

## DESIGN IN THE SHADOW OF IMPACT POPULATION

### ■ Anne-Marie Willis

*This article explores the implications of population growth for the achievement of sustainable ways of living in Australia. Attention should be focused on the per capita impact of resource use, which in industrial societies is of the order of 50 times higher than in 1900. Amongst other reforms, radical changes in the way we design our built environment will be needed if we are to live in a sustainable way.*

### INTRODUCTION

How are overarching global issues such as world population and climate change relevant to architects and other kinds of designers? Such issues are usually made to appear as quantified abstractions, which can leave all except the number crunchers feeling irrelevant and helpless. The United Nations has just finished a \$4 million study, Pilot Analysis of Global Ecosystems (PAGE for short), a work of 175 scientists that has generated a mass of data, which in its layering of problems can become stupefying and depressing. Some examples:

- Half the world's wetlands have been lost in the last century.
- 80 per cent of grasslands are suffering from soil degradation.
- 40 per cent of agricultural land has been badly degraded.
- 2.3 billion people face water shortages, which is 60 per cent more than previous estimates.
- the world fishing fleet is 40 per cent larger than the oceans can sustain.
- 20 per cent of freshwater species have vanished or been driven toward extinction in recent decades.<sup>1</sup>

Frequently such impacts are blamed on population. It took from the coming into existence of the human species to the year 1900 to reach a global population of 1.6 billion people. It has taken from 1900 to 2000 for this population to increase to

six billion (and it is projected to rise to 8.5 billion in the next 50 years).<sup>2</sup>

NSW Premier Bob Carr cited population as the key environmental problem in a strategically placed dawn-of-the-new-millennium article on 6 January for the *Sydney Morning Herald*. This generated a flurry of responses on the extent to which increasing numbers of people on the planet do constitute a problem<sup>3</sup> and the sub-topic (which soon degenerated into the main event) of whether it was appropriate for a State Premier to speculate on global issues over which he had no power, when there were plenty of pressing problems that he could do something about. Maybe the Premier took heed of this, as his next *SMH* campaign was far more limited in scope, with its focus on the poor standard of apartment design in Sydney. But this time the Premier's published words generated a more engaged and longer running response, even leading to action (an urban design forum to generate proposals to be worked up by the Urban Design Advisory Council for consideration by the Premier and Cabinet).

The debate sparked by Carr on urban design became preoccupied with questions of aesthetics, of who is to blame for poor quality design, and issues of regulation. The population issue slipped out of view, with urban design and architectural concerns not being

connected to questions of population and sustainability. That's what this paper will try to do — to bring population and sustainability issues to questions of design, dwelling spaces and lifestyle.

#### **POPULATION**

'Population' may seem like a neutral, empirical category, just a way of referring to numbers of people, but it only seems to get mobilised when claims are made about it being excessive, echoing the long-standing fear of numbers that was first let loose by Malthus's essay 'On the Principle of Population' in 1798. Yet even for those (like Bob Carr) who believe that increasing numbers of human beings on the planet is the most pressing problem needing to be addressed, there is something more fundamental that underlies that position. And that is that it is not *numbers* per se but the *impacts that they have* that matters most.<sup>4</sup>

The idea of population, from its outset has been, unwittingly, an ecological concept, concerned with the relation between numbers of people and the physical environment needed to sustain them. This was first expressed in terms of carrying capacity — the correlation between population and available supplies of food and water. Here population was seen as a problem when numbers outstrip supply. Historically, this problem was sought to be solved in two ways: by finding ways of slowing population growth by birth control and by finding ways of producing more food. The latter has been pursued via technical interventions to increase agricultural productivity. These have successful in some respects, but have also had negative impacts such as the lingering effects of pesticides in environments and reduction of plant biodiversity through commercialised seed production favouring only a few

high yield strains. Measures taken to slow population growth in poor nations (many within the context of United Nations sponsored programs) have been even more controversial: coerced sterilisations in India, women in Latin America being used as guinea pigs in contraceptive trials and then there is China's enforced one child policy. Yet many of the more draconian measures have failed to make significant dent in population growth because the people to whom they were directed found ways of resisting official pressures. Finally at the 1994 United Nations population conference in Cairo, the 'by-numbers approach' (such as targets for sterilisations and vasectomies) were dropped in favour of indirect measures such as improving women's education, health care and reproductive choices, measures which have been found to be more effective in the long term in reducing birth rates.<sup>5</sup>

