and investment and thus access to research funding.

Language is also used to perpetuate the status quo, where some older discourses are replaced or transformed. Language can be powerful in reproducing certain institutional forms and hegemony, where "older" or "pre-existing" scientific areas are redefined using more sanitised contemporary language that factors in the positive

connotations of “progress” or downplays any inherent “danger.” Gottweis observes that this “progress talk” is a counterstrategy employed to defray resistance, such as in the debates around genetic engineering. "Social resistance against genetic engineering was met by counterstrategies seeking to establish a framing of biotechnology as an articulation of progress and modernization" (Gottweis 1997, 79).

The language of “risk” is a powerful example of how science is defined and articulated. A number of authors have written on the pervasive nature of risk discourse, including Beck (1992), Crook (1998), Douglas and Wildavsky (1982), Leiss and Chociolko (1994), and Winner (1986). Winner notes "One's initial definition of the problem helps shape subsequent inquiries into its features" (Winner 1986, 152). The choice of the word “risk” in biotechnology and nanotechnology research tends to imply that the chance of harm in question is accepted willingly in the expectation of gain. However according to Winner, “this disposition to weigh and compare is not invoked by concepts that might be employed as alternatives to 'risk' - 'danger,' 'peril,' 'hazard,' and 'threat.' Such terms do not presuppose that the source of possible injury is also a source of benefits" (Winner 1986, 149). Crook raises another problematic aspect related to risk, that of how to articulate risk discourse itself. “The rhetorical battle over the cultural riskiness of biotechnology and nanotechnology is fought along two main axes, one running between “natural” and “unnatural,” the other between “old” and “new.” If “new” and “unnatural” are both risky, it is important to its proponents that biotechnology should not be seen as having both characteristics at once. The ideal, but perhaps implausible, strategy would be to position biotechnology as both “old” and “natural” (Crook 1998, 141).

In any event, when decision makers are faced with uncertainty and possible “risk,” Winner suggests the result is, "prudence becomes not a matter of acting effectively to remedy a suspected source of injury, but of waiting for better research findings" (Winner 1984, 144).

And if Maori say no, what then?

Ultimately Maori, and other Indigenous peoples, have found that Western reductionist science takes precedence over any resistance to new technologies. Donna Ngaronoa Gardiner sees this as symptomatic of the arrogance of Western reductionist science.

> In the event of a community saying no to the experiments, Western scientists view that resistance as being based on ignorance and misunderstanding of the projects aspirations. These attitudes reflect beliefs about western racial superiority – that western science knows best – even if the subjects of that science do not consent. This is also a symptom of arrogance and the belief that any innumerable number of experiments can be undertaken in the name of science. The fact that Indigenous populations may not consent because of a fundamental difference in world view is of little consequence to unscrupulous companies and scientists. (Gardiner 1997, 54)

Conclusion

The question that immediately comes to our minds with nanotechnology is, 'why are we being pushed down another one-way road?' The New Zealand public are not being given any choice in whether New Zealand will engage with nanotechnology. The decision has already been made for us. The government and main research funding body in New Zealand, the Foundation for Research Science and Technology, have already indicated significant investment now and in the future in nanotechnology.

We are a little short on hope as to how effective our collective voices can be in stemming the overzealous and reckless rush toward high cost technological development. We (Maori and other Indigenous peoples) have been here many times before. Over and over again our concerns have been voiced. Over and over again our concerns have been marginalised. When we hear comments of the sort voiced at a recent symposium on nanotechnology that describe the technology as 'tools' that are neutral, with little regard for the political economy that these tools operate within, we know that we are not being heard.

The 'McScience' of reductionist western science such as biotechnology, genetic engineering, and nanotechnology, has evolved from a strong colonialist ideology of, "we know what's best for the rest." This type of arrogance also applies to the types of applications utilised such as genetic engineering and some nanotechnologies, where "man" (because it often is a man) wields control over nature, where "man" believes in

the seeming immortality of humans, and “man” believes that profit takes precedence over everything else.

