

This Thesis is submitted to Auckland University of Technology in partial fulfilment of the degree of  
Master of Arts in Art and Design.

# Lightness, Sustainability, Design: Framing Product Design

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## attestation of authorship

"I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the qualification of any other degree or diploma of a university or other institution of higher learning, except where due acknowledgement is made in the acknowledgements."

Signed \_\_\_\_\_ 1<sup>st</sup> August 2007

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## intellectual property

All unacknowledged material contained within this thesis document, including all directly associated visual material, statistical data and three dimensional product prototypes are the exclusive intellectual property of the candidate/author.

## abstract

### **Lightness, Sustainability, Design: Framing Product Design**

To design anything with lightness in mind is perhaps a contradiction in itself. To impose upon the designer such a factor from the outset of a brief surely creates a burden or limitation in the consideration of materials and form. However, the focus of this research project is to examine and apply lightness in a range of contexts or conditions. The aim is to explore the singularity of each condition; then to discuss the paradox and contradictions that are often present in new products that continue to predominate with a duplicitous emphasis on aesthetics and form.

For the purpose of exploration of lightness, a series of products will be created to expose the paradox that exists in deploying a strategy such as lightness in singularity, without considering broader implication of product design on the environment, economy and society. These 3D outputs comprise the practice based component of this research, the balance to be a written exegesis.

The genuine crisis of sustainable design is the need to design to construct a point of view on design – a paradoxically futile position that is directly linked to the challenge of engaging in true sustainable product design practice. This paradox will be investigated through a range of Sustainable Product Design strategies, examining the irony that exists in producing more goods and services to solve the problems of a world already oversupplied with the ‘stuff’ of humankind.

## introduction

### **Why Lightness?**

For the purposes of this research project I have chosen a condition that is perceived as desirable from a user perspective, advantageous from a technical or performance perspective and valuable from a sustainable perspective. Lightness crosses borders, both tangible and theoretical, making it the ideal vehicle to explore a conceptual position in a design paradigm. Philosopher and architectural critic, John Rajchman, asks: what is lightness as a concept? In a variation of modes lightness as a concept "...has an open ended relationship to design. It must itself become complex, inventing a space of free connection to other concepts." (Rajchman 1988) It is for this potential to make connections across conceptual boundaries that I have chosen lightness to explore the paradoxes that exist in design. When discussing object materiality, lightness may be interpreted as desirable or undesirable. Lightness may be real or virtual, physical or illusory; it has relevance across all human senses – tactile, olfactory, ocular, auditory and gustatory. For these reasons it is the chosen vehicle to discuss and engage argument for and against sustainable product design.

Sustainability is broad, contemporary and littered with emotional rhetoric, unproven scientific theory (to be realised over time) and recent media hype. To establish a research project with such blurry boundaries carries risk and has required the identification of a context (lightness) to bring focus and to juxtapose contemporary discussion on the subject.

It is important to acknowledge that, in the case of sustainable development, while we recognise that many of our conventional approaches are unsustainable, we do not know what a sustainable approach might look like. This truly is a journey of exploration.....but we must leave behind our preconceptions, many of the things we hold dear and many of our expectations. This is not a comfortable thing we do.....but this is the nature of

exploration. It is also the nature of Design. To be a designer is to be on uncertain ground.  
(Walker 2006)

It is here that the paradox begins. Access to, and knowledge of lightweight materials, has enabled designers to challenge the form and function of object, dwellings and systems alike. Materials such as carbon fibre composites, Kevlar, high-performance plastics and metals have all enabled designers and engineers to challenge the limits of construction and manufacture – yet under accepted eco-design principles these are some of the least sustainable materials humankind has ever conceived of.

As recently as March 2007, designer of high performance racing yachts, Bruce Farr, announced his belief that sailing vessels can continue to become faster and stronger, yet the limitations on performance are now human centred, based on protecting the crew contained within the vessel. Surely such a craft is the epitome of lightness in the context of modern design and man-made materials; however the act of sailing around the world non-stop, pushing sailors to and beyond their physical and mental limits does not subscribe to the concept of lightness in any way, shape or form. The same may be said of the Space Shuttle, the only man-made vehicle capable of escaping Earth's gravitational pull, orbiting the planet and returning its crew to Earth ready to fly again on the next mission. Space exploration is surely the pinnacle of mankind's scientific and technological achievements representing the cutting edge of lightness embodying strength of materials and minimum mass. Many of the materials that have emerged from the world of space exploration have come into common use and are indeed desirable for their function, performance, and at times aesthetic value.

### **Lightness at home and at play**

It is most often our pursuit of extreme leisure activities that has brought high-performance materials from the science laboratory into our very homes. We desire materials such as Kevlar and carbon fibre in the same way that our forebears may have valued a piece of straight grained timber for an axe handle. Our familiarity with the new and the extreme is underpinned by the ability to access technical information and materials on a global scale, via the World Wide Web and international courier services. For example one can purchase a carbon fibre windsurfing mast designed in California, tested in Hawaii, manufactured in China and sold in New Zealand!

The financial cost of lightness is undoubtedly high. The majority of high-performance plastics and metals require high levels of processing, extreme quality control and are often limited in quantity and local availability. This cost is often passed directly on to the consumer in the form of an expectation; that to achieve lightness and performance through materials, one must have only the most recent iteration and the highest quality available. To this end we find the consumer may discard previous models, not because they are worn out or damaged but simply because of the availability of later version offering the potential of incremental improvement in performance. At times this performance characteristic is only perceived. A case in point is the very laptop this thesis is being prepared on; the Lenovo IBM ThinkPad Z60 M. Complete with a titanium lid, lightness and performance are surely guaranteed; however this was the heaviest laptop in its range! The role of the 'Ferrari' of metals – Titanium has been reduced to that of an aesthetic signifier representing lightness and strength, but in truth contributing to the product's mass and the unrecyclability at end-of-life.

Competitive and recreational sports such as sailing and cycling provide another good example of this scenario. A newcomer to these sports may be overwhelmed by the variety and selection of componentry available; however, it is soon evident that performance is reflected in cost [financial]



which in turn is directly related to lightness, rigidity and durability. Those in pursuit of lightness are often happy to pay – and to bear the inherent risk, for many of these materials are prone to spectacular performance *and* spectacular failure. Carbon fibre composite is extremely rigid and unyielding, until it reaches its point of critical deflection and subsequent fracture - examples of which have become some of the most spectacular sporting television footage of all time. These include carbon fibre track bikes from the Olympic Games, Formula One motor racing cars, and probably most familiar to New Zealanders, the failure of the mast on NZL 82 in the America's Cup sailing regatta.

### **Design for .....**

Many of the arguments surrounding sustainability and product design are based around technical strategies regarding materials and manufacturing processes. In the last decade designers have sought to include whole-of-life planning for their products, endeavouring to ensure that the product may be reused or recovered in some way in its post-consumer phase. This strategy makes sound economic sense, enabling suppliers and manufacturers to plan for a percentage recovery of raw materials, and in some instances 100% recovery may be possible. The strategy is referred to as the closed-loop cycle. Examples include the Philips electronic company and BMW motor vehicles. Eco-design strategies have seen these companies substantially reduce the variety of plastics, metals and electronic componentry used in each product, knowing full well that it is they who will be recovering and disassembling their products. To ensure this process is cost effective additional strategies such as design for disassembly [DfD] and ISO materials labelling have become the norm in recent years.

The 'Design for' strategy is a sound proposition in as much as it is located early in the design process. Design for Durability (product endurance), Design for Dematerialisation (lightweighting),



Design for Reuse, Repair, Recovery, Recycling and Remanufacture all subscribe to the concept of closed loop manufacturing, enabling source reduction; avoiding the additional production of virgin materials. The most extreme example is that of aluminium – the recycling of which requires only 5% of the energy required for production of virgin aluminium. – *Tellus Institute 1992* (Lewis and Gertsakis 2001).

### Global Issues

Governments have sought to legislate and manage ecological approaches to manufacturing and post-consumer waste streams via incentive and penalty strategies. Voluntary covenants such as New Zealand's own Packaging Accord of 2004 seek to encourage product stewardship and extended producer responsibility (EPR) through industry leaders setting targets for waste reduction and recovery. One must question whether these strategies are simply the proverbial 'ambulances at the bottom of the cliff'. The sustainability debate is still young and not enough time has passed to prove any one, or combination of strategies has had the desired effect on balancing energy and material flows within the manufacture and consumption of designed goods and services. If one is to fully believe the recent media frenzy surrounding the prospect of global warming caused by humankind's industrial activities over the past 150 years, then we could certainly be too late. However these outpourings of angst and emotional finger pointing are without substantive and irrefutable evidence. While the phenomenon of global warming appears to have reached a level of acceptance worldwide, debate surrounding the actual cause swings like a proverbial pendulum. The question remains; who has the responsibility for initiating change and who will sustain the debate over time? Historical evidence points to legislative approaches having a greater effect than incentives. Product design has the potential to claim a proactive and creative stance at the front end of any process to manufacture goods. However one only needs to speak with young graduate designers or to monitor design websites to see that the focus



(BMW 2006)

remains on achieving status through the creation of high end desirable goods. Product Design as a profession is caught in an identity paradox - to create products and systems solely for the purpose of meeting anthropocentric pleasures and/or to create non-anthropocentric products designed to support and integrate with all systems – organic and mineral that make up the biosphere we call Earth.