#### **IMPACT POPULATION**

Population policies have been driven by the fear of sheer numbers outstripping 'carrying capacity'. More recently, carrying capacity as a concept has been stretched to incorporate environmental criteria, such as air and water quality, availability of energy resources, even the setting aside of national parks. As an essentially biophysical concept 'carrying capacity' has limited applicability to human beings, who in their cultural differences can never be defined reductively as bundles of physical needs. The satisfaction of human needs is always culturally mediated even; food and shelter do not exist in pure, basic forms that are then culturally elaborated. Rather they always arrive already formed as culturally specific. We also know that cultural practices vary in their impact potential, with western(ised) industrialised (and industrialising) cultures having

developed the most extensive and complex impact practices ever known, resulting in effects ranging from devastation of whole regions to extract minerals or timber, create space for settlement as well as the subtle accumulative effects of chemical by-products on the Earth's atmosphere and on the genetic structures of diverse living creatures.

What is needed then is a measure which brings numbers of human beings and their impacts together. At the EcoDesign Foundation we have been working on developing the concept of 'impact population'. A simple approach would be to take the per capita level of consumption and multiply it by a given population. There are some available methodologies such as the PAT formula of P (population) x A (affluence or per capita consumption) x T (technology), that is  $I$  (environmental impact) =  $P \times A \times T$  or the CSIRO's P,L,O,T, formula (Population, Lifestyle, Organisation, Technology).<sup>6</sup> Detailed discussion of these approaches is beyond the scope of this paper, however we should acknowledge that such broad categories may be problematic. Where for example to draw the line between technology and consumption? While human societies can be characterised in terms of their dominant technologies of production, for contemporary affluent populations technology is inseparable from lifestyles and modes of social organisation. Technology is simultaneously a means of production and that which is consumed (materially and symbolically). It is not a stable category, but is constantly mutating. This is demonstrated by the now totally familiar idea of information technology, an idea which would have seemed strange a few decades ago.

To assist policy development and stra-

tegic planning, more refined impact population categories are needed, ones which are connected to varied lifestyle patterns and modes of urban development. Though we should note that 'lifestyle' is not a universal concept.<sup>7</sup> But for now, a global quantitative picture will be registered, as a way of evoking what has to be thought and calculated rather than as an absolutely accurate characterisation.

The global population increased from 1.6 billion at the beginning of the 20th century to six billion by the end of it. By 2050 it is likely to be in the region of 8.5 billion. But with the expansion of resource-intensive industrial (and post-industrial) culture over the last 100 years, per capita environmental impact has increased dramatically. Very roughly one could say that, over the course of the last 100 years, the environmental impact of a single person averaged across the environmental impacts of industrialised society, in terms of potable water, materials intensity, land use, non-renewable energy utilisation and so on, is of the order of 50 times higher than it was in 1900. This estimate takes into account the widespread uptake of electricity, domestic appliances, motor cars, piped water, sewerage systems, processed and packaged food, factory-manufactured clothing, mass and home entertainment, and air travel. In 1900 about one tenth of the world's population were urban-industrial. Over the century the number of members of industrialised societies has increased eightfold, which means today (roughly and conservatively) 1.28 billion.<sup>8</sup> So the impact population would be something of the order of 1.28 billion x 50 = 68.72 billion industrialised people living at 1900 levels.

The next thing to do is to get a bit more specific about the differential impacts of designated populations. David Suzuki and others have often made the point that an average American 'consume,' over 200 times more than an Indian peasant. One may wish to argue over the value of the multiplier, but the importance of such observations (which at a certain level are Basil Fawltyesque 'theories of the bleeding obvious') is that high impact western lifestyles are the model followed by the populations of industrialising nations. There is a certain irony in the fact that, in nations like Indonesia, birth control is promoted by juxtaposing images of large, impoverished peasant families with images of much smaller urban families with lots of western material possessions. So, while 'progress' might be achieved in bringing population levels down, this is almost always accompanied with an increased impact of the smaller population.<sup>9</sup> This is not to suggest that the standard of living of the poor should not rise. However, if impacts are to be reduced the corollary is that standards of living of the well-off should fall; that is, redistributive justice is needed.

