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Contents

OUR FUTURE
Navigating complexity - its hard work!

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The New Zealand Futures Trust (Inc),
P 0 Box 12-008,
Wellington.
Contact person: Yvonne Curtis (04) 383 5080
e-mail: info@futurestrust.org.nz
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Yvonne Curtis

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Hard Work

Wendy McGuinness

What do we really mean by 'hard work'? As the authors of Accounting for Mother Nature (Anderson et. al, 2008) note, in the broadest sense, economic activity depends on inputs from only two sources: the wealth of nature, and human ingenuity and effort. New Zealanders may be wealthy from sources of nature, but are we wealthy in terms of ingenuity and effort? Is our oft-touted 'Number 8 Wire' innovation a cultural myth? Historically, New Zealand was built on hard work, but what does 'hard work' mean in the context of scarcity of natural resources, an aging and increasingly obese population, increasing cultural diversity and global warming? This Think Piece explores a changing labour force, and what this means for New Zealand's long-term strategy.

The Thing About Life Is That One Day You'll Be Dead (Shields, 2008) provides the reader with no doubt as to the certainty of the outcome for each of us. It does, however, suggest to the reader that it may be timely to contemplate our existence in terms of humanity. There is considerable debate over when we can count our early predecessors as human; estimates suggest that that point occurred some 50,000 years ago, making the total number of humans who have lived in the vicinity of 100 billion.

In today's terms, 93 billion have died and we represent the nearly 7 billion currently still breathing. In New Zealand, we are part of the 4 billion living on more than US$2 per day (see Think Piece 4). Less than half of this 4 billion are financially and physically independent, meaning that we are part of the 2 billion people that have the time and money to make a difference. Putting it in context, this makes us part of the 2% of the total human population to date that can make a difference now. It is our time to contribute.

As to our location on the evolutionary path, one speaker at the 2008 World Futures Conference discussed the concept that we are entering 'adolescence' – with all the trials and tribulations of facing reality. The time when Mother Earth provided abundantly for our inexhaustible wants and needs is now over, and we are learning that it is our time to make hard choices and learn important lessons about our future – which brings me to the point of this Think Piece - the 'hard work' ahead.

To the rest of the world, New Zealand will increasingly seem to be the bounty in a resource constrained world. New Zealand is a relatively young country, but a relatively old inclusive democracy (New Zealand being amongst the first to adopt Universal Suffrage). We are 'natural resources' rich; we have abundant arable land per capita, an extensive coastline, large fishing grounds (EEZ) and territorial sovereignty over an area of Antarctica known as the Ross Sea Region (which is 17 times the size of New Zealand). In short, New Zealand benefits from a small population, and a resource-rich territory. We will further explore our natural resources in a report and Think Piece later this year. To summarise, New Zealand will become increasingly the pearl in the Pacific and the Pacific will increasingly be a sanctuary in a dangerous world.

But we also have internal changes that we must consider and manage. We have an increasingly culturally diverse society with projections indicating that by 2058 we could see a reduction in 'European and other' population by

Wendy McGuinness is the chief executive of Sustainable Future, see www.sustainablefuture.info an organisation whose key project is currently Project 2058, which involves exploring and developing a strategy for New Zealand's long-term future. Wendy is a Chartered Accountant who has worked in both the public and private sectors. More recently, she has moved from risk management into futures and has joined the NZ Futures Trust Board for the next two years.

20%, with the reduction being taken up by Asian, Pacific and Maori, in that order. Within this dynamic, we are facing two demographical challenges. Firstly, we are getting older. Over the next 50 years our population will increase only slightly but we will be living longer, resulting in a significant increase in our median age from 36 to 44 years of age.

Secondly, we are getting bigger. A staggering 63% of New Zealanders are currently overweight or obese. An unhealthy, aging population is a serious concern, considering that our workforce sits in the top third of the OECD, in terms of average number of hours worked per week.

Based on the above, we believe New Zealand not only has 'hard work' to do, but that the term 'hard work' needs to be redefined.

Hard work will no longer be about the sweat on the brow, the long day's work or the number of gadgets produced. It will increasingly be about tackling hard complex issues, standing up for rights, supporting those that do not accept the mediocre - such as the whistle blower, identifying diverse options, creating space for dialogue, being patient, adopting principles such as 'polluter pays' rather than making rules, policing rigorously, demanding transparency and doing what is best for the country–now and in the future.

From a human resources point of view, the challenges for employers and, more precisely, the human resources profession is to select, employ and improve 'ingenuity and effort' in the workplace. To this end, we support the joint New Zealand Council of Trade Unions and Business New Zealand project 'Te Huarahi mo ngā Kaimahi' which explores a vision of the future workplace–one that is high-wage, high-value, highly skilled and sustainable.

Redefining hard work and improving employment practices is a global problem: one that is brilliantly articulated by Malcolm Gladwell (author of The Tipping Point and Blink) at the New Yorker 'Stories from the Near Future' Conference held in May 2008. Gladwell provides a very entertaining talk on this issue, discussing the 'mismatch' between the skills we use to hire and the skills that are necessary to complete the job. In other words, an effective policeman may not be a fit, tough, strong guy, but a quiet thinker who communicates well. Similarly, Stephen R. Covey argues in 'Leading in The Knowledge Worker Age' (in The Leader of the Future 2, 2006) that our management practices have changed little since the Industrial Age, with people still being viewed as expense within the Profit and Loss Account and machines being assets in the Balance Sheet. Our challenge seems to increasingly be on the need for people: people with attitude, people with confidence, people with patience, people who care, people who can listen, people who can think and people who communicate.

What that means in practice is that we need to ensure that the skills we use to hire fit the current and future needs. For example, the move from an oil company to an energy company means that to be effective they need staff that can work in teams, can communicate with a wide range of stakeholders, are skilled at analysing complex issues, capable of exploring innovative solutions, are flexible to move between large numbers of alternative energy sources and have the ethics and clarity of purpose to do all of the above in the public interest.

This is clearly a challenge for business, due to the responsibilities that are perceived by many as beyond their duty–but others see it differently. William R. Blackburn in his recent book, The Sustainability Handbook (2007), argues that because the three overarching areas of sustainability have both internal and external aspects, the survival of organisations is dependent upon the long-term survival of the communities in which they operate. According to Blackburn, it is vital for organisations to move beyond their internal silos to understand, be part of, and help improve the external world upon which they depend. This means a move from the internal to the external as reflected by the dotted line in Figure 1 below.