What does seem clear is that humankind is living in a time of awakening. This period in the post-modern era will be reflected upon in terms of Triple Bottom Line awareness on a global scale. Issues of social equity, environmental management and economic justice are protested and debated at will. As rampant consumerism spreads across the globe, formerly third world countries are rapidly achieving first world standards of living. It seems, even in layman's terms, the prospect of one billion people in China and one billion people in the Indian subcontinent, wanting to eat sleep, and shop the way of the Western world, will undoubtedly lead to economic boom and ecological bust under current regimes of free market economies and free trade agreements. The examples that have now been touted for nearly three decades include the fact that just 20% of the world's population consumes nearly 80% of the world's energy resources – an equation that is clearly out of balance. The Wuppertal Institute (Germany) and Rocky Mountain Institute (USA) called for an urgent response to address this imbalance through a strategy called Factor 4 - a proposal to double wealth and halve energy consumption. This was soon to be superseded by an alternative proposal; Factor 10 [UNEP Global Environmental Outlook 2000] calling for dramatic reductions in resource consumption and the support of sustainable growth strategies in emerging nations.

So was Victor Papanek right? More than 30 years ago, he suggested the best thing that industrial designers could do was to simply stop! Had the practice of design simply stopped in its tracks it is highly questionable whether this would have had any great long term effect on manufacturers

and markets as they would have simply looked elsewhere for the supply of ideas. Therefore design and designers have a role to play in ensuring that the products consumers demand are fit for the user, the market and the planet.

The relationship between humankind, technology (and design) and our environment is a complex one. Our ability to design and shape our environment, our dwellings and more recently to give form to any product concept makes us unique among the living inhabitants of our planet. We are the only creature who has inflicted a significant negative effect on the very environment we rely upon to sustain life. We consume energy at a rate greater than it can be replenished (by sunlight) and each of us claims ownership of a share of natural resources for the duration of our very brief lifespan. The concept of ownership is potentially at the root of our economic and social difficulties and has in just a few short decades translated into a cycle of production, consumption and disposal that has ensured environmental destruction on a scale never before witnessed in the history of humankind.

What follows includes an exploration of a series of design scenarios, initially via a questioning of design methods. Four design scenarios are explored in order to expose on the one hand, the rhetorical frameworks of design formation of aesthetics that predominates in product design. And on the other hand, these designed products open a debate on consumption and sustainability, with respect to materiality, function and product life-cycle.

## literature review

**“The most important thing about Spaceship Earth – an instruction book didn’t come with it!” - Buckminster Fuller**

The selection of writings in the genre of sustainability and sustainable design encompasses a relatively brief and recent timeframe. To position this research project in context it is important to first locate it within contemporary Sustainable Product Design (SPD) practice and to position it on a continuum that includes environmentalism, design history, and a number of technical aspects of sustainability within industrial and product design; primarily focusing on cultures of materials and their use within design contexts. Finally there is a degree of engagement in design philosophy, questioning the role of humankind, the act of designing and the relationship with nature, technology and materialistic cultures.

The move towards SPD and a new generation of less harmful consumer products traces its origins back to the late 1960s. This decade brought us a number of global developments that have undoubtedly contributed to the birth of the ‘ecoism’ and the ‘greening’ of consumer culture. The earliest pictures of Earth, taken from space in the 1960s offered us a view of our planet unlike anything we had seen before. For the first time in history we could see our home as a single entity, a circular horizon that represented our smallness in the universe and the finiteness of our ‘resource’ - Earth.

Rachel Carson’s *Silent Spring* (1962) is credited with kick-starting a second tier ‘environmental movement’ in the United States of America. Her brutal criticism centred on the crop farming sector, the overuse of pesticides containing industrial chemicals and subsequent poisoning of the

land. Previously environmentalism has centred on the halting of visible destruction such as deforestation and the contamination of pristine waterways. Carson's heralding of an invisible enemy eventually led [10 years later] to the banning of DDT in America and Europe. The early 1970's also witnessed a number of publications and reports regarding the exponential growth in the global population, pressure on the planet's natural resources and the consideration of how many people the Earth could comfortably sustain (a question still eagerly debated today). These publications included: Club of Rome report *Limits to Growth* (1972) and the follow up *Beyond the Limits* (1992); Ehrlich's *The Population Bomb* (1968) and *Population Explosion* (1984). While these publications have limited relevance to this study, they are in many respects the founding documents of environmentalism and the subsequent raising of awareness in the impact mankind is having on his environment through the consumption of natural resources to produce man-made consumer goods. Globally recognised events such as the peace movement, the Cold War and the space race may all have had a stake in our realisation of how unsustainable our rampant westernised consumer culture had become. 150 years of industrialisation had taken its toll, not only on the natural environment, but on the hearts and minds of many in design, manufacturing and business.

### **Think Global – Act Local**

With this new sense of awareness and urgency a plethora of initiatives, agencies and organisations began to influence global thinking on the future health of humanity and the planet we inhabit. The 1972 Stockholm Conference on the Human Environment that led to the founding of the United Nations Environmental Programme (UNEP) saw an unprecedented role being played by NGOs in shaping the international environmental agenda. The *Stockholm Action Plan*, in Recommendation 97, stated that, "the programme must provide means of stimulating active participation by the citizens, and of eliciting interest and contributions from non-governmental

organizations for the preservation and development of the environment". (UNEP 2001). The Stockholm plan was followed in 1992 by the Agenda 21 summit in Rio and again in 1997 at the UN Framework Convention on Climate Change, now simply referred to as the 'Kyoto Protocol'.

Sustainability in its many guises (economic, social and environmental) was the catch-cry of the 1990s. With a number of NGOs achieving an unprecedented level of credibility and global recognition (Greenpeace, FoE, WWF) and the world's media focused upon a string of environmental disasters (Chernobyl, Exxon Valdez, Amazon and Malaysian deforestation) and dramatically documented weather events. There has been a continued 'greening' of general consumer behaviour across western nations. Western governments have been forced to advance and elevate the profile of environmental portfolios and initiatives. As occurred in Germany some 20 years ago, here in New Zealand we have seen the rise and rise of the Green Party as a 'player' in policy formation with the two dominant parties. New Zealand as a nation is now confronting its place in world trade agreements (Economy), evaluating its caretaker role in an increasingly unstable Pacific (Equity) and attempting to manage (salvage) its 'clean green' image (Environment).

Most recently there have been several national developments in an attempt to establish New Zealand's place in the knowledge and technology economies. Such initiatives include a substantial push by the Ministry for the Environment (MfE) to include sustainable thinking in all levels of manufacturing and production. Unfortunately not all government agencies are on the same 'page' as MfE. The Better by Design initiative has been established by New Zealand Trade and Industry (NZTI) in response to the 2003 Design Industry Taskforce. The aim was "to develop a strategy that would boost economic development for New Zealand through the better use of design by our exporters." After searching the Better by Design website and making an enquiry through one of their senior Design Auditors it was apparent that there is no consideration

of Sustainable Design in any context – economic, social or environmental. BBD Director, Judith Thompson, was contacted for comment. However, at the time of writing there had been no reply.

### **Eurocentric Design**

Lead by a strong green movement in northern and central Europe, the way we design, manufacture, consume and dispose of goods passed through a period of massive development throughout the latter part of the 20<sup>th</sup> century. Through a number of design initiatives and movements, the initial reaction from designers and design schools was to highlight how useful artefacts could be created from the detritus and remnants of a consumer society focused on not replacing old with new, but exchanging near new for newest. Probably the most well known design group of this period was Droog Design from the Netherlands. Throughout the 1990s and into the beginning of the 21st century the Droog collective of designers and Eindhoven graduates has presented a vast number of products and exhibitions focused on taking a second look at the products we already have, and reusing them in interesting, playful and innovative ways. The products are often considered to be of “high” design and are only available in limited production runs. Underpinned by a paradigmatic shift in societal attitudes to waste, this recycling trend became the focus of many design schools throughout the EU, most notably the Eindhoven Academy, and for a short period of time the RCA in London. This attempt at recovering and reusing existing materials had some large scale commercial spin-offs such as Patagonia's clothing range from recycled PET bottles and the Freitag Bag Company's recycling of PVC truck curtain-sides, however the sustainability argument was weak. Suzette Sherman's (New Materialism, 2002) attack on this recycling trend in design makes the point clearly.

While “Design for Disassembly” has been the industrial designer's mantra for the past few years, less enlightened form-givers seem to prefer “found objects”. With the best intentions, many design schools are teaching students to jerry-build trash into presumably useful products. The result of this strategy is mixed at best.....furniture built



from discarded soda cans and assorted other detritus filled an entire hall with one-liners, for the most part unattractive objects that failed to address the critical issues of aesthetics, mass production, or large scale recycling efforts. (p 94)

Sherman's observations highlight the short-term, 'knee-jerk' reaction to a much longer term problem. While attitudes to waste were clearly changing, and attempts were made to highlight what design can do to help, the connection to design and production was still to be evidenced in such a way that design students and design practitioners could claim a net positive effect.

### **Theory meets Practice**

Since the mid-nineties there have been far more concerted efforts to address the debate around SPD. Technologically sound, socially responsible, financially rewarding examples are emerging to show the way in terms of "*Remaking the Way we Make Things*". (McDonough and Braungart 2002) It is this last phrase that is perhaps at the heart of any strategy to take SPD forward into the 21<sup>st</sup> century and beyond.