#### **ECOLOGICAL FOOTPRINTS**

Another concept which shifts the emphasis from numbers to impacts (which, as said, is the underlying concern of even those who concentrate on numbers alone is that of the 'ecological footprint' or 'ecological space'. An ecological footprint is defined as the amount of land required to support the lifestyle of an individual, a city or nation in terms of their uptake of food, housing, transport, consumer good and services and the space needed to assimilate waste products (particularly the area needed to assimilate carbon dioxide emissions). The

important difference between this and the numbers only approach is the emphasis on differential lifestyles and their draw on resources. For example, one study calculated the ecological footprint of the average Canadian lifestyle as approximately 4.2 hectares per person, but when income differences are taken into consideration, families with incomes of \$100,000 per year had ecological footprints in excess of 12 hectares per person. An ecological space study of The Netherlands calculated that Netherlands agriculture uses, for consumption and export, an area seven time the area of cultivated land within its own borders. In order to reduce the ecological space appropriated by the consumption of The Netherlands population, the study concluded that per capita reductions of 50-80 per cent are needed in the consumption of energy, freshwater, wood products, and arable land.<sup>10</sup>

#### **CLIMATE CHANGE AND GREENHOUSE**

Most of the world's scientists now agree human-generated greenhouse gas emissions contribute to global warming and that unpredictable types of climate change are likely. Climatologists suggest that the critical period is 2060-70. If emissions are not reduced substantially by that date then there will be a situation wherein climatic and other effects will accelerate and the ability to mitigate them will diminish.<sup>11</sup> Greenhouse gases (ghg), it should be remembered, are accumulative, so, for example, CO<sub>2</sub> remains in the atmosphere for between 50 and 200 years.

Amongst industrialised nations, the USA has the highest per capita greenhouse gas emissions from energy use (20.6 tonnes per person per annum). Australia comes second with 17.6 tonnes. However if the effects of land clearing are

added in this takes the figure over 26.7 tonnes and puts Australia into the lead. In contrast some of the Northern European nations are around the 10 tonnes per person mark.<sup>12</sup> John Byrne et al. argue that to actually prevent the 2060 critical point arriving, the reduction target (on the basis of current and projected population numbers) needs to be 3.3 tonnes.<sup>13</sup> This target reduction presents an enormous challenge for policy makers, but also for those influencing lifestyle choices, like designers.

#### **REDUCTION IMPERATIVES**

Australia's current per capita level of emissions is 17.6 tonnes (that is, let's be optimistic and assume land clearing will stop). If this is to be reduced to 3.3 tonnes per capita, we are talking about a six-fold per capita decrease in greenhouse emissions. Such an order of magnitude makes current official efforts of 'limiting' Australia's ghg's to an increase of eight per cent look suicidal, and even makes the Europeans who advocate a 20 per cent reduction look moderate. Some of the clean, renewable energy technologies are already well advanced (for example, photovoltaics, windpower) but are not yet cost competitive because of continuing structural subsidies to fossil fuels. Others are much further away, such as the hydrogen fuel cell touted as the future power source for cars. Its major hurdle is that at present the only cost effective way to obtain the hydrogen is by splitting it off from fossil fuels, which means releasing CO<sub>2</sub> — thus no greenhouse benefit.<sup>14</sup>

However the magnitude of reductions required means that we cannot rely on technologies alone, and certainly not on approaches which focus solely on per unit reductions while ignoring increases in units produced (whether these be units of delivered energy or of material product).

Demand reduction is absolutely essential.

In many ways it is not difficult to formulate policy and economic measures to bring about significant changes. But what is absent is the consumer desire and the political will to embrace changes which would involve significant sacrifices. A common condition is that of living the contradiction of wanting environmental improvements while remaining attached to values and habits based on everything remaining the same. Why is this so? The unsustainability of everyday life is contradictory, being both structurally imposed and individually desired. Take one example — many people are compelled to buy a car to travel to work because of inadequate public transport, but once they go down the road of purchasing a car they are drawn into the marketplace logic of brands, models, features, prices and deals, and so 'necessity' switches over to anticipatory pleasure. And gradually the car gets structured into, and structures, life beyond work (taking the kids to school, shopping on the way home from work, making friends in distant suburbs, and so on) and the car is then perceived as an absolute necessity (which it is, within the logic of the lives whose patterns it has created). Even when practical needs are rationally evaluated, purchase can quickly flip over to becoming a matter of overpowering attraction to an object of desire, with a buyer being pulled between functional requirements (a means of personal transportation) and the image they want to project to the world. (Such contradictions are perceived or not to vastly varying degrees, from the keenly felt to the oblivion of simply giving over to the desired.)