Figure 1 (below) Examples of Internal and External Aspects of Sustainability

Source: Blackburn William R. The Sustainability Handbook (2007). Cornwall: Earthscan, p.28. (Dotted line added).

New Zealand will increasingly be faced with high levels of complexity and uncertainty. In our view, this can be countered by ensuring New Zealand develops more clarity and certainty over its long-term goals and objectives. At Sustainable Future, we believe this can only be obtained through a national strategy – which is not a plan, but a way of developing consensus about who we are, what we do not want, what we want and how we think we should get there. Regardless of whether people work independently or together, as long as we are all working towards the same goals, we believe we can make a great country exceptional.

This article has been adapted from the Sustainable Future Think Piece, Hard Work (September 2008). This Think Piece and others are available from www.sustainablefuture.info

TBL COMPONENT	2R'S COMPONENT	INTERNAL (COMPANY) ASPECT	EXTERNAL (SOCIETAL) ASPECT
Economic	Wise use of economic resources	Achieving economic success of company	Achieving economic prosperity of society
Environmental	Wise use of natural resources	Leaving enough resources to meet current and future needs of company	Leaving enough resources to meet current and future needs of society
	Respect for living things	Treating things with respect within company operations (e.g., respecting animal rights)	Protecting ecosystems so living things can survive in the environment
		Preventing and controlling pollution within company property (sometimes considered social sustainability)	Preventing controlling pollution of the external environment
Social	Respect for people	Respecting the needs of people inside the company	Respecting the needs of people outside the company

Figure 1

Navigating Complexity Adaptive Leadership and public participation

Anne Pattillo and Cath Nesus

These are changing and complex times in which we live. They are times where we need to pause and rethink about how we do business within the realms of government and corporations. To consider how we keep pace and keep ahead of change to fully meet the challenges and opportunities that change and complexity bring.

There are a range of factors which contribute to these changes and complex situations:

- Times are changing because 21st century New Zealand is more diverse than ever before across a range of dimensions such as ethnicity, culture, family structures, levels of assets and incomes. It is compounded by the effects over time of changing demographics, global trends and developments.
- Times are changing because as consumers, we are quicker to assert our rights. We expect to have more influence over decisions that affect our choices of where to invest and what to consume, and in decisions about what services we receive from both the public and private sector.
- Times are changing because we are no longer untouched by what is happening in the rest of the world. Global issues such as climate change and the current economic crises have and will continue to have a significant impact on New Zealand and on our daily lives.
- Times are changing because of the significant impact of information technology. The public has greater and faster access to information than ever before. We can access participation websites and participate in processes to inform decisions, in many fora and on a wide range of issues.

Complexity emerging from these changing times means that we can no longer expect leadership to be exercised in the same way as it always has been. Doing more of the same or doing it better is not a substitute for responding to complexity.

These times call for a different style of leadership. They require a critical shift to new approaches which will support decisions to be made in a different way. Approaches which are future-proofed, which build resilience and adaptability, and which share the responsibility of problem solving and exploring solutions with others.

Different leadership skills and new approaches

Different leadership styles to decision making require a different set of leadership skills. Leaders must be adaptive and flexible so they can plan for change rather than continue to respond. They must recognise that what has worked in straightforward situations before is unlikely to provide resolutions in complex situations.

A different approach to decision-making requires leaders to bring others into the problem solving process. To work in a collaborative and facilitative way with people outside their organisations who will bring diverse views and experience to apply to resolving complex problems.

The authors of *Getting to Maybe: How the World has Changed* consider leadership in complex times as: [1]

> *.....accepting that certain aspects of our work are inherently unknowable. It means accessing the wisdom in our communities, rather than being the 'Big Brain' leader who provides the wisdom. It means not beating up on ourselves when we can't figure something out. Leadership in complexity requires different skills than traditional models of leadership. It requires us to think of leadership as inquiry, and this in turn means that we need to think much more critically about the kinds of questions that we ask. It may not be the answers that need changing, but the questions.*

Collaboration to solve complex problems presents exciting prospects for communities to build new and strengthen their existing capabilities to fully engage in problem solving. They bring their experiences and expertise to unlock the connective tissue of the problem, to find out what works, to learn from what works best and put these learnings into practice. The emphasis is on finding solutions rather than cutting deals.

As a nation, this collaborative approach enables a rich description of the future we seek to have. It will set measures to guide choices and decision making. Complexity will be embraced with the development of sensible and sustainable solutions. It establishes a shared responsibility in which the solutions and the problems will be owned by many.

Public participation in decision making

A collaborative approach to decision making has public participation at its core. Here we profile a range of the diverse techniques and approaches to participation that supports public participation in problem solving and decision-making.

Internet

The Internet has changed the way that we deal with information and connect. If people want to know how to get involved in decision making there are numerous ways that this can happen using the Internet.

It hosts websites which focus on public participation in many forms. For example, mySociety.org is described as a democracy website which builds websites that 'give people benefits in the civic and community aspects of their lives'. In doing so, it has built websites that provide information to the public to enable them to keep tabs on British MPs, to report problems in their streets or to petition No 10 Downing Street.

Very useful links to participation websites:

www.iap2.org
www.iap2.org.au
www.activedemocracy.net
www.deliberative-democracy.net
www.mySociety.org
www.thataway.org

Anne Pattillo and Cath Nesus are members of the pattillo team (www.pattillo.co.nz) who offer advice and training for businesses and communities seeking new participatory ways of working.

Crowdsourcing brings people together in a collaborative effort. Its purpose is for a collective of individuals to complete business-related tasks that a company would normally either perform itself or outsource in a third-party provider. They often do so without meeting each other in person.

Deliberative Democracy

Deliberative democracy is an approach that is successfully being used in Australia, North America and many other parts of the world. It is not a new process but one that originated from Athens in the 5th century B.C.

Its key feature is that participants are generally selected randomly; they may not know each other and may not have any association with the problem at hand. They are brought together and given space to think, discuss and analyse the problem resulting in a collective solution and outcome to the problem. It requires leadership to trust that this process does work and have confidence that the participants will find solutions.

Using this participatory approach brings a range of people and views into the process. The problem undergoes critical thinking and will be considered from a range of perspectives. The solutions will be well considered and are likely to be innovative with participants sharing responsibility for both the problem and its solution.

Deliberative democracy has a good fit to decision making around complexity. It involves people at its centre who can and do influence decisions and in doing so makes a critical shift from the consumer back into the community. We need to build these practices into our everyday expectations of leaders in New Zealand. And there is no reason why we can't – the foundations are already there, we are a single state, a small country with a small population so we are well placed to use this approach to resolve our complex problems.