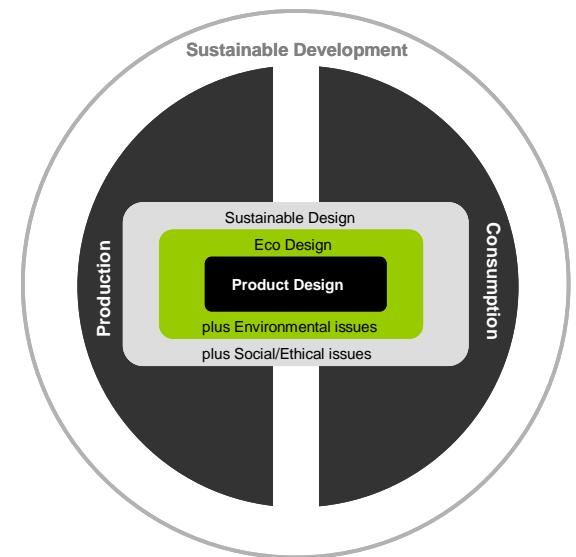
An Architect and Industrial Chemist seem an unlikely allegiance; however William McDonough and Michael Braungart have entered the sustainable debate with an argument that all products, great and small should be designed and manufactured with a preordained whole-of-life cycle. This strategy involves the classification of *all* materials into two categories: biological and technical. The former consisting of all materials of an organic nature, capable of being returned to the earth for natural decomposition and regrowth. Techno-nutrients consist of those man-made materials harvested from minerals and manufactured into secondary materials such as plastics and metals. The strategy for these materials involves the complete avoidance of cross contamination with bio-nutrients allowing the technical materials to be recovered and recycled an *infinite* number of times, avoiding so called 'down-cycling'. Where techno and bio materials must come into contact the product should be constructed using non-permanent bonds with an

allowance for disassembly and recovery. In variance to many of the academic arguments for SPD, McDonough and Braungart have succeeded in applying their theory in practice on an industrial scale with large multinational companies such as Ford, Herman Miller and Interface.

In this research project, it is my intention to utilize the simplicity of the 'Cradle to Cradle' strategy, by tracing materials and production methods back to the point of origin, eliminating waste and reducing embodied energy. The employment of 'cold construction' techniques is a strategy that enables the future-proofing of each design allowing the disassembly and recovery of materials, either bio-nutrient or techno-nutrient. The avoidance of permanent bonds, adhesives or hybrid materials has the effect of deepening the exploration of construction techniques – both old and new to seek innovative solutions over convenience and cost savings.

### **Educating Designers for a Sustainable Future**

A great deal of technical focus was brought to the fore in the general discussion of sustainable design practice. A number of University based programmes such as the Centre for Sustainable Design at Surrey University - England, the Delft Technical Universities in Holland and the Centre for Design at RMIT in Melbourne, Australia have lead the way with conferences and academic publications focused on the need to better understand the issues of sustainability confronting industrial design and the production of consumer goods and services. Probably the most useful publication on this front is Design + Environment (Lewis and Gertsakis 2001). This text was written with university undergraduates in mind offering clear and concise guidelines to sustainable product design strategies as well as a historical overview and contemporary case studies of applied SPD. While this text is already six years old it has remained current while the uptake of SPD strategies by designers and manufacturers has been encouraged and enforced by governments and NGOs alike.



(Charter 2001)

Universities and industry-based researchers have led the way in establishing many sustainable strategies and publications for product and industrial design, and this has started to become evident in design practice. The same cannot be said for design education. Current models for the education of industrial or product designers remain unchanged since the middle part of the 20th century. While the number of students seeking a formal education in design and the creative arts has steadily increased, the number of education providers offering courses specialising in sustainable design is negligible. There are but a few aforementioned Universities specialising in SPD and a handful more offering particular specialist courses in SPD within a degree programme.

Sustainable strategies for designers range from the highly technical, scientific and costly end of the spectrum, such as full Life Cycle Analysis – LCA, to the whimsical 'eco-ism' previously discussed. The problem facing any product designer is to decide where and when to engage in the SPD debate and how to execute such a technically difficult process in a way that will engage the client, manufacturer or consumer to bear the financial cost of this burden. Product design is only one small part of a wider, more complex equation. However, as a profession, and as part of the new product development process it carries a heavy burden of responsibility. Product design exists for the sole purpose of creating new products and services, or the improvement (economic, ergonomic and environmental) of existing products and services. When design has finished, production begins and so called environmental impacts are 'locked in' for the life of the product.(Lewis and Gertsakis 2001)

**“There is almost no tradition of projective thinking about what design designs.” (Fry p90)**

The next stage of this research project concerns the broader ethical question of whether to design at all. This is underpinned by a discussion regarding the design of design itself. How has design evolved to a point where it has become a tool for the sustainment of anthropocentric wants and desires and consumer driven markets? The concept of sustainable design operating in a seamless ecological, economical and socially equitable paradigm seems to be a lost cause. In ‘Defuturing’ (Fry 1999) Tony Fry presents a narrative highlighting the unsustainability of the relationship between man, machine and nature throughout the 20<sup>th</sup> century. Fry’s focus on war, warring and war machines reinforces his claim that “war is the most extreme case of ontological designing.....there is no condition more violent or dramatic in which worlds and things meet and clash than at war.” It is war that lays bare our anthropocentrism. A case in point is the humble riding stirrup – sic “designed to transform man and beast into a stable platform from which the rider may focus the point of his weapon with the force of body weight and the speed of a charging stallion.”(p40) The anthropocentric argument is further explored as Fry refers to the commodification of the human body itself, being a component in the emergence of sub-economies “.....that drive a constantly changing plural palette of unsustainable image possibilities.” (p190) In other words our insatiable desire for ‘the new’ is unattainable due to market and economic paradigms that ensure that one never arrives at the ultimate goal of self realisation.

This widely held belief, that the problems we have encountered are not solely man-made since the industrial revolution but are systemic, having developed over a longer period of time, and that we have failed to understand or appreciate the systems we are inextricably bonded to. History is littered with examples of man's attempts to dominate nature: attempts to move mountains, re-direct rivers, obliterate species and harvest rare mineral resources. Schumacher (1973) discusses the concept of Natural Capital:

Fossil fuels are merely a part of the 'natural capital' which we steadfastly insist on treating as expendable, as if it were income, and by no means the most important part. If we squander our fossil fuels, we threaten civilisation; but if we squander the capital represented by living nature around us, we threaten life itself. (Schumacher 1973)

This concept of material 'ownership' is one of the key elements of this research project. We desire goods and services that enhance our lives (and lifestyles) yet the idea of 'borrowing' these from nature is foreign to us. The only source of income planet Earth has is solar; all life – animal, mineral and vegetable springs from the sunlight that strikes the earth's surface. The conversion of plant matter into useful mineral deposits has taken many millions of years yet the consumption and disposal of downstream products has reached entirely unsustainable rates. The trace of manufactured objects' mineral origins has been lost on the consumer, and within the object. Craft artisans once sought to expose a beautiful grain and use its directional strength to promote and enhance 'good design' in a piece of furniture. We have since headed in another direction; a path of design concealment, where technology is packaged in slick containers, 'Bobjects' (Rashid 2002) to confound and delight without ever understanding the organic or technological origin – least of all without ever conceiving true embodied energy. Owners of Apple's super-slim iBook laptop computer would undoubtedly be reviled by the knowledge that ten tonnes (10,000kg) of production materials and energy are required to produce such a product – hardly the embodiment of visual and tactile designer delights to enhance portable computing.

Many product designers past and present have built a reputation as stylists – someone capable of giving a product a new look, but not capable of engineering or technological improvements. The fact that an apprehension exists between engineers and designers is well known, each sitting at ends of the technological continuum: designers questioning the lack of creativity in 'engineered' solutions, and in turn engineers questioning the need for the creative approach



designers bring to what is often technical problem solving. Heidegger (1977) raises similar issues in the relationship between humankind and technology. The progression of technology through history has been such that our understanding and use of technology has shifted. The craft artisan may be seen as engaging technology as a method for the 'revealing' of the craft object. The appreciation of the object-ness is absolute: an understanding that the artisan has brought together material and form to achieve an "unconcealment" of the object, "revealing the truth". Heidegger goes on to question the essence of [Modern] technology: the revealing (*poesis*) has been somewhat changed and has become a 'challenging', placing a demand on nature to provide the energy, ore, minerals and the very elements that sustain life. This shift to an anthropocentric model – man over nature - is further defined as a 'standing reserve'; a source of potential [energy] for whatever humankind decides to apply it to for the "maximum yield". The 'standing reserve' is however not simply a stockpile in the sense of a resource waiting to be consumed. It is in essence the possibility (designed) of technology to 'reveal' at humanity's disposal. In the final iteration of this concept, it is human beings themselves who become a source of standing reserve for technological production purposes. There is clear evidence of the value organisations place on the potential efficiencies to be gained in the effective management of their workforce – as any 'Human Resources' department would attest to.

Manzini (2004) presses the point in discussion relating to the social nature of production and consumption. In describing the "crisis of the common 'goods'" he presents the notion that we are now losing the ability to share or appreciate such resources. "...that belonged to everybody and nobody in particular." As long as these goods remained common they could not be owned or traded. A resource such as air or water, may construct such a sense of community in that it could not be bought or sold; therefore it could not be reduced to a tradable commodity.

Water, as a 'common good' has already passed into the realms of commodity and market ownership on a global scale. While access to water has historically provided a strategic position for the establishment of population groups it had always been available for all. To deny water was to deny life itself. The commoditisation of water in packaged consumer form is a phenomenon that has emerged in the past two decades and has now generated a global market worth an estimated 22 billion US Dollars in 2003. One quarter of the 89 billion litres of bottled water produced annually is transported outside of its country of origin – a direct contribution to global carbon emissions. ([www.wateryear2003.org](http://www.wateryear2003.org)). We have literally conceived a system and designed a product form whereby the trade in 'common goods' generates a waste stream of packaging and transport emissions greater than the mass of the intended commodity:

The common character of 'remedial goods' is that their use or consumption is not improving the quality of life or opening opportunities for the user. They simply restore a degree of acceptability to a context of life that has already been degraded.

(Manzini 2004)

The same may be said of design; at its best design solves problems, improves lives and brings beauty through form and function. At its worst design (in hand with designed promotion and marketing) generates an intense desire for ownership of what should not be owned, and cloaks the true nature of the ecology of 'things'.

## methodology

This project follows a path of inquiry based on revealing a distinctive paradox. As a design educator, product designer *and* craft artisan I have often found that working and researching in these three contexts does not always offer a level of synthesis. While one could argue that design is the common denominator, in reality the *approach to* design in each context presents a number of contradictions.