Many more examples could be cited of the way in which the products of design insinuate themselves into our lives, of how they prompt actions which become

solidified into habits — takeaway food, microwave ovens, computers — and thus come to be perceived as necessities. Furthermore, perceptions of ‘necessity’ are absolutely fluid and ever expandable, but always floating above an individually set Plimsol line of a certain standard to be maintained or bettered — unless circumstances beyond our control sink the ship. For the affluent especially, ‘need’ is a dysfunctional category; it is the sheer rationalisation of desire. While needs, desires — whatever someone chooses to call them — are experienced individually and intensely, they are no longer generated from within, they are a product of products, the culture of the everywhere marketplace and its pervasive image machine. In this sense desires are designed by the materiality and meanings (which themselves are products of design) of our everyday worlds. Individual lines of desire are laid out, they drift, float and take anchor in a sign economy which endlessly multiplies designed modes of differentiation — more goods, more services, more things to spend money on, infinite choices. Forty years ago an affluent Australian family was likely to own a car, a three bedroom house, good quality clothing, furniture, radio, record player, TV, washing machine, fridge and a few other appliances; they would take an annual holiday somewhere in Australia and maybe one or two overseas trips in their life. Today’s affluent Australian family is likely to be smaller in number yet to have two or more cars, a much larger house, more furniture, many more domestic appliances, mechanical equipment for garden and DIY, electronic infotainment equipment, a higher throughput of poorer quality household goods and fad-inspired clothing, and to take regular overseas holidays.<sup>15</sup>

This is the designed and designing

context in which a six-fold per capita reduction in greenhouse emissions has to occur!

Clearly major reductions in energy intensive activities and dramatic lifestyle changes will be required. This extends beyond the direct use of energy: petrol for cars, electricity or gas for hot water, space heating and cooling, appliances, computers, and so on. It includes the embodied energy of building materials, of food (particularly highly processed foods), clothing and other consumer goods. Everything in our lives has an energy cost. Then there are other environmental costs: raw materials, water (not just for drinking and hygiene, but for industrial processes, such as the vast amounts of water needed to manufacture silicon chips that power electronic infrastructures), pollutants produced by industrial processes, etc. Should all these be quantified and have reduction targets associated with them? Should there be a world per capita target for 2060 for, say, water consumption, solid waste generation or toxic pollutant emissions?

But this kind of calculative, policy development exercise of benchmarking and targeting is destined to be ineffectual unless it is accompanied by a cultural strategy. This fact is already partially recognised — these days the implementation of almost every new policy or program is accompanied by an imaging and marketing campaign. Who could forget the ‘unchain my heart’ GST advertising campaign?) The Sustainable Energy Development Agency of NSW (SEDA) has run a series of colour press adverts promoting energy smart homes, which depict ‘average’ domestic interiors indicating the energy savings that can be made while not sacrificing current lifestyles. What we’re suggesting as the next necessary (and very difficult) step is

promoting 'designed down' lifestyles, linked to new, non-income-based measures of standard of living. Quality of life needs to displace standard of living, while material divestment and downscaling need to be promoted in terms of the individual and social advantages they can bring.

Given that we live in a political-economic system that is driven by desire rather than imposition, activities focused on the creation of desire for sustainable lifestyles are absolutely essential. Yet that's the one big thing missing.

### **DESIGN, ARCHITECTURE AND LIFESTYLE**

The work of architects and urban designers is often thought to be that of improving the aesthetics of the built environment. This is a very limited view. Designers could make a very significant contribution to the creation of desires for more sustainable lifestyles, and not just when designing the new, but in transforming the old. This is something that needs greater recognition both by designers themselves, policy makers and the wider public. The urban design debate prompted earlier this year by Premier Bob Carr became focused upon poor quality of Sydney apartments. But this was understood purely in terms of aesthetics, facades and streetscapes.

Instead, why not judge urban developments according to the extent to which their design promotes sustainable or unsustainable lifestyles? Over the past few years apartment construction has forged ahead in Sydney, driven very much by urban consolidation policies. If we were to subject these developments to a sustainability assessment, this is what it might look like, in brief summary:

First, the positives:

- There are some projects that are

intelligently designed to conserve energy, such as apartment buildings with cross flow natural ventilation, and living areas oriented to take advantage of winter sun and summer shading. The apartments of the new suburb of Newington (originally built as the Olympic Village) are a good example.