International Association for Public Participation (IAP2)

The IAP2 is an international organisation that promotes the values and best practices associated with involving the public in decisions that affect their lives. In New Zealand there are many public and private sector organisations successfully using the IAP2 approach to engage with the public.

INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
Provide balanced and objective information to the public to assist with their understanding of the problem	Obtain public feedback on analysis, alternatives and/or decisions	Work directly with the public throughout the process to ensure that public concerns and aspirations are understood and considered	Partner with the public on each aspect of the decision including the development of alternatives and identification of the preferred solution	Public makes the final decisions

IAP2 uses a five-step spectrum to build a comprehensive participation plan which will guide the participation process. It is comprehensive because:- it gives a full range of information about the participation process, it clarifies the problem, it identifies who will participate both through conversations and formal participation, it identifies any issues related to the problem and the level of participation that is required. Importantly, it requires an internal commitment from the organisation up front about the process and identifies who will be making the final decisions once participation has been completed. Unlike the Deliberative Democracy approach where participant selection is random, IAP2 focus on the publics and/or stakeholders who are perceived to have an interest or are likely to be affected (directly or indirectly) by the decision.

The unique feature of this process is the Public Participation Spectrum which provides different levels of participation appropriate to the decision and the engagement expectations of the sponsoring organisation and the publics. Techniques are varied and matched to the decision and stakeholder.

Framework for Wicked Problems

Of particular interest is the Wicked Problem Framework. It has been designed specifically for complex problems within a policy context. It recognises that the current policy framework is well suited to straightforward issues but that it struggles to respond to the increasing challenges around solving complex problems.

It acknowledges that it is not easy to navigate complexity, let alone find solutions for them, and that once we start exploring the problem, certainty becomes less certain. We know that solutions to these problems are likely to need multiple responses. And we know that we need participation from others to work through the complexity to solutions and decision making.

Collaborative work is the cornerstone of this framework with an emphasis on finding successful solutions and making sound decisions. It brings together participants to solve the problem with permission to probe, explore, test and create. Stakeholders are invited to participate who have diversity of skills, expertise, understanding and interest as the basis of selection.

Depending on the problem, the participant group may comprise community and/or business stakeholders and practitioners, government/private sector representatives — all those that have a stake in the outcome. Different contribution may be needed as the problem evolves and becomes clearer so that the 'membership' of this group is not necessarily fixed — new participants may join while others may be required for discrete aspects of the problem solving process.

This framework is becoming more important and relevant to the policy sector – to navigate ways in which the collective effort of many can be applied to reach practical solutions for increasingly more complex policy problems.

Summary comments

In these changing and complex times we need to rethink about how we do business and how decisions are made. These times call for a different style of leadership with leadership skills which are future focussed, adaptive and flexible.

Leadership must be balanced with new approaches to decision making. They must be grounded by engaging the public in ways which enable people to work in a collaborative and facilitative way to find solutions to complexity. Views and experiences are applied to the problems which result in innovative solutions that are informed by this diversity and richness. Participation instils a sense of ownership in the process and a shared responsibility for both the problem and the solution.

OBITUARY

Diane Campbell-Hunt

1 May 1952 – 7 October 2008

Diane Campbell-Hunt was one of New Zealand's few futurists. Diane was involved in researching, documenting and helping to determine the long-term future of New Zealand all her adult life.

She was one of the researchers who worked for the short-lived government think-tank, The Commission for the Future, in the late 1970s when the concept of long-term future planning was briefly officially accepted in New Zealand. Diane continued her interest in futures thinking and as family commitments allowed she was an active member of the New Zealand Futures Trust over many years. She served on the NZFT Board from Aug 88 - May 92 and Nov 98 - Oct 03 and during the latter period Diane was the leader for two major projects for NZFT. These resulted in the UNESCO Cultural Futures Kit, published in 2000 and distributed at no cost to all secondary schools and a report, "Visions for the Future - What New Zealanders Want", based on a futures analysis of the postcard responses of nearly 8000 people to a letterbox drop New Zealand Post Competition in 2001.

During Diane's time in Wellington she was involved in many other groups and in particular, just before she left Wellington, she wrote a history of the establishment of the Karori Sanctuary, in part as a hand book for other groups wanting to set up similar sanctuaries in the future.

When the Campbell-Hunt family moved to Dunedin early in 2003 she continued her interest in environmental sanctuaries and became a key figure in the establishment of the Orokonui Ecosanctuary. At the time of her death she had begun studies for a PhD on the challenges facing community-driven biodiversity projects.

Her passion was to create sustainable, livable environments for communities and she honed the skills needed for this task and used them wisely to make a difference wherever she went.

As Robin Gunston (a past chairperson of Futures Thinking Aotearoa) writes in his tribute to Diane:

I first met Diane when she and I served on the Committee of the Strategic Management Society back in 1999. She immediately impressed me as someone who had a creative but very long term focus to everything she did, and we immediately clicked because of our experience of using scenarios for long term planning.

Acting as MC at her 50th birthday party I became more aware of Diane's immense circle of interests and the way she influenced many organisations with her thought processes and her activism - she did not just think, she carried out her actions.

Diane died tragically whilst in the outdoors, a place she loved and knew much about. Her place in the future of NZ has been secured by the many positive things she initiated in many differing organisations. We extend our affections as futurists to Colin and the rest of the family at this time of their loss.

Yvonne Curtis

Navigating Complexity Continued

Anne Pattillo and Cath Nesus

There are public participation processes that are well suited to working through complexity. Of particular interest is the Framework for Wicked Problems which has been developed specifically for complex issues. It has a distinct participation process embedded in the framework which connects participants to the problem and the solution. It also recognises that participants may change throughout the process depending on the expertise needed at any given time.

Taking the step towards change requires leaders to be courageous, and to share problem solving and opportunity taking with people to produce sustainable decisions and solutions.