Design educators must maintain professional currency through engagement in research and practice. As a designer whose 'specialisation' is sustainable practice I have found that opportunities for 'research in practice' are extremely limited; in fact the primary opportunity for design research is centred on pedagogy and curriculum development. Therefore this project is based more in line with 'research on practice'; a series of 'snapshots' of engagement in designing and making. This facilitates reflective analysis during one-off or limited batch production of objects produced for the sole purpose of academic research. The emphasis shifts to researching in a conceptual mode, exploring through making of representational objects with limited or no production value and devoid of a true market context that would define an output as a 'product'. The paradox of product designer verses craft artisan is ever-present as the realisation of each idea is based heavily on a level of tacit knowledge of materials and processes. The project brief also has a critical role to play: in the case of the designer it is most often externally generated, focused upon a clear set of parameters and of a problem solving nature. In the case of the artisan: the brief is often generated from within, parameters are formed through tacit knowledge of materials and processes leading to an exploratory output (the client is unknown). Virtually no consideration of market or user feasibility is undertaken and the classification of the object as a 'design' requires only the presentation to a virtual market through exhibition or publication.



The value of practice based knowledge is implied through the design process, craftsmanship and aesthetic judgement. Linking this activity to a theoretical context *and* potential application in an educational context validates the research and at the same time negates the need for a true market context. Scrivener highlights the difficulty in validating research in creative production:

For these candidates the artefacts arising from the research cannot simply be conceived as by-products or exemplification of know-how. Instead they are objects of value in their own right. (Scrivener 2005)

### **Research on Lightness**

An initial engagement in broad based discussion of sustainability and the desirability of lightness lead to a phase of immersion and an initial series of 3D outputs documented later in this exegesis. The full revelation of meaning in these artefacts would not fully realise itself until much later in the process of researching and writing this thesis.

The theoretical component raises the notion of a design paradox. The problem that confronts design (and designers) is that design, in its undertaking, expresses a position on any contemporary or historical design issue – such as sustainability. The design of design itself is to engage in a process that is potentially unsustainable; requiring the designer to undertake the creation and production of the artefact that is both new and different. This paradox is explored through the production of a series of three dimensional designed objects (products) such as hand-crafted material interventions and limited (industrial) batch productions, primarily in plastic and composite materials. This production evidences the paradox via a series of ‘case’ studies. Each object will expose or contradict an existing product that best represents the lack of lightness and sustainability in contemporary industrial design practice. This is discussed further in terms of ‘common goods’ and the cloaking of the ‘truth’ to materials. Lightness, in the context of the user’s perception of an object may be typically represented, not just in relative mass but through visual

and tactile variations such as matt and gloss finishes, opacity, translucency, surface texture pattern and colour. In a sustainable context, lightness will be contrasted through reduced embodied energy, materials and processes, source, distance to market, product endurance and recyclability.

This design paradox was first explored in an exhibition of designed artefacts. ('Closing Time' – MA Design Year 1, AUT University, Oct 2006). The exhibition comprising four lightweight domestic bowls, each under 75 grams in mass, deceptively and delightfully expressed lightness through tactile and visual elements. What is not seen or clearly perceived is that beneath each form exists a dark and weighty path of mineral extraction, catalytic conversion, polymerisation, extrusion, tool-making, vacuum forming, machining and detailing.



Lightness at 'Closing Time' (M Boulton, 2006)

Secondly, while these objects represent a level of hand-made artisanship, the manufacturing process behind these lightweight forms also demonstrates a literal contradiction. Each of the lightweight vacuum formed shells requires a heavy mould or former consisting of approximately 8 kg of Medium Density Fibreboard. MDF is a *less than desirable* material consisting of low grade wood pulp bonded with a formaldehyde based resin. The formers are laminated using a PVA adhesive (also a potential carcinogen) then machined in a fairly wasteful and messy process requiring the maker to wear numerous items of protective wear. The formers are a typical representation of the often unseen tools and processes required to deliver beautiful objects to the consumer market.

Undoubtedly there is potential for a contradicting set of circumstances where weight, inertia and mass are desirable in the achievement of certain tasks - a paperweight, wrought ironwork, the feel of a ceramic vessel, and solidity in architectural constructions. This exposes lightness as a negative property. However when examined by a second underlying principle which focuses on associated issues of sustainability (economic, social and environmental), lightness is a pragmatic driver in terms of achieving reduced embodied energy and dematerialisation – key elements in Design for Environment (DfE) strategies (Lewis and Gertsakis 2001). Principles of lightness must be applied with knowledge, skill and care in order to safely maximise efficiencies in the design and construction of man-made artefacts, buildings and systems. The selection and application of materials for new product development (NPD) is part of a detailed iterative process, based on strong empirical evidence, proven business models and detailed engineering or scientific analysis. This again reinforces that notion that often the object fails to convey its value, the time spent in development or the historicity and origins of the form. What has 'gone before' is lost on the consumer, and a sense of intrinsic value is not clearly evident.

Contemporary product design practice has seen the integration of strong business and marketing models that now dominate successful NPD methodologies. Such principles as SET (Social, Economic, Technological) Factors and POG (Product Opportunity Gaps), and Stage Gate™ (Cooper 2001) process management strategies are starting to bring rigour, method and clarity to what is described as “the fuzzy front end” of product design and development.

In *Creating Breakthrough Products*, (2002) Cagan and Vogel identify seven classes of attributes that can create value by contributing to a product's usefulness, usability, and desirability -- all of which create an experience that fulfils a consumer's fantasy.

**Emotion:** The perceptual experience that a consumer has when using a product. It can include a sense of adventure, independence, security, or sensuality.

**Aesthetics:** A focus on sensory perception, including the visual form, tactile interactions, and auditory, olfactory, and gustatory signals.

**Product Identity:** A statement about individuality and personality, expressing uniqueness, timeliness of style, and appropriateness in the context.

**Impact:** The social or environmental effects, which are connected with the customer's personal value system and can often, help to build brand loyalty.

**Ergonomics:** A product's basic usability reflects its ease of use from both a physical and a cognitive perspective. It must also be safe and comfortable.

**Core Technology:** The ability to function properly and perform to expectations. It must be reliable enough to work consistently.

**Quality:** The durability, precision, and accuracy of manufacturing processes, material composition, and methods of attachment must all meet the customer's expectations

These 'value criteria' present an entirely anthropocentric model for NPD where the only needs met are those of the consumer, where technological, environmental, social and economic pathways lead to achieving high levels of user desirability rather than responsibility.

### **Methodology summary**

The place of lightness at the centre of this research project provides a point of reference to discuss the paradox that exists in the design of design. Product Design has its roots in the culture of materials and the desires and pleasures that mankind derives from the ownership of goods. This is contrasted against the work of the designer-maker or craft artisan who may explore the production of objects for the sole purpose of researching the relationship with the material in order to gain a greater understanding and depth of knowledge.

Through object making it is possible to challenge the perception of lightness (which is capable of description and scientific measurement in both quantity and quality) in a design context (which lays it open to a high level of subjectivity). This research project includes a series of 'lightness' driven material interventions; each has value in that it may offer the opportunity to reduce energy flows in manufacture and transportation of goods, embodied energy of materials and increase the aesthetic values and longevity of manufactured products. The highly questionable nature of the need for such objects will I hope, expose the lack of consideration that is reflected in a consumer society intent on exhausting our planets' resources (common goods) for short term enhancement of anthropocentric wants and *perceived* needs.

## discussion

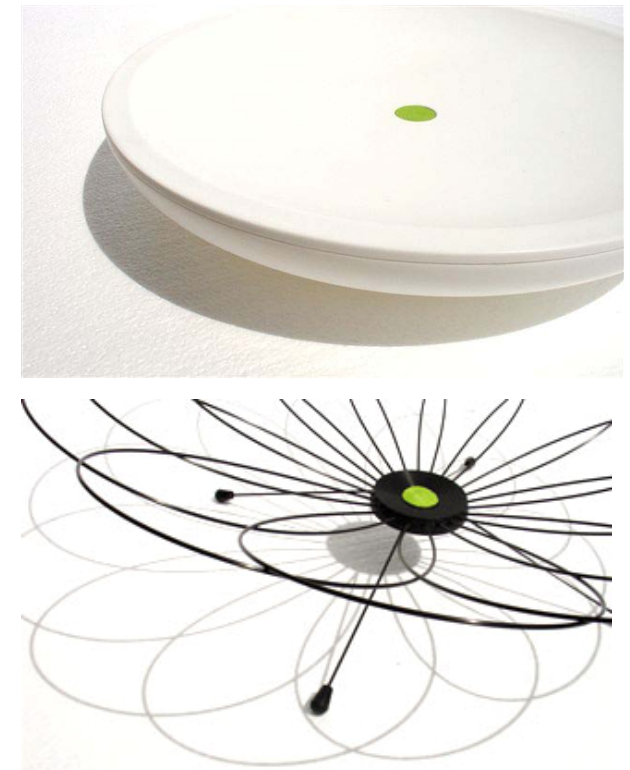
case studies exploring  
the paradox of sustainable product design