- There are even fewer that do this as well as incorporating water conservation measures (like capturing and storing stormwater for irrigation and other external uses).

Opposed to this are:

- Thermally inappropriate design requiring apartments to be air conditioned.
- Apartments with several bathrooms, guest powder rooms and other water-hungry facilities (unfortunately the Newington, Olympic Games site apartments also exemplify this).
- The general tendency towards luxury, and where budget doesn't allow for this, the appearance of luxury, which often means inferior, short lifespan materials and structural elements disguised by even more short-lived veneers.

Potential environmental benefits of urban consolidation are undermined by business-(or rather lifestyle)-as usual, for example:

- A doubling up of resources: valet services and in-house catering on offer in developments where every apartment has fully equipped laundries and kitchens (why not downscale these?)
- Generous parking space for developments that are marketed for their convenience to public transport (with site profit maximisation pushing parking underground, thus large amounts of energy expended on excavation and removal of excavated material).

The list could go on. The simple an-

swer to this negative assessment is ‘this is what the market demands’. But instantly there are two rejoinders: markets operate in limit conditions set by governments (sustainability needs to be the over-riding limit) and there is a long tradition of innovative architects constantly struggling against mainstream expectations (sustainability rather than expression of artistic ego has to become the stake of the struggle).

Proponents of urban consolidation often argue that this is a more efficient form of development in its use of space, infrastructure, services. This does not necessarily mean that a dense development has a smaller ecological footprint than a less dense one. Another way of putting it: Sydney’s actual population is increasing (from 3.9 million in 1996 to a projected 4.9 by 2026),<sup>16</sup> at the same time its ‘impact population’ is also increasing as the ante is constantly upped in terms of the growing wealth and consumption of certain sectors of that population, including their consumption of housing, services and travel. In such a scenario, increased efficiency (for example, of energy) does not necessarily mean lower impacts, as what Malcolm Slessor has called ‘the rebound effect’ kicks in, wherein money and energy savings in one sector of the economy actually stimulate demand in other sectors.<sup>17</sup> So energy efficient apartments are clearly not sufficient sustainability measures in themselves, neither are more efficient cars.

You may want to quibble with the need for a sixfold per capita reduction in greenhouse emissions — maybe it should only be four or five. Other multipliers are open to contestation. However, they are all going to be huge, irrespective of adjustment. But let’s stay with the sixfold estimate and treat it as a heuristic to

generate ‘futuring’ ideas. Here is an enterprise that requires imaginative projection and prefiguration of less-is-more, quality rather than quantity lifestyle scenarios. New modes of dwelling, new images to be desired. These modes and images need to become the project of many kinds of creative professionals. But images have to be given substance, hence the importance of those who design the material conditions of everyday life, like architects and product designers. Historically, unsustainable lifestyles arrived by design. Sustainable ones can too.<sup>18</sup>

For the sake of argument let us accept that the sustainability imperative means that we must reduce greenhouse emissions by a factor of six. What would this mean as far as dwelling design is concerned? Here are some questions to ponder:

- What would it mean for leisure facilities, schools, hospitals, commercial and industrial developments, infrastructure design, retrofits of existing buildings?
- What kind of sustainability assessment would need to precede the briefs for such projects?
- What would it mean for offices, information technologies, factories and transport?
- What kinds of things might never be built again?
- What entirely new things can be glimpsed on the horizon?
- How would a really rigorous and politically supported commitment to sustainability change the practice of professional designers?

We finish with these questions in the spirit of opening rather than closing a debate. The concept of an impact population begs much thought and investigation, and certainly to be taken

beyond the broad (and somewhat dry) PAT formulae. Design strategies that can respond to growing impacts and that go to the amelioration of problems, the retrofitting of existing structures, the creation of new alternatives, the promotion of new directions and desires are important. But design, even in the

expanded way it has been evoked here, cannot solve everything.

#### Note

This article has been adapted from a briefing paper written for 'Issues of the Coming Decade: Design, Climate Change and Population' organised by the EcoDesign Foundation for the Royal Australian Institute of Architects (NSW chapter), May 2000. My thanks to Tony Fry who contributed significantly to the ideas and arguments presented here.