[1] *Westley, F. Zimmerman, B. Patton, M. Getting to Maybe: How the World has Changed (Random House 2006)*

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An information service on current, international perspectives on our futures, prepared by futures scanner **Jennifer Coote.** *Annual dates in last two digits.*

FUTURE WATCH

ECONOMIC/BUSINESS

The Meltdown

G. Soros, The New Paradigm for Financial Markets: the Credit Crisis of 2008 and What It Means, Public Affairs, 08, argues that three trends were contained in the current super-bubble. A long-term trend towards ever-increasing credit expansion, globalisation of financial markets and the progressive removal of financial regulations. Underlying this is the belief that markets tend towards equilibrium, even as each "bubble" is misinterpreted and the problem intensifies. A sounder theory utilises reflexivity, the relationship between thinking and reality, leading to the following conjectures:-the sixty year period of credit expansion centred on the US has ended; regulators will regain control over banking and investment depending on the severity of the crisis; global contraction of credit depends on the countervailing influence of China, India and some oil states; US power has declined dramatically through poor political leadership, and this will be reinforced by a US recession; a great period of uncertainty and destruction of financial wealth will result before a new order emerges.

London School of Economics Professor **R. Wade**, *Challenge July-August, 08*, examines the first-world debt crisis of 2007-2010 and suggests some regulatory responses. Financial firms need to be on the same footing as drugs, tobacco and explosives. A global norm is required which positively correlates debts with ability to repay. New financial instruments such as GDP-linked bonds could be devised. The Basel 2 capital equity accord could be hard-wired into a counter-cyclical capital requirement and Basel 3 should shrink the scope for self-regulation and require governments to tax the banking system. International Accountancy Standard 39 needs to be revised to remove pro-cyclical effects. A change is needed in global norms to permit capital controls on inflows and outflows either in the form of quantitative restrictions or taxes. National financial regulation, especially for the US, needs to be joined up and a wider range of organisations brought within the regulatory scope, especially hedge funds and investment banks. Banks need to be mandated to backstop the financial system in a crisis and also curb the momentum towards a crisis. Overall the banking and finance sector should be reformed to create a mixed economy with some financial firms having a large component of public ownership or public guarantees. Finland and France provide models with their co-operative banks. If the costs of capital rise as result, that reflects that it also carries risks.

US venture capitalist **E. Janszen**, *The Independent (NZ), 21 August, 08 pp 6-7*, argues that the present US government policy could stimulate another bubble in an economy dominated by the finance, insurance and real estate industries (FIRE), even as it lowers taxes which would finance needed infrastructure development and the economy as a whole. He argues in a forthcoming book **The New New Deal: Re-industrialisation of Post Depression America**, that the way out of the current stagflation is to remove the government subsidies to the FIRE sector. The resulting funds should be applied to tax cuts to boost the productive, innovative capacity which will benefit national exports and regain a productive place in the global economy.

Rogue Economics: Capitalism's New Reality, L. Napoleoni, Allen & Unwin, 08. An Italian economist and money laundering expert examines the black and criminal markets and unregulated grey area. That these flourish in times of political upheavals, was illustrated in the E. European transition time around 1990. The operations of this underworld are hidden by the official illusions of the "market matrix."

Economic Ideas

Common Wealth: Economics for a Crowded Planet, J. D. Sachs, Penguin/ Allen Lane, 08. To achieve a sustainable use of energy, land and resources humanity must evolve to meet the challenges ahead. Stabilizing the global population is a major plank. Sachs surveys the statistics, the challenges and the global institutions, and offers optimistic strategies, utilising both technologies and human co-operative effort. The Millennium Development Goals are vital in the elimination of poverty, and fundamental to social stability.

Future Directions for Heterodox Economics. Eds J. T. Harvey, R.F. Garnett Jr, Univ of Michigan, 08. Two US academics provide studies of the many theories and communities of practitioners of the alternatives to mainstream economics. These include:- ecological, feminist, Austrian, Marxian-radical, institutional evolutionary, Post Keynesian and social economics. While standard economic theory has become more concerned with simplified assumptions such as perfect competition and can be criticised for becoming divorced from the real world, most heterodox economists are concerned to make the world a better place.

J. Madrick, *Challenge, Nov-Dec, 07*, examines the contribution of prevailing economic theory which has contributed to the diminished role of government in economic growth. For an economy to work well for all, government needs to retain a vigorous presence. A richer theory of economic growth, which is demand-led, would include high levels of public investment in public goods such as universal, early education; self-sufficient energy supply and improved transportation, a reformed and improved health service, and support for full employment and minimum wages.

B. Gates, How to Fix Capitalism, *Time, 11 Aug 08*, enthuses that capitalism has improved the lives of billions of people, but has left out billions more. It will take too long for governments and non-profits to overcome this unless corporations, by becoming creative capitalists, pitch in. This stretching of market forces is already operating but with a nudge from activists such as Bono, more can be done. Corporations can find opportunities such as innovative systems using cellphones in Africa, or they can be facilitated by non-profits and governments.

Mobilizing Science-based Enterprise for Energy, Water and Medicines in Nigeria, US National Academies and Nigerian Academy of Science, 08 reported *Science, 25 January 08, p 385*, examined the potential for a sustainable approach to supplying basic services by encouraging private companies to become involved. Business models, cost estimates, and the potential for the local market to gear-up to supply equipment were examined. It was concluded that business could supply such resources as small-scale photovoltaic systems, low-cost water filtration systems and

malaria drugs, while operating profitably. Government incentives and educational campaigns, plus a shift in the strategies of donor organisations, are required.

Creating a World Without Poverty: Social Business and the Future of Capitalism. M. Yunas, Public Affairs, 07. The founder of the Grameen bank argues that unfettered markets have failed to solve social problems and may exacerbate social ills, while non-profits cannot be expected to fill the gap. Another capitalist structure is needed; a business which is set up by entrepreneurs less for personal gain than for specific social goals. The bottom line for such a business is to operate without incurring loss while serving the people and the planet. Two kinds are possible: one which provides a social benefit such as poverty reduction, or health care, and a profit-maximising one which is owned by the poor or disadvantaged, not necessarily for social benefit.

Just Another Emperor: The Myths and Realities of Philanthrocapitalism, M. Edwards, Demos/Young Foundation, 08. A leading development analyst takes a critical, comprehensive look at this innovative approach which is likely to be highly influential. The hype runs ahead of the ability to deliver results and merges civil society with business thinking, undermining democratic politics.

Two leading UK researchers and academics connected with the Royal Society for Encouragement of the Arts, Manufactures and Commerce, **M. Prescott, M. Taylor**, *World Policy Journal, Spring 08*, argue for a policy of personal restriction on carbon emissions to complement industrial cap-and-trade emission policies in the EU. Each citizen would be allowed an equal number of credits which could be surrendered electronically for the purchase of fuel and energy. Those using less could trade with those needing more. Such a proposal would be better applied in local communities than across international borders. It is an educational device which would need to be flexible and encourage learning and experimentation.