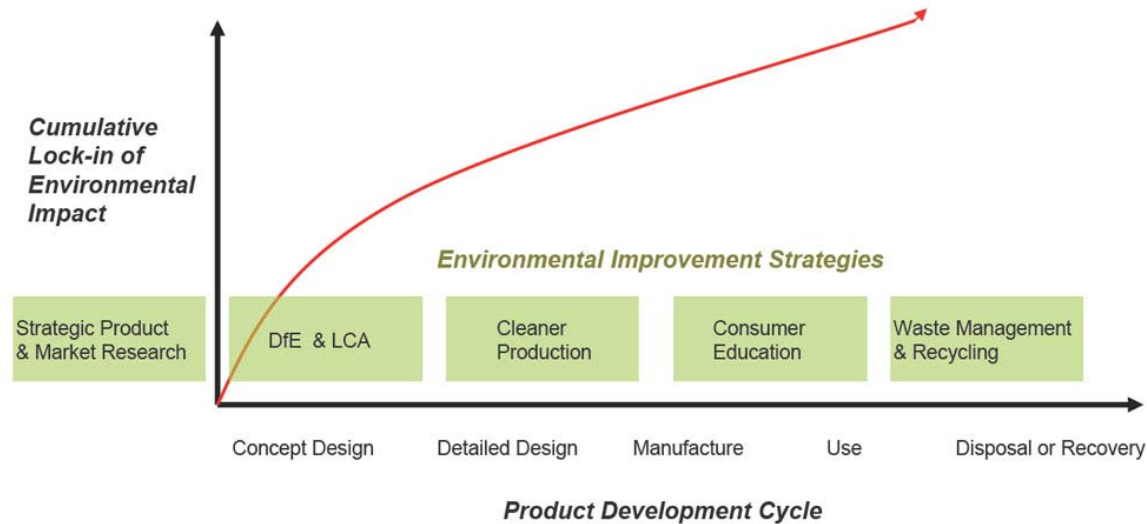
## case 1

### environmental lock-in

The investment in high-performance materials is not limited to military applications or the sport and leisure industry. Those who seek to market commonplace and everyday consumer products have taken a lead from the high-performance sporting goods industry. They have applied such materials as plastic, carbon and glass fibre composites, elastomers and synthetic rubbers to products such as ballpoint pens, razors, toothbrushes in the hope that we may believe we are just like our Olympic heroes! The superfluous and frivolous application of such high performance materials to low performance products is an example of the manipulation of design in the hands of marketers. The fundamental principles of sustainable product design requires of all designers to not only improve products, dwellings and systems but to improve the lives and experiences of the user through appropriate context, product stewardship and environmental responsibility.

Case 1 is a series of domestic decorative bowls constructed of very lightweight materials. There is simplicity in their form and an element of surprise when users engage with the product as the degree of lightness is unexpected. Like many manufactured plastic or composite products, the bowls mask a substantial body of material, technology and energy that goes into the production of the finished object yet remains unseen by the consumer. The lightness is evident and desirable, however it *is* superficial. This is a representation of the impact that a simple design decision, and lack of sustainable planning can have on the sustainability of a product. Lewis and Gertsakis (2001 pg 75) discuss the concept of environmental 'lock-in', where they identify the necessity to eliminate impacts at the earliest possible planning phase in the design process.





Lewis, H & Gertsakis J. (2001) Design + Environment.

These domestic low-performance products both contradict and exemplify the use of elastomers in such low stress situations. In the case of the bowls, the use of the elastomer is purely decorative, and featured in such a way that it may be removed or changed by simply 'popping' the piece out. However in the production of razors and toothbrushes the elastomer is over-moulded – irreversibly bonded to the substrate material. Such products, where possible, should be of homogenous construction. When materials are required to be blended to meet certain performance criteria, a design for disassembly (DfD) strategy must be engaged to enable closed loop recovery of materials at the products' end-of-life. I would advance the argument that every toothbrush decorated in rainbow coloured rubber polymers (in the name of market appeal) has voided its 'added value' quotient through misdirected use of inappropriate materials. I consider



the design intervention of elastomer grips has rendered the product useless – a ‘Frankenstein’ object, not capable of a second life via post-consumer recovery. There is simply no need for the humble hand-held domestic artefact to be designed and manufactured in such a way. Sustainable options do exist, yet they are seen as ‘alternative’ in the eyes of marketers and consumers alike.

As decisions to reduce environmental impacts are taken later in the [design] process, the more profound the damage done and the greater the cost of recovery. A case in point is has been the [d]evolution of toothbrush design. The marketing campaigns behind leading market brands have focused upon firstly the ergonomics of tooth brushing, and secondly the ability to achieve a whole-of-mouth cleaning experience. Product designers have sought to enhance the brushing experience by providing soft and brightly coloured elastomer grips on the handles and more recently interventions in the brush head to enhance cleaning capability.

In many parts of the world teeth cleaning is still carried out with great efficiency with a softwood stake or chewing stick. Certain timbers, such as Tea Tree (N.Z. Manuka), were used for their antiseptic qualities. Small sticks and roots are gathered, cut to length and cleaned. The end of a chewing stick is chewed to produce a fibrous pulp and then the fibres are used to effectively brush the teeth. This product concept is still widely available in health stores and also available for pets. In contrast the plastic toothbrush is made up primarily of two main components; the handle and the brush head bristles. The bristles are nearly always made of nylon and this is a highly recyclable material. The handle is most commonly manufactured from injection moulded polypropylene - another highly recyclable material. The process of over-moulding or co-moulding elastomers during the injection moulding process creates a permanent bond between the elastomer and the polypropylene rendering the toothbrush suitable only for landfill.



(Made-in-China 2007)

The argument for the addition of elastomers is fragile at best. The need for a high performance sports grip on a toothbrush or razor is less about function and more about increasing wants and desires through feelings of association. Jordan describes these as pleasurable products, delivering the user a pleasurable experience in one of four broad categories: Physio, Socio, Psycho and Ideo.

The toothbrush with its brightly coloured elastomer grips is typical of many current hand-held products where manufacturers have enhanced the tactile experience contrasting hard and soft and smooth with texture. (Jordan 2000)

The question, however, is how necessary are these features? Changes to the brush head are promoted as delivering a better cleaning action – a highly functional requirement and hopefully backed by a degree of research; after all cleaning teeth is the key requirement of a toothbrush. However, the application of 'grip' to the toothbrush handle raises the question of whether this is intended as an aesthetic modification or a truly functional requirement to avoid dropping (or even swallowing) one's toothbrush! This contradiction seems to be confirmed by recommended brushing methods which advocate a gentle and slow brushing action – hardly requiring the type of grip often seen on the ski pole of an Olympic downhill skier.

Given the potential to recycle all toothbrushes, and that approximately 100,000 tonnes of toothbrushes were disposed of to landfill in the US last year one can quickly understand how a small design decision can have a large impact. Using a form of streamlined life cycle analysis (LCA) gives some indication of where the impacts are occurring in the design of such simple everyday products. This information includes eco-indicator scores as a single piece of numeric data capable of representing a direct comparison for materials, manufacturing processes, packaging and transportation and end-of-life disposal impacts. Impacts occur in three phases of a product's life: manufacture, operational use and end of life. By gaining a greater understanding



(Colgate 2007)

of where and how impacts are occurring designers need only carry out streamlined LCA to have a real chance of reducing a products' 'eco-footprint'.

A plastic toothbrush in its most common form typically has a high impact in the manufacturing phase, reduced impact during use and high impact at the end of life. This could be contrasted with an electric toothbrush which would have a significantly increased impact during operational use due to its consumption of mains electricity or disposable batteries.

Visualise then a toothbrush manufactured from renewable materials, used in conjunction with phosphate free toothpaste during its operational phase and finally returned for recycling in a closed-loop system or potentially land-filled if made from biodegradable materials. The Radius toothbrush company produces such a product, offering alternatives such as a removable head and a handle manufactured from flax and post-consumer polypropylene or wood fibre blended with biodegradable plastic (PLA). Like many eco-products they come with increased costs that even the 'deepest green' consumer may be reluctant to pay.

Material/ Process	Unit (Kg)	Eco- Indicator Score	Positive Environmental Features	Negative Environmental Features
Polypropylene (PP)	1	26	Good fatigue resistance and durable - extended product life Low eco-indicator impact score Promotes closed loop material flows	Derived from a non renewable source (crude oil)  Marginally reduced physical properties compared with the virgin PP
PP Recycled	1	22	Reduces the amount of renewable Resources consumed Reduces eco-indicator impact score compared with the virgin PP	
EPDM Elastomer	1	63	Durable and good impact resistance - extended product life	Derived from a non renewable sources (crude oil) Not commonly recycled Often bonded with other plastics
Injection Moulding	1	5	Minimal waste generated	High eco-indicator score high resource investment - steel tooling
PP Incineration	1	86	Energy recovery from incineration	Depletion of resources which could be reused or recycled
PP landfill	1	0.7		Depletion of resources which could be reused or recycled Increased solid waste going to landfill

Source: RAT – Rapid Assessment Tool for Product Designers (Johns 2006)

It is important to consider that the actual product/object is in fact a form of packaging in its own right. The concept of 'product as packaging' refers to the fact that many products are actually a form of shell for the functional components inside. Walker (2006 p156) describes this as an "exploration of enclosure and exposure."

- *The product can be considered as comprising dominant and subordinate components.*
- *A primary concern of the industrial designer is the definition of the subordinate components.*
- *The design of these components as enclosure or facade is infinitely variable.*
- *The constant redesign of the subordinate components stimulate consumerism that can also contribute to effects that are detrimental to environmental stewardship, social justice and the creation of a meaningful material culture.*

It is this desire to manipulate the 'enclosure' or facade in the name of consumerism that has set generations of designers on a path of materialistic servitude. The father of responsible design, Victor Papanek (1995) probably said it best when he notoriously stated "There are professions more harmful than industrial design, but only a few of them." Product and industrial design practice has I believe, lost touch with its origins, and could be said to have been spirited away by the baubles of high market returns and personal recognition for the creation of an object of beauty. The truth is that beauty [of products] is perceived as only skin deep and this project aims to explore the paradox that exists within design: an inability to communicate the value of materials processes and the embodied energy contained within every designed object.