So how do we move forward to ensure our views and concerns as Treaty partner, as indigenous peoples, as kaitiaki, as parents and grandparents of our future generations, around new technologies such as nanotechnology are heard?

As hollow and naive as this statement may sound, we believe that there may be an opportunity here for Maori to be proactive on voicing their opinions and views around this new technology. As a fledgling technology, we are in a position as Treaty Partner (not to be subsumed as one of many public interest groups) to be able to influence the direction of nanotechnology applications and provide sound advice, learnt first hand from our disastrous experiences and engagements with the development of genetic engineering applications, on the appropriateness of the different application areas. Central to any developments of this new technology is the urgent need to conduct studies that outline the impacts of nanotechnology, with particular focus on social, health and environmental impacts. It is incumbent upon us as Maori and Indigenous peoples to stand up and be heard. Our tupuna are counting on us.

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[i] Others includes Australia, Canada, China, Eastern Europe, the Former Soviet Union, Singapore, Taiwan and other countries with nanotechnology R&D. For example, in Mexico there are 20 research groups working independently on nanotechnology. Korea, already a world player in electronics, has an ambitious 10-year programme to attain a world class position in nanotechnology.

[ii] Cram 2001, Gardiner 1997, Hutrchings, 2004a, Hutchings 2004, Reynolds 1999, 2004, 2005, Mead 1997, Smith 1999.

[iii] It is important to differentiate that not all forms of science purport a reductionist worldview with the more holistic sciences being the exception. For example ecology acknowledges the interconnectedness between living organisms and their ecosystems and supports the diversity of whole ecosystems as living.

Bionanotechnology is a science that sits at the convergence of nanotechnology and biology. Nanobiology and nanobiotechnology are other names that are used interchangeably with bionanotechnology. The field applies the tools of nanotechnology to biological problems, creating specialized applications.Â The field of biotechnology is focused on basic research into the mechanisms of disease toward the development of new therapeutic and diagnostic devices. Bionanotechnology applications within biotechnology include the development of microfluidic devices for high throughput drug discovery assays, nanotechnology-based drug delivery devices, genome sequencing, proteomics, and imaging. One example is the use of nanoparticles for drug delivery. Nanotechnology (or "nanotech") is the use of matter on an atomic, molecular, and supramolecular scale for industrial purposes.Â Nanotechnology may be able to create many new materials and devices with a vast range of applications, such as in nanomedicine, nanoelectronics, biomaterials energy production, and consumer products.Â In 2006, a team of Korean researchers from the Korea Advanced Institute of Science and Technology (KAIST) and the National Nano Fab Center developed a 3 nm MOSFET, the world's smallest nanoelectronic device. It was based on gate-all-around (GAA) FinFET technology.[30][31]. Over sixty countries created nanotechnology research and development (R&D) government programs between 2001 and 2004. Nanotechnology, Biotechnology, Information Technology, Cognitive Science (NBIC). Last Updated: January 25, 2017.Â Cognitive science applies in various ways to IT-related research and the pursuit of items such as technologies that map the brain. Proponents of this kind of development argue that using converging technologies, or NBIC principles, can enable the human populations of the future to be stronger, healthier and more capable overall. These ideas often relate to the idea of "singularity" which posits the emergence of artificial intelligence, and a point where technologies approach the human mind in terms of simulation, collaboration or other outcomes. Are you missing out when it comes to M Biotechnology, along with information technology and nanotechnology, are essential for innovative development of modern economy. Currently there is a growing need for organizations that can provide scientific support to major biotechnology projects and coordinate research activities, as well as to work out programs for the scientific and technological development of the biotechnology industry.Â The strategic goal of the Center that integrates resources, facilities and experience of the Russian leading research institutions in the field of biotechnology is to create scientific and technological basis for bioeconomy development.