Listings

The China Price: The True Cost of Chinese Competitive Advantage, A. Harney, Penguin, 08. This financial journalist's analysis of the way China had become the workshop of the world to the immense benefit of billion of its people also shows the downsides, socially and environmentally. Some of China's advantages are eroding with rising wages and material costs, a dwindling supply of cheap workers, stronger calls for product quality and safety, along with downward pressure on profit margins. Some business circles are devising a China-plus one strategy with another country as hedge for additional operations.

Making Monetary Mischief: Using Currency as a Weapon, J. Liss, *World Policy Journal, Winter 07/08*. Though rarely talked about, this method for maliciously creating political turmoil, especially against an emerging country, hovers in some international dealings. It has been used, notably in Nigeria's civil war against Biafra, 1967-70.

ENVIRONMENT

Climate Change
The Nitrogen Cycle

Nature 17 Jan 08, Special Feature to mark Year of Planet Earth 2008, a joint initiative of UNESCO and International Union of Geological Sciences, environmental scientists **N. Gruber, J. N. Galloway**, examine an earth-system perspective on the global nitrogen cycle, the critical relationship between nitrogen-carbon-climate interactions, and the question of how availability of nitrogen will affect the capacity of Earth's biosphere to continue to absorb carbon from the atmosphere. The expected population increase is likely to double the turnover rates of the nitrogen in the Earth's systems, with consequent acceleration of eutrophication of terrestrial aquatic systems, global acidification and stratospheric ozone loss. Already data from Earth's past records indicates that human impact on these systems has pushed into territory never seen on Earth for 650,000 years. Already it is clear that the potential huge impact must be limited by reduction in burning fossil fuels.

Forests

In June 08 scientists and policy makers were to meet and work out how to manage the world's tropical forests, *Nature, 6 March 08, pp 8-9*. The Bali Climate Change agreement late 07 had placed deforestation on the agenda for a future global warming treaty. Old divisions emerged over whether to integrate forestry issues into a cap-and-trade emissions agreement, or to treat forestry separately through government programmes. Questions arise as to whether markets are suitable mechanisms for such forestry conservation. Sceptics are especially concerned that developed nations can pay forestry credits and do little to reduce their forestry consumption. Developing nations such as Brazil and Indonesia want firm commitments backed with adequate resources, to conserve their forests instead of making profits from them.

F. Pearce, *New Scientist, 11 Dec 07, pp 40-43* reports that in parts of Indonesia where tropical forest has been cleared to create vast palm-oil plantations, a rich release of greenhouse emission is resulting as great peat bogs beneath the forest are drained. It is estimated that about 30% more such gas is released than might be saved by the plantation. Further environmental hazard is created if the peatland is fire-cleared, because the resulting brown cloud swathes much of S.E. Asia, contributing to Himalayan glacier melt.

Our Forests, Your Ecosystems, Their Timber: Communities, Conservation, and the State in Community-Based Forest Management, N. K. Menzies, Colombia Univ. Press, 07. It is estimated that in 2002 some 11% of the world's forests were under some form of community-based ownership. This study examines several of them in China, Zanzibar, Brazil, India, Mexico, Nigeria, Quebec and Oregon. Here, the relationship between states, communities and other interests are reconfiguring sustainable use and environmental protection with ethical concerns for social justice, human rights, local interests and improved livelihoods.

Climate Change and Forests: Emerging Policy and Market Opportunities, Eds C. Streck et al, Brookings, 08. This wide range of scholarly contributors argues that forests are one of the sectors less regarded in the policies to combat climate change but they offer one of the cheapest mitigating options. An effective post-Kyoto agreement must include a comprehensive accounting system which establishes incentives to reduce emissions from deforestation.

Asia

The Himalayas, the largest store of global ice after the Poles, are melting fast, as 82% of the glaciers have retreated in the past half-century, *Nature, 24 July 08, pp 393-396*. Rising temperatures have been increasing here three times as fast as for the planet overall. At the current rate over 60% of the glaciers will be gone by 2050. Retreating glaciers leave residual lakes behind dams of debris, creating major natural hazards. Of greater long-term concern is the eventual catastrophic fall in the melt water which feeds the major river systems which run though to China, S.E. Asia and Asia. The alpine ecosystems will be severely degraded as the permafrost becomes unstable in higher temperatures, releasing far more greenhouse emissions, while there is suggestion that warming could severely weaken the annual monsoon. Much more data is needed.

The Economist, 7 June 08, pp 27-30, reports that China and India are beginning to

face the realities of climate change and the need to develop and implement plans to meet the challenges, as studies suggest that they are rising to the top of the list of climate change emitters. Both have released policy plans, with China in particular, attempting to reduce fossil fuel consumption and boost use of renewables. Both have success with recent home-grown alternative energy-companies.

Updates

F. Pearce, M. Le Page, *New Scientist, 16 Aug 08, pp 26-30*, report on shorter range forecasts on climate change effects for the next decade. Based on underlying trends of warming caused by increases in greenhouse gases, there are likely to be fluctuations because the oceans take a long time to heat up and to cool down. They are crucial because they store so much heat. Droughts in Australia could be due to the persistently low sea surface temperatures north of the continent, which may be the result of the changed phase of the El Nino-Southern Oscillation, which may have a long term moderating effect on rising temperatures. A similar Oscillation in the Northern Pacific, the Pacific Decal Oscillation, (PDO) has changed its phase since the late 1970's and may also be contributing to prolonged droughts. The rapid warming in the Arctic recently may be strongly influenced by another Oscillation in the N. Atlantic, which changed phase in the 1990s, affecting the rainfall in the Asian monsoons, in West Africa and possibly also enhanced hurricanes in the Atlantic. Changes in the phasing of the PDO could slow the rapid Arctic warming, increase drought in S. Asia, the Sahel, while increasing rain in the American Midwest.

Research reports, *Science, 15 Feb 08, p 889*, offer a brighter prospect for determining the role of clouds in understanding of greenhouse warming, which has been uncertain for over two decades. Clouds respond to increases in greenhouse gases far more quickly than had been anticipated, making modelling much more reliable.

What To Do

The Hot Topic. G. Walker, D. King, Bloomsbury/Harvest Books 08. A forceful, engaging, simple-format overview on climate change for the general reader. The two specialists provide real depth and insight in the later section which examines the politics involved and the range of solutions.

Carbon Neutral by 2020: How New Zealanders Can Tackle Climate Change, Eds N Harre, Q. D. Atkinson, Craig Potton Publishing, 07. This wide ranging NZ selection covers much of the usual range of topics, with specifics for groups such as schools, the Auckland transport system, malls, investing, political activism, computers and the psychological challenge.