The desirability and enjoyment of the product is undoubtedly linked to its market success. Brand identification, point of difference and competitiveness contributes to the designing of minor iterative changes year upon year. If one is to examine the 'design creep' evident in toothbrushes

over 50 years it is clear the overall form of the object has changed very little. Anecdotal evidence suggests that the performance characteristics of the product are also without significant improvement. What has changed is that your current toothbrush now resembles a piece of mountain climbing or SCUBA diving equipment and that it is less recyclable than it was 50 years ago. These changes have been made in the name of marketing and have come at a cost to the consumer that is measured, not only in dollars and cents, but in lost energy, consumption of natural resources, loss of habitable land, reduced biodiversity and general pollution to the environment.

The series of lightweight plastic and composite bowls represents straightforward statements of design, on design. The experience of lightness - both visual and tactile is exhibited through a carefully crafted facade that is in effect, unnecessary, yet ultimately desirable. It is this pursuit of desirability that drives the over-decoration of everyday things, yet the actual cost of such material interventions is not fully understood by the majority of designers, producers or consumers.

## case 2

### rebound effect

Case number two is a reflection on the rebound effect and the myth of the 'paperless office'. As a focus for Case Two I have chosen to present an argument for the portability of arguably the greatest book of all time – The Holy Bible. This object is realised in the form of a religious artefact – a crucifix complete with built in 1GB USB memory chip. The crucifix is produced in polyethylene based light curing resin. Each piece is manufactured using SLA [Stereo Lithography Aqueous] technology as a means of creating one off prototypes with zero tooling and minimal waste. The finished product has a downloaded PDF of The King James Bible. This version has by some estimates been printed more than six billion times (IPL 2007). For Christians, the Word of God is often carried at hand as an object of worship, in the way of any religious artefact. The Holy Bible is widely accepted in secular society as an object that can be referred upon as a measure of truthfulness or honesty such as in Courts of Law. I have approached the design of this piece intending the user to have a highly personal, valued and wearable artefact that offers a viable alternative to a substantive printed text.

It is the honesty of this piece that I have tried to highlight – a low impact product, engaging contemporary, leading edge, and sustainable technology. This object and its underlying production methods assists in framing the paradox and complexity of the rebound effect argument. The 'God Is' USB is an example of production technology that is constantly developing and simultaneously unearthing new market opportunities, previously unexpected when the technology first emerged.



Stereo lithography is in effect, a form of 3D printing involving the integration of CAD, CAM and light sensitive polymer technology. Put simply, a computer generated drawing file is uploaded to a machine capable of directing a laser over the virtual surface of the computer image in a contained space. The space is layered or filled with a light curing polymer resin, which is in turn only cured upon contact with the laser light. The excess, uncured material is drained or swept away leaving only the solid object as an identical replica of the original CAD file. This process has a lightness that is unmatched by traditional plastic moulding production methods which involve the pre-production of tooling moulds worth many thousands of dollars. Initial use of this technology was restricted to model-making for design and architectural applications however recent developments in resin and plastic technology have seen opportunities emerge to make products of a more permanent nature. STL technology and its associated markets have shifted from prototyping to production. The longevity and performance characteristics of the resin has improved so significantly that production runs previously considered impossible are now being considered as an economically viable alternative.

The 'God Is' USB began as a series of drawings based around the smallest size USB memory chip available. An STL file was created using SolidWorks CAD software and the crucifix form was detailed to accept the chip in the lower section. Based on low impact eco-design strategies this 'plastic' object achieves lightness through:

- Homogenous material – no hybrid co-moulding or over-moulding
- Zero waste production method
- No coatings, paints, plating or sealants
- Cold construction attachment of peripheral items
- Embossed text detail – no overprinting

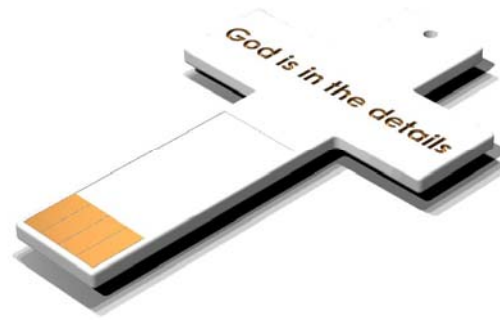


Images: Case 2

Drawing



CAD



Object



### Rebound Effect

Approaches to product design using recovered or recycled materials are subject to a phenomenon known as the 'Rebound' or 'Boomerang effect'. (Manzini 2002). A classic example is the Freitag Bag Company of Switzerland, which presented an innovative method of removing several potentially toxic or hazardous waste materials from the waste stream. Freitag's bags used recycled PVC curtain-sides from trucks, seatbelt webbing from cars and bicycle inner tubes. These were constructed into a well designed 'courier bag' which soon became a must-have in Swiss youth culture. The Freitag bag has grown in popularity to attain globally recognised icon status which inevitably brought about the rebound effect. The 'rebound' came in the form of Chinese copies of the Freitag Bag, using virgin PVC to imitate the look of the recycled original. As a result, an increase in the production of PVC as opposed to the sustainable opportunity to reduce PVC waste as presented by Freitag.



(Freitag 2005)

Examples on a greater scale include the predicted 'paperless office'. Proponents of electronic media and the arrival of the internet envisioned a day when paper would no longer be required for record keeping or communication. In reality the opposite was the case, with an eight-fold increase in paper usage at the time the paperless office was predicted to eventuate. An unprecedented 'rebound' was in effect as the ability to communicate became easier and faster we emailed more documents, wrote more personal communications and downloaded more data than at any other time in history. This information wave was printed and stored, both electronically and in 'hard copy'. The internet has also taken the blame for the increase in air travel. In the same way as paper based documentation increased, so too has our ability to conduct business in any corner of the world. The growth in western and emerging economies has been steadily increasing in size and velocity.

In my lifetime global population has doubled, energy production has more than tripled, economic output has risen by a factor of five, and computer processing speeds and

storage have both increased over a million fold. It took from the beginning of human history to the year 1900 to grow world economy that produced \$600 billion in output; today, the world economy grows by that amount every two years. (Thakara 2005)

## **Rationale**

It is clear that as a race of beings we have become genetically predisposed to reading on paper. The very design of fonts includes the use of serifs (or not – ‘sans’) to enable the eye to flow from one letter to the next first forming words then sentences of paragraphs and so on. The ‘feel’ of a good book may not only be measured by the quality of the writing within but also by the quality of the book as an object - binding, choice of paper stock and print quality of images and text. Many a product designer has tried and failed to capture the market of electronic books. In their various iterations we have seen attempts to bring about the portability of online content and the availability of the world's libraries. Most recently internet company Google have launched a proposal called ‘Google Book’. Their aim is to enable ‘search and sample’ on-line access to content from every book ever published. Currently Google estimate that only 20% of the world's texts are actually ‘in print’.

McDonough and Braungart open their account of Cradle to Cradle design with the examination of a book as a product. In the opening chapters they contrast the design of three books. The first is a standard paperback, glossy cover, good-quality paper stock and crisp clear printing, the sort of book one might find when purchasing a new paper back as you're about to embark on an international flight. The second book represents the concept of recycling or in this case ‘down-cycling’. The cover is flimsy; monotone on lightweight card-stock, the glue binding is of an organic nature and is beginning to fail. The paper stock is recycled and the ink is soy based providing a poor contrast and causing the eyes to strain. Book three is the representation of the Cradle to Cradle concept – a crisp clean plastic book (techno nutrient) with a polymer based ink that can be

washed off in extremely high temperature water – to be recovered for later use. Such a book meets all the requirements of an eco-product; efficient in production, low in impact during operational use and very low in impact during disposal and recovery. In terms of pure product design it is not unfamiliar. It is not the proposed electronic book of the future; it does not require any variance in systems for production, delivery or retailing. It brings pleasure to the reader in the same way as any other text would and it may be loaned, shared or resold within a secondary user scenario – extending product life indefinitely. (McDonough and Braungart 2002)

The 'Good Book' (Holy Bible) is widely available on-line in various forms of download from fully illustrated King James Version as a PDF file to daily excerpts of the scriptures sent to your mobile phone as a text message. The increase in the availability and use of portable electronic devices such as the iPod, PDA's and mobile phones has been complemented and enabled by the exponential expansion in the capacity of digital memory (RAM). Nokia has predicted that 70% of teenagers will be 'Always On' by 2010 – in other words always carrying a device that is internet enabled. While this may contradict the concept of a downloaded bible the reality is that on-line content is fluid – constantly changing and may not be available the next time content is sought. In contrast, The Bible, while available in many versions and translations, has remained essentially unchanged for many hundreds of years. Combining these factors into one product concept represents the potential lightness of carrying copies of personal information, family documents or favourite texts at all times. The nature of ubiquitous technology is now widely accepted – although many people may be highly unaware of just how ubiquitous the humble 'computer chip' has become. As the price of memory has reduced the ability to insert smart components into everyday objects has become more common. The 'singing' birthday card is an example of how disposable computing has come to pass.

So could a product such as the 'God Is' USB be the answer for environmentally concerned Christians? Here again we see the Rebound Effect at work and the critically complex path of designing any new product with pre-planned environmental initiatives. As stated in the introduction, computing is an area of manufacture that has huge environmental impact. While there are concerted efforts to 'mop up' the waste stream of post-consumer computers the reality is that the production processes of many computing components involves harmful toxic materials and waste laden packaging and transportation issues. According to a study published in the Journal of Environmental Science and Technology it takes 1.7 kilograms of material to make a typical microchip. This is a factor of 630 times the mass of the final product. (Graham 2002)

So how does the 'God Is' USB stack up against its bound hard copy version? Paper production is renowned for its high environmental impact. Paper in its lowest impact form, needs to be from a renewable source and of a non-bleached variety and printed with soy based inks. Unfortunately this is the type of paper unlikely to be found in the production of a quality text. As many Bibles are bought as gifts often the production values are high ensuring the longevity of the book.