#### References

- <sup>1</sup> Figures cited in *Time*, *ibid.*, April-May 2000. See especially 'State of the Planet', pp. 18-24.
- <sup>2</sup> UN estimates range between 7.3 and 10.7 billion by 2050, *Time* Earth Day 2000 edition, p. 48.
- <sup>3</sup> For example, Geoff Angel argues that per capita consumption of resources such as water and energy is more significant than questions of sheer numbers, 'Curbing our addiction to consumption', *Sydney Morning Herald*, (SMH) 13 January, 2000, p. 11.
- <sup>4</sup> In fact Bob Carr's second article on population, written in the light of responses to the first, puts much greater emphasis on environmental impacts, especially global warming. 'We must win this war for the world', *SMH*, 19 January, 2000, p. 15
- <sup>5</sup> 'Population', *Time*, *op. cit.*, April-May 2000, pp 48-9
- <sup>6</sup> D. Cocks, *People Policy*, University of New South Wales (UNSW) Press, Sydney, 1996, p. 113
- <sup>7</sup> The EcoDesign Foundation is currently developing ways to profile impact population that are able to assist in design, planning and decision making.
- <sup>8</sup> The urbanised population is predicted to reach 50 per cent of total world population not long after 2000, but this includes dwellers in many non-industrialised cities (e.g., in Africa), as well as the dispossessed of the urban fringes. See Molly O'Meara, *Reinventing Cities for People and the Planet*, World Watch Institute, Paper 147, Washington, 2000.
- <sup>9</sup> The Indonesian middle class at 20 million is larger than the Australian population. The *Financial Review* (19 November, 1999), reported that economists were pleasantly surprised by the cashed-up crowds stampeding a new Carrefour French food hypermarket in Jakarta, which had been besieged by looting mobs just twelve months earlier.
- <sup>10</sup> This account of ecological footprints is drawn from an essay on the CSIRO's Ecumene Project. See [www.dwe.csiro.au/research/Futures/ecumene/ect4.htm](http://www.dwe.csiro.au/research/Futures/ecumene/ect4.htm) The Canadian study referred to can be found in Mathis Wackernagel and William Rees, *Our Ecological Footprint*, Gabriola Island, British Columbia, New Society Publishers, 1994. Their work also came to the now well-known conclusion that if everyone on Earth lived like the average North American, we would require three planet Earths.
- <sup>11</sup> For example, as presented by John Byrne of the Centre for Energy and Environmental Policy, University of Delaware, to the OECD Solar City Seminar hosted by Royal Australian Institute of Architects (New South Wales chapter) in Sydney in March 2000.
- <sup>12</sup> C. Hamilton and H. Turton, 'Population policy and environmental degradation: sources and trends in greenhouse gas emissions', *People and Place*, vol. 7, no. 4, 1999, pp. 43-46
- <sup>13</sup> J. Byrne, Y. Wang, S. Yun, C. Kim, Y. Mun and J. Rosales, 'Reclaiming our atmospheric commons', Centre for Energy and Environmental Policy, University of Delaware, Newark, 1998. This work is summarised in D. Yencken and D. Wilkinson, *Resetting the Compass: Australia's Journey Towards Sustainability*, CSIRO, Collingwood, 2000, pp 168-170.
- <sup>14</sup> There are schemes to store CO<sub>2</sub> they were underground, such as in aquifers. See 'Climate' in *Time*, *op. cit.*, pp 61-3
- <sup>15</sup> Houses and cars are twice as big and twice as thirsty as, forty years ago. The original 2.4 litre Holden used much less fuel than its 'fuel efficient' modern counterpart with power steering, air-conditioning, and so on.
- <sup>16</sup> A. Cuplin, S. Nugent and J. Truscott, 'Population projections for NSW — A regional analysis', *People and Place*, vol. 8, no. 1, 2000, pp. 14-15
- <sup>17</sup> Malcolm Slessor, University of Edinburgh, cited in CSIRO Ecumene Project. Also cited in this paper is work at Carnegie Mellon University in Pittsburgh which shows that the USA economy has not become more energy efficient over the last 20-30 years, although in the last five years it has. Although household appliances (for example, TV sets) are 'more efficient' the expansion of cable channels now means that every home has two to four sets (ref. Hadi Dowlatabadi).
- <sup>18</sup> For an account of design-driven unsustainability, defuturing and futuring, see Tony Fry, *A New Design Theory: An Introduction to Defuturing*, Sydney, UNSW Press, 1999.