Climate Change and Adaptation, Eds N. Leary et al, Earthscan, 08. Adaptation is essential if we can hope to limit harm, is the message from this wide range of case studies drawn from over a hundred and fifty countries, ranging from Africa, China, the Pacific and Latin America. Five general lessons:-Adapt now; Create enabling conditions; Integrate adaptation with development; Increase awareness and knowledge; Strengthen institutions.

The Economist, 6 Sept, 08 pp 90-92, reports that a Royal Society series of studies outline options for possible experiments to determine if geo-engineering could buy time for the transition to a low carbon economy. Possibilities include the removal of excess carbon dioxide from the atmosphere, by reducing the amount of sunlight reaching the ground using iron to fertilise the plankton in the oceans. This can certainly accelerate planktonic bloom, but it is not clear what happens to the carbon dioxide. Or the greenhouse gas could be recycled as fuel by reacting it with hydrogen, but that hydrogen must be generated without more emissions. Or carbon dioxide could be ejected from the atmosphere at the Poles using the Earth's magnetic fields, and steered by finely tuned radio waves. Other possibilities include using Space, or making clouds more reflective.

Water, Water….

Australasian Science, Aug 08, p 14, reports that recent research has clarified a long-standing discrepancy between the observational data and models of global warming. It confirms that over the past four decades sea-levels have been rising, along with ocean temperatures, and both have been 50% greater than the estimates.

R. J. Diaz , D. Rosenberg report, *Science, 15 Aug 08*, that dead zones, where oxygen has been exhausted, are spreading in marine ecosystems. Increase in primary production using fertilisers and the burning of fossils fuels have caused this, with serious effects for over 400 systems. The coasts of N. America, Europe, but increasingly E. Asia, S. America, the Middle East and Australasia are chiefly affected. Climate change is though to probably exacerbate the problems in a number of ways. Reduction of nutrient use to the levels of the mid 20th century would alleviate the problems.

Water & Atmosphere, (National Institute of Water and Atmosphere, NZ), Vol 16/1, 08 reports that The Census of Marine Life is "the most comprehensive research programme on ocean biology". Two thousand researchers from 80 nations have divided the oceans into various realms for 14 field studies, from abyssal trenches to the poles, tropical reefs, and planktonic and microbial ecosystems. New Zealand is crucial part of the Census, as host to the study on seamounts. Like many of the other realms, little is known compared with what needs to be known to promote the health of the oceans and marine life.

Scientific American, Aug 08 feature on **The Freshwater Crisis, P. Rogers**, warns that investment in new and current technologies is needed at a rate of US$ 1trillion annually to meet requirements through to 2030. Otherwise three quarters of the world's population could face scarcities. Five solutions are outlined:-Financial fix, more investment in water conservation, not waste; Agricultural action, a 10% drop in irrigation wastage would pay off hugely; Plumbing action, such as use of dry composting toilets; Proxy Trade remedy, in 'virtual' water, as countries in climates marginal for crops trade with those with sufficient water to grow more crops; Supply-side; exploit advanced desalination technology, such as reverse-osmosis carbon nanotube filters. For details of innovative approaches to desalination, see *Nature, 20 March, 08 pp 260-261*.

Financial Times, April 4 08, p 7, argues that water is priced far too cheaply, especially in the developed world. Consequently there is global trade in "virtual water", with Australia by far the largest exporter in wheat and other crops. Consumers do not notice the real costs of producing their food because of heavy agricultural subsidies. Some countries such as India, are jeopardising future supplies of underground water. Fairly priced, cap-and-trade systems for water use could work, with allowances for basic human needs and infrastructures to provide local access to water.

Our Common Future

E. Ostrom, *Environment, July-Aug 08*, summarises the impacts of the original 1987 seminal study "**Our Common Future**" and later reviews, including the 2000-2005 Millennium Ecosystem Assessment of the state of the world's ecosystems and their services. Overall, the problems remain and will seriously diminish future prospects for future generations. Questions remain about what "the commons" really means, and also how to manage and improve them. Lessons learned since 1987:-simple panaceas, at whatever level, may work in some settings but fail in others because ecosystems are diverse, policies must be tailored to local situations and environments combined with effective

monitoring. Five basic requirements for governing the diversity of "the commons":- achieving accurate and relevant information; dealing with conflict; enhancing rules of compliance; providing infrastructure; and encouraging adaptation and change.

Environmental Principles and Policies: An Interdisciplinary Introduction, S. Beder, Earthscan, 06. An Australian social sciences academic discusses six principles:- Sustainability; polluter pays; participation; precautionary; equity; and human rights. Additionally, measuring environmental value, monetary evaluation and economic instruments are related to these. The principles are applied to policies. She concludes that there is fundamental divergence between the goals and assumptions underlying economic-base principles and the social principles which concern communities and governments.

Dirt: The Erosion of Civilizations, D. Montgomery, Univ. Calif. Press, 07. A US geomorphologist argues that soil is fundamental to the survival of a culture but today it is being exhausted at a faster rate than it is being replenished because of population pressures and the shrinkage of the land base. Technological know-how is not enough because the soil needs to be treated as an investment under international stewardship.

FUTURES THINKING

Futures of Feminism

In this issue of *Futures, May 08*, which features a range of contributors, several of them from Australia, guest editors, **I. Milojevic et al** invited consideration of such issues as the distinctiveness of women's way of knowing, the core of feminist thinking and values, the challenges to these, the preferable vision from the women's movement and women futurists, common themes from feminist utopian and science fiction, and the current trends globally and locally which are impacting on women.

The Editors survey the contribution of feminism, especially the "Golden Age" decades post-1960 and its legacies in the categories of gender and patriarchy for social systems study, and the preferred alternative of the gender-equal society. They also consider the impacts of change in democratic societies, in communications technologies and women's working lives. Feminism is still crucial to futures. Contributors explore current alternatives to patriarchy worldwide, the changes in US families and parenting, the role of values-consciousness in theory and in the practicalities of women's lives, contemporary film images of the future from an eco-feminist perspective; an understanding of time which reveals the values in women's way of knowing. A highlight article features extensive conversations with twelve women futurist from around the world and across several generations. Finally, a review of a recent book on notable feminist and peace researcher/practitioner, **Elise Boulding: a Life in the Cause of Peace, M.L. Morrison,** McFarland & Co, 05.