The capacity of microchips continues to defy belief. The doubling of processing speeds (known as Moore's Law) occurs approximately every 18 months making your new computer effectively redundant after 2-3 years. The memory chips used in the production of the 'God Is' USB are 1GB but are also available in 4GB and retail for less than \$50. Such a 'chip' has the capacity to hold many thousands of pages of text, high resolution colour images and multimedia files. The potential exists for creative Christians to develop a truly personalised multimedia Bible to be carried, shared and further personalised over time.

So a digital Bible presents a smaller environmental footprint through a reduction in paper use. This reduction is ultimately questionable due to the fact that as a gift, a Bible may be kept

indefinitely, achieving 'cherish' or antique status. Finally the encapsulation of pages of data on a single memory chip offers no guarantee that these pages will not be printed anyway; and to further complicate the argument there are questions over the 'readability' of long digital documents. In essence this product represents the complexity of any SPD project. Gains and losses may be made through technical innovations in materials, dematerialisation through technology or achieving product longevity through increased appreciation of the designed object.

The rebound effect serves to highlight the complexity of sustainable product design strategies and the unpredictability of outcomes when human factors are added to the equation. To emphasize this fact the final designed feature in this product features an embossed quote from architect and designer, Ludwig Mies van der Rohe. Perhaps, with a greater understanding of the impact humankind has when design is undertaken, we may pay greater attention to even the most insignificant of design decisions, as if "God is in the details".



## case 3

### food miles

***Hey farmer farmer,  
put away that D.D.T now.  
Give me spots on my apples,  
but leave me the birds and the bees***

Joni Mitchell 1970 'Big Yellow Taxi'



The next case in this series of products focuses on issues of production, trade, marketing and transportation. The object is a titanium case for the packaging and carrying of produce across the globe via air transport. The case features a water-cut net (pattern) and is hand folded. It includes engraved details showing the international travel destination tags LAX [Los Angeles], AKL [Auckland] and the distance in kilometres [10517]. Titanium has been chosen as a high performance, lightweight material with exceptional longevity. It is also widely used in the manufacture of aircraft fuselage and engine components.

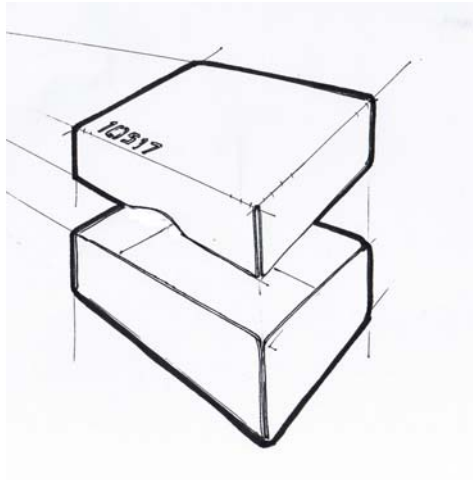
The object has been well received through display and user interaction. The sustainability narrative is embedded, reasonably complex and not immediately apparent. However the

lightness, detailing and playful nature of the object engages the user and raises a level of inquisitiveness. Small boxes are well known for their high level of desirability in an antique artefact context. This box is constructed of a material [titanium] that is unfamiliar to most people and could quite easily be described as exotic (making it most appropriate for the shipping of dried grapes across the planet). It is quite obvious that it is not aluminium (colour and stiffness) yet it is also lighter than a steel box of comparative size. The design is very utilitarian in as much that it takes its form directly from the fundamentals of packaging design and construction. The folds have been relieved with slotted cuts to allow for the easy and accurate bending of the titanium – a task that would have been nearly impossible for such a small and confined container as traditional sheet metal forming equipment would not have been able to access the interior space. The tolerance and fit were determined based on the original packaging for a 14g box of California raisins. This produce choice may also have contributed to the playfulness of the object as the food item in question is a stable ingredient in many children's school lunchbox. Users who have interacted with the product cannot resist repeating the opening and closing of the box due to its close fit and springy yet forgiving nature of the folded sides. The message on the top: **LAX-AKL: 10517 KM** does succeed in raising questions and initiating a discussion regarding Food Miles.

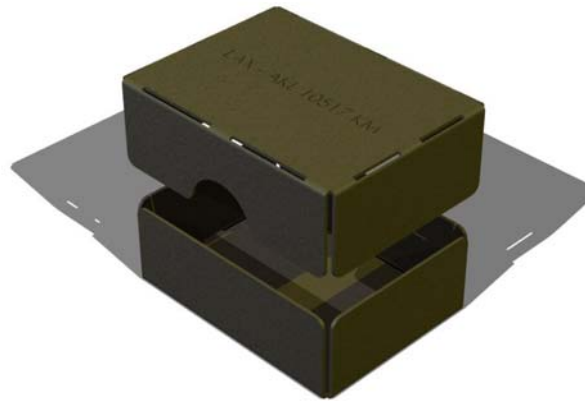


### Images: Case 3

**Drawing**



**CAD**



**Object**



## **Rationale**

“Food Miles” is but one of many popularist notions created by a number of Non-Governmental Organisations (NGOs) and intended to raise the level of concern surrounding globalisation practices and the ongoing economic, social and environmental impacts of global trade agreements. This challenges, directly, the very notion of ‘sustainable’ growth for all. As early as the 1970s writers such as Schumacher were advocating a more equitable approach to global economic management and the nature of trade, while Papanek and Fuller were extolling the virtues of design and technology to provide social equity for stakeholders as well as environmental stewardship. Popular culture has played an increasing role in raising awareness of the increasing differences between rich and poor countries. Events such as LiveAid and latterly Live8 concerts have seen the elevation to virtual sainthood of ‘rock stars with a conscience’ such as Sir Bob Geldoff and U2’s Bono [Paul Hewson].

The emergence of Triple Bottom Line business practices such as Extended Producer Responsibility and Corporate Social Responsibility has seen brands like BodyShop and Patagonia become market leaders having offered consumers a responsible choice when faced with the complexity of buying goods sourced and manufactured in an equitable and fair manner. NGOs such as Friends of the Earth ([www.foe.org](http://www.foe.org)) and Greenpeace ([www.greenpeace.org](http://www.greenpeace.org)) have spent much of the last decade raising awareness in the First World, of the plight of Third World producers who have suffered under increasingly stringent and one-sided trade negotiations. A number of high profile companies have been brought to task regarding the ethical nature of their commercial manufacturing practices offshore. Examples include Nike’s use of child labour to produce sporting goods (Boggan 2001) and Starbucks’ use of ‘Fair Trade’ coffee (Starbucks 2006). As designers, producers, manufacturers and retailers have come under the ‘green’ spotlight Governments too have been undergoing change. Nearly all first world governments have witnessed the mainstreaming of Green politics including proportional representation in

governments throughout Europe, North America and Oceania. This represents a paradigm shift from the traditionally held view of Green parties 'leftist' values and extreme policies. More recently, and of greatest concern to New Zealand, producers and exporters have witnessed the emergence of multiple campaigns based around the concept of 'food miles'. The essence of Food Miles is that food and produce travels unnecessary distances across continents and around the globe; all in the name of international trade agreements. In recent years the annual meeting of the World Trade Organisation has become the focus of increasingly violent protests against the G8 group of countries who dominate world trade negotiations.

Public sentiments regarding the fair and equitable exchange of goods across international borders have now extended to general awareness that buying locally is a more sustainable act – equitably and environmentally if not economically. In the United Kingdom the rebirth of traditional farmers markets has come hot on the heels of several major produce centred disasters – the 1998 BSE crisis, 2001 Foot and Mouth outbreak and more recently the threat of Avian Flu in the poultry sector. Increasingly consumers are turning away from imported produce in favour of locally produced meat, poultry, fruit and vegetables. A renewed appreciation of organic farming methods has seen the emergence of separate sections in the supermarket focused entirely upon organic produce. This has also sparked heated debate around the concept of genetically engineered or modified foods. New Zealand has for many years traded on its reputation for producing some of the world's finest produce, from beef and lamb to seafood and fruit; all grown in clean, green pastures nurtured by pristine streams and fresh mountain air. The challenge for our primary producers has always been our distance to market – either by sea or air which in turn adds cost and a direct challenge to maintaining produce freshness. Technology has nearly always saved the day - it is already 100 years since the first frozen meat exports left our shores for Great Britain. Our ability to overcome this distance challenge is now directly effected by the concept of Food Miles.

Transportation not only costs in terms of fuel and logistics management but now a direct correlation to CO<sub>2</sub> outputs or carbon emissions must be factored into export equations. The chart below offers comparison of the various modes of transportation. While New Zealand has always shipped the majority of produce by sea, it seems we cannot escape the fact that some produce is flown to Europe and North America and the link between the two has been seized upon by our competitors. As early as 1994 a German advertising campaign compared a locally grown apple next to a huge glossy imported New Zealand Apple; the latter was drizzled in engine oil indicating the pollution caused by transporting such produce.