From Vision to Decison

Mana, Aug-Sept 07, features an extract from **Resistance - an Indigenous Response to Neoliberalism, Ed M. Bargh**, Huia, 07, the story of the historic Wai 262 claim to the Waitangi Tribunal, finished 2007, decision awaited. In 1991 this claim arose from the vision of Maori elders concerned at the loss of native flora and fauna overseas, aggravated by the lack of Maori involvement in decision making about granting of intellectual property rights over these and other aspects of a Maori language and culture which were regarded as taonga (treasures). The claim is based on the historic guarantee under the 1840 Treaty of Waitangi, to protect Maori world-view, culture and identity. Internationally Maori language as well as the flora and fauna have been appropriated and even trademarked indiscriminately, without reference to Maori. A German company threatened a Maori performing artist because her own birth name had been trademarked by the company. Wai 262 seeks to establish a process based on Maori custom to protect Maori taonga, in partnership with the Crown and other interests. It will also be an historic achievement for other indigenous culture.

J. C. Camillus, Univ. of Pittsburg, *Harvard Business Review, May 08*, analyses his research into how companies manage wicked strategy problems. Companies have been slow to admit the wickedness of these, not because the problems are intractable but because they are so complex, with innumerable causes. It may not be possible for the company alone to solve the wicked problem. Such a problem has many stakeholders making social complexity a key challenge because different values and priorities are involved. It is unprecedented with complex causes and there is nothing to provide the right answer. Companies need to start by defining their own identity, competencies and aspirations, then involve stakeholders to understand their assumptions and preferences and scan the environment continuously. From this they can develop scenarios for analysis to formulate options and use pareto analysis to define a small number of actions with strong impact.

Climate Cataclysm: The Foreign Policy and National Security Implications, Ed K. M. Campbell, Brookings, 08. A two year study by a group of experts developed three plausible scenarios to 2040 and 2100. Expected climate change:- including reduced water availability; extreme weather; upward pressure on oil prices; higher risk of nuclear accident; need for greater provision of disaster relief, refugees flows and food aid. Severe climate change:- unexpected rise in temperatures; higher sea level rise; crops strongly affected; river system collapse in W. US and Mexico; failure of democracies in Latin America and water scarcity leading to political collapse in N. African states. Catastrophic climate change through to 2100:- tempertaures rise 5.6C and 6.6ft rise in sea level; many coastal regions uninhabitable; acute shortage of food; shorter life spans; anarchy in many regions with many refugees armed; collapse of globalisation and transactional institutions; and S. Asia implodes.

SCI/TECH/BIO/TECH/SPACE

Out in the Universe

Living Cosmos: Our Search for Life in the Universe, C. Impey, Random House, 07. In this thoughtful, and accessible survey, an astronomer first raises question about the potential for extra extra-terrestrial life for art and science. He covers modern science's development and its examination of terrestrial life, especially in extreme environments, then moves out into space to cover intelligent life, interstellar travel, current and future space missions and extra solar-planet research.

Humanity 3000. Humans and Space: The Next Thousand Years, Foundation for the Future, 06, www.futurefoundation.org. One of a series of workshops where experts consider very, very, long term futures. This 2005 event with nineteen participants reflected on three main issues to be addressed if humanity in space is to be realised and the critical factors which will lead to such an expansion. Many possibilities and reflections resulted.

While Mars is getting large funding missions, Venus, our relatively close neighbour, has been forgotten. Deep atmosphere exploration and surface exploration is being promoted, to follow on from the European 2005 launch of Venus Express, *Nature 6 Sept, 07 pp 607-608*. Human exploration of Venus is almost impossible but there are plenty of questions which closer mechanical exploration, for instance using huge balloons to float in the Venusian atmosphere, could help to answer. Surface rovers are probably too expensive

since they would require a continuous power source, probably nuclear. Russia and Japan have indicated interest to follow on from the European initiative.

C. Dingwell et al, *Scientific American, Oct. 07*, provide the details of the latest initiative by NASA and US companies to develop a space transport system, Constellation, which by 2020 will convey humans to and from the moon. They are starting with the Orion, which has much the same functionality as the former Apollo spacecraft, with far more advanced overall design and technology, and can accommodate a larger crew. This is planned to be underway by 2015.

Scientific American, Oct. 07, has summaries of the overall strategies for future Space Exploration, both human and robotic, which by 2057 could offer insights into the following challenges:- monitoring Earth's climate by replacing the present aging satellites; preparing for asteroid defence by searching for 100-1000-metre bodies in near-Earth space; seeking out new life, with Mars, Jupiter, Titan, and Europa as targets; explaining the genesis of the planets to follow up from the fabulous collection obtained from the recent Stardust mission; and breaking out of the Solar system, using a dedicated probe to follow Voyager.

http://www.cnn.com/2008/WORLD/europe/10/02/space.elevator/reports that a former science fiction concept is taking steps towards becoming reality in the 21st century, as international scientists gather to confer on further development of a space elevator, a cable which can transport objects and people into orbit directly from the earth. The technology facilitating this is the rapidly developing application of carbon nanotubes with tensile strength 180 times stronger than steel. These can provide a tether with about a quarter of the required strength for the cable. Still to be resolved are how to build the base, how to design the elevator and where, since the base will need to be on geosynchronous orbit. The elevator is envisaged to become a supply system to a space station. It could enable space exploration to lift off beyond Earth's deep gravity well, and for humans to become a space-bearing species.

Adventures in Physics And Robotics

Scientific American, Feb 08, reports, **C.P Collins, C. Quigg, and B. Barish**, on the prospects opened up as the Large Hadron Collider (CERN) enables energy scales to move up to the terascale, smashing elementary particles together with a combined energy of approximately a trillion volts. Particle physicists have been exploring the near limits for half a century but the terascale is new territory for exploring the nature of matter, the Standard Model of particle physics and its symmetry, the energy in the universe and more possibly bizarre discoveries such as new dimensions of matter. Already a new machine is on the drawing boards to succeed and complement CERN a decade hence.

A controversial existing research facility, High Frequency Active Aural Program (HAARP) in Alaska, is a super-powerful ionospheric heater designed to inject radio waves into the atmosphere, accelerating the electrons there which in turn affect the ionosphere. This will enable studies of the fundamental physics behind how plasma and electromagnetic waves interact. Already an artificial aurora has been created. The facility was developed to provide extremely low frequency (ELF) waves to communicate with underwater submarines during the Cold War. *Nature, 24 April 08, pp 930-932.*

Robotic Futures, Special Section, *Science 16 November, 07*, offers a range of perspectives on developments in robotics. While engineers have not yet found ways to create self-replicating robots, some robots have acquired sufficient autonomy to explore hostile environments with minimal human supervision, such as in deep space and deep oceans. Improvements in robotic performance are resulting from application of biological models found in living body plans and substructures. Artificial muscles are being developed which could eventually allow robots to run, jump and climb untethered. Some robots have brain like devices to carry out tasks in the presence of visual cues and other sensory feedback, part of our developing understanding of human thinking and learning. *Science Editorial, p 1083*, same issue, raises questions about the need to develop Robot Ethical codes, to apply in the human- robot relationship. Japan, S. Korea and EU are already devising such systems.

Human Minds

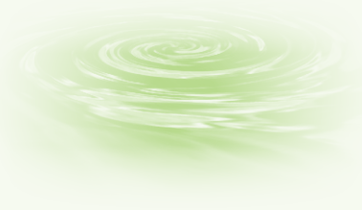
Mirrors in the Brain, G.Rizzolatti, C. Sinigaglia, Tr. F. Anderson, O.U.P, 07. This readable survey covers the discovery of mirror neurons a decade ago, its progress through stages of scepticism and acceptance and its significance. Mirror neurons fire in the brain as a human or animal watches or imagines another action or impending action, and they also orchestrate when the hand and fingers move to perform an action. Consequently they are significant in our understanding of cognition. Whether this is an evolved ability, or one acquired by associative learning, is yet to be decided.

Towards Brian-Computer Interfacing, Ed. G. Dornhege, MIT Press, 07, provides contributions from a range of research groups, some using electrodes and some not. The research goals are:- to provide new communication channels for patients with severe neuromuscular disabilities; provide a powerful tool for computational neuroscience; to advance understanding of the brain; and to provide a generic, novel, independent communication method for man-machine interaction.

Scientific American, March 08, **R. D. Fields** reports on the advances in understanding the role of white matter in the brain, which lies beneath the layers of grey matter (neurons). Long considered passive tissue, the myelin-coated axons of white matter have been revealed by a new magnetic resonance technology to be active. They control the signals that the neurons share. The myelin is partially formed at birth and gradually develops as the brain reaches adulthood. The timing affects learning, self-control and some mental illnesses.

Contemplative Science: Where Buddhism and Neuroscience Converge, B. A. Wallace, Colombia Univ. Press, 07, argues that 'there is nothing fundamentally incompatible between contemplation and science'. This contemplative science seeks to reintegrate the human pursuit of genuine happiness, truth and virtue in an empirical way without adherence to any belief system. A variety of western and eastern perspectives are explored around the theme of first-person observations of mental phenomena and their relation to the world at large.

The Economist, March 22 08, pp 83-85, reports on a new three-year project **"Explaining Religion"**, the largest ever scientific study involving researchers from fourteen universities and a range of disciplines. The project will look at mental mechanisms that are needed to represent an omniscient deity and belief in such an entity. Neurochemical research can be tied to scanning studies looking for those parts of the brain which may be involved, some to focus on the limbic system while others consider that religious activity is spread across many parts of the brain. Anthropological studies focus on the long term benefits, and the positive or negative effects of religious constraints, such as uses of food. Economists are using their games to explore religious influences in economic behaviour.



James Duncan Futures Prize 2008

Yvonne Curtis

The James Duncan Futures prize is awarded annually, at the NIWA Wellington Science and Technology Fair, to commemorate the NZ Futures Trust Founding Chairman, Professor James Duncan. He had lifetime interests in science and future studies, and a belief in the innovativeness of young people and was one of the founders of Science Fairs in New Zealand.

The aim of the award is to encourage young researchers to understand that a consideration of possible long-term consequences is a very important part of scientific research. The students are required to submit an essay or notes of about 100 words, outlining the likely positive and negative impacts their project could have in 5-25 years' time, as part of their exhibit.

This year there were a pleasing number of entrants, particularly in the younger age groups and the judges decided to divide the prize money available and awarded a first prize of $100 to Matthew Keary, a Year 10 student from Wellington College, for his project called "Passive Solar Heating." As well two further prizes of $75 each, were awarded to Bryony Campbell, a Year 7 student from South Wellington Intermediate ("Power Ranger"), and jointly to Bradon McCaughey and Ben Murton, Year 8 students from Paremata School, for their project "Wind 'N' Save".

The three winning projects this year all focussed on aspects of the issue of peak oil and the likely greater costs of energy in the future. Matthew Keary (see essay below) explored some of the less well-known options for building designs to make more efficient use of passive solar energy available to heat buildings. For example he included, in his exhibit, a description of a roof pond passive solar heating system and a water wall passive solar heating system as examples of other ways of heating a room.

Bradon and Ben decided to find the most efficient micro wind turbines to install at their school and where to site them. They concluded; *"People should get micro wind turbines on their property because they will save on the power bill as electricity is going to be more expensive in the future and producing and electricity into the grid can reduce your carbon footprint."*

Bryony's project was to measure the power usage of common household appliances and suggest how to reduce household power consumption by up to 20%. She noted that just turning off heaters to make savings could cause more harm than good as people *"may end up ill, placing a burden on the health system and the workforce."* She concluded; *"Whichever way we look at it, we need to think about our own personal impact on the environment for the future."*

Once again it was a pleasure to be a judge and to see the thoughtful projects and a delight to talk to the enthusiastic students. Being a participant in any role in a Science Fair is being one member of a happy group of people from many backgrounds working as a community to help young people expand their knowledge and their horizons in a very practical and possibly life-changing way.

HARNESSING SOLAR ENERGY

By Matthew Keary

Peak oil is the phrase on everyone's lips and refers to the fact that the days of plentiful and easily recovered oil are nearing an end. The world now consumes 85,000,000 barrels of oil per day, or 40,000 gallons per second and it's widely acknowledged by the world's leading petroleum geologists that more then 95% of all recoverable oil has already been found.

There is an urgent need for mankind to harness alternative sources of energy before our current source is no longer available. The sun represents by far the largest alternative source of energy to man. The energy itself is 100% clean, inexhaustible and totally free, but the technology needed to collect and use it is quite costly. Currently, the sun's energy is used to heat water and homes, and to create electricity using photovoltaic cells, but we need to significantly increase its use and reduce our dependence on dirty and environmentally damaging fossil fuels. If governments encourage the use of solar energy by developing technology and even offering subsidies, the future will be brighter for everyone.