Method of Transportation	Unit Tonnes/Km	Eco-indicator score
<b>Delivery van</b>	tkm	44
<b>Truck, 16 ton</b>	tkm	11
<b>Truck, 28 ton</b>	tkm	16
<b>Truck, 40 ton</b>	tkm	3
<b>Tanker ship, oceanic</b>	tkm	1
<b>Freighter, inland</b>	tkm	6
<b>Freighter, oceanic</b>	tkm	1
<b>Container ship, oceanic</b>	tkm	1
<b>Train</b>	tkm	1
<b>Air, intercontinental</b>	tkm	40

Source: RAT (Johns 2006)

The food miles campaign is also not without paradox and contradiction. In a recent address by British M.P., Stephen Byers, he called for an importation tax on produce imports citing each kilogram of NZ Kiwifruit carried a CO<sub>2</sub> emission of 5Kg due to the distance it was air freighted. In fact Kiwifruit are sea freighted like 99% of all New Zealand's primary exports. (Barnett 2007). And so the debate rages – with this response from our Minister of Agriculture: “As a recent Lincoln University study revealed, other produce grown efficiently in New Zealand and shipped to Europe is much less carbon intensive than produce grown in Europe.” (Anderton 2006)

Public reaction to media hype can be swift and often uninformed. Already the debate surrounding the transportation of food across the planet has switched to focus upon the travel industry. Travel journalism has started to embrace the concept of the carbon footprint and those who are ‘environmentally concerned’ are starting to reflect on the necessity of their travel plans. While the airline industry remains concerned, there is no evidence of an immediate drop-off in numbers, in fact the opposite has occurred as the number of people using air travel has steadily increased by an average of 6% globally, despite spiralling fuel costs and an initial slump following the Sept 11 terrorist attacks in New York. The World Wide Web now offers immediate relief to those fretting over travel plans with numerous carbon footprint calculators. My foray into [carboNZero.co.nz](http://carboNZero.co.nz) (operated by Landcare Research) to calculate the delivery of raisins from California indicates carbon emissions of 1156.87 kg. The website offers a secure payment interface where I am encouraged to donate NZD\$ 39.04 to offset my travel indiscretion – the payment going towards the cost of an established tree planting programme by this NZ government agency. (carboNZero 2007)

The production cost of each small titanium raisin box was approximately \$250 – 300 (materials and water cutting). While the question of worth, or need for such a small and expensive container has not arisen during exhibition of the product, perhaps this high value, desirable and collectable



form of packaging *is* a valid way of representing the true costs involved in the global, (and some might say unnecessary) exchange of consumer goods. Such a product is of course, economically and ecologically *unsustainable*, which is a true reflection on the perishable goods contained within and the systems of economic trade that continue to move them across the planet.

## case 4

### cherish



The final product in this series of explorations sought to make a direct and uncompromising comparison between disposable and cherishable objects. This object is constructed from a bale of crushed aluminium drink cans; a pre-recycling form created by Metalman recyclers in Auckland. These billets are then exported to Australia and Japan for reprocessing. The irony is that we have been unable to sustain a reprocessing aluminium smelter in New Zealand. The paradox is presented as a clash of old and new; of cherished craft work verses discarded post consumer waste.

A new product was constructed of 10mm aluminium plate fabricated into a rectangular box form exactly matching the weight and dimensions of the crushed can bale. The design concept was to offer a furniture platform as a side table or seating. The top plate was CNC machined with the words "Cherish – Nostalgic – Antique". Each word machined into the aluminium at a different depth of 0.25mm, 0.5mm and 1.0mm respectively. This detail represents the concept of product longevity: as the text would wear away over time, each word disappearing as the object achieved aged status.

The Dutch journalist Henk Hofland described the product aging process in one of his columns. He said that objects first become cherishable, after which they get nostalgic value. Finally they end up being antiques. The problem we face today is that many products don't even make it to the first cherishable stage. (van Hinte 2001)

While the narrative behind this product held all the right components: paradox, irony and a strong sustainability argument, the truth is that the context was lost on most, if not all casual observers (the piece had been on display in a public space for over one month). Shifting post consumer waste items into a furniture context is a questionable strategy and at best represents a 'holding pattern' until the next time the product is discarded. If the object is not desirable in its own right, nor triggers any of the *seven classes of attributes* (Cagan and Vogel 2002) identify as contributing to the creation of successful products, then it probably, as in this case, is doomed to failure. Discarded drink cans and slabs of cleverly engraved aluminium do not guarantee a desirable, useful, worthy or sustainable product. Discarded drink cans are a valuable source of recoverable material capable of existing in a closed loop, efficient energy cycle. It is the complex and interwoven social conditions associated with the use of such a receptacle that ensure it continues to fail to meet recovery targets – and no amount of designed irony will alter that fact.

### Rationale

Aluminium, like titanium is stripped from the earth in the form of ore, then processed using large amounts of energy. Bauxite ore is mined in Weipa in far north of Australia. The ore is shipped to Gladstone, Queensland where it is refined to extract Alumina powder which is in turn shipped to Tiwai Point in Southland, New Zealand. This aluminium smelter is the single largest consumer of electricity in New Zealand consuming one fifth of the total electricity consumption in the industrial/commercial sector. One tonne of aluminium consumes approximately 13,300 kW/hours. Source: Zero Waste NZ. Post-consumer recovered aluminium suffers nil degradation in the recycling-smelting process and requires just 5% of the energy required to produce virgin





aluminium. Packaging New Zealand in association with the Ministry for Environment sets guidelines and targets for the recovery of all forms of post-consumer waste including aluminium. The 2002 mass balance data for the aluminium sector indicates that 4615 tonnes of aluminium was produced for the packaging production (cans) and 3240 tonnes (70%) was recovered for recycling. (RONZ 2004)

### **Droog**

This object was to be something of a tribute to the Droog movement, both praised and derided for their 'dry' approach to irony and paradox in design. Many Droog designs capture lightness through an uncompromising truth to materials. Each product features an absence of ornamentation or over-decoration yet one would not describe the outcome as austere. In fact there is often a playfulness or tribute to some degree of utility that has been overlooked by a throw-away consumer society.

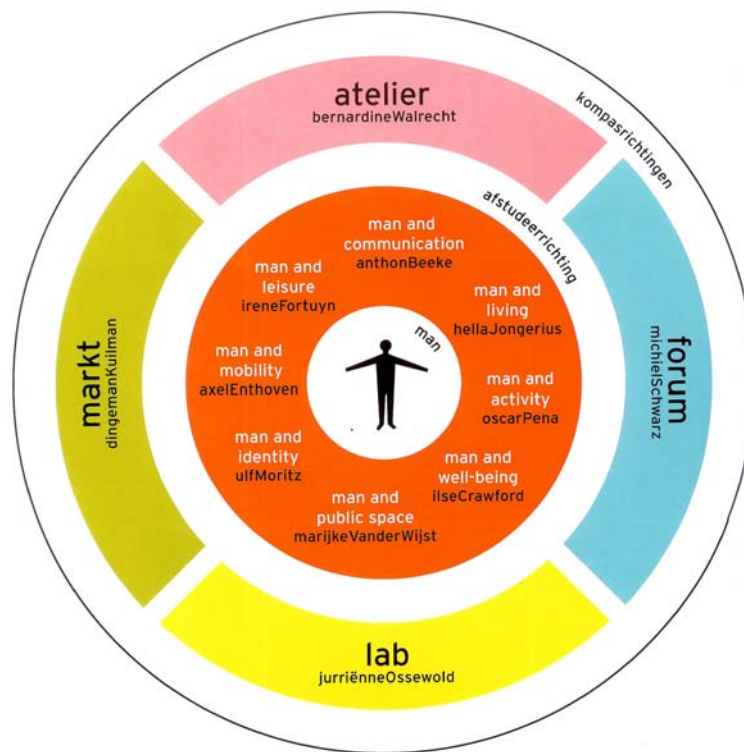
Again the paradox of such a design movement becomes evident as the popularity of such 'designer' pieces takes hold - Tejo Remy's rag chair sells for approximately € 2000 Euro. The Droog designers were leaders in a time when post-modernist design was at a loss as to where to go next. Not since the Memphis movement in the 1980s had such a collective emerged to become a benchmark for others to follow. Design groups such as Jam and El Ultimo Grito became the Avant Garde and design schools across northern Europe followed with the initiation of sustainable design courses at undergraduate and post graduate level.

Lightness and product longevity were design themes in general use amongst designers from the Dutch schools of design and engineering. The Doors of Perception conference in 2001 focused upon lightness as a theme. This was followed by the Time in Design conference in 2003 organised by the Eternally Yours Foundation and lead by Ed van Hinte and John Thakara. The concept of enduring products was discussed and work-shopped resulting in two acclaimed



Rag Chair – Droog Design  
(Remy 1993 )

editorial publications combining the outcomes of ten years of research. As the sustainability debate has evolved to a more mainstream forum, design institutions have inevitably shifted focus. Recently the very identity of 'Dutch Design' has been brought into question and this has seen a major rewrite of the design curriculum at the Eindhoven Design Academy. Criticism from industry and student graduates as to the unpractical nature of the design outcomes emerging from Eindhoven programmes has seen a shift in focus to a more user centred model in which 'Man' is as the centre of all design interactions.



(Eindhoven 2007)

With the exception of examples from the automotive industry (ironically) virtually no product has a planned lifespan beyond 20 – 40 years. It was understood that “making a product last long is different to making a long lasting product.” (van Hinte 2004) The theory of enduring products was more complicated than first thought. Van Hinte observes that there is a ‘possession hierarchy of value’, whereby new things differ in newness value. The example given is that cheap electronic devices such as DVD players and printers have become so low in price that they are perceived as disposable. Objects that have a residual emotional value such as toys, jewellery, musical instruments tend to be passed amongst family members until eventually sold or traded on-line on forums such as eBay and Trade Me. Product longevity cannot be said to be a ‘magic bullet’ for designers. It cannot be achieved through clever aesthetic manipulation and it cannot be imbued through mass personalisation. Whilst antique status may be desirable for some types of object, many household effects should have an intended short lifespan. With this in mind designers need to plan for a closed-loop cycle with the full intention of returning each and every material to its source.

## summary

The primary purpose of this research project was to explore a singular element (lightness) within accepted sustainable design practice to highlight the complexity of the issues facing designers in an age of extended producer responsibility and heightened consumer awareness.

The research takes a position in which Lightness is advantageous:

- If there is less of something from the onset of design, then less energy has been consumed in the manufacturing or production phase.
- If the product is lighter or consumes less energy in the use phase, social and environmental impacts are reduced.
- If the product remains light at the end-of-life phase; disposal, recovery or renewal costs are reduced.

However achieving lightness is more complicated than simply selecting materials that are physically light. The origins of many light materials have their roots in some of our most energy hungry and destructive production methods known to humankind. The extraction of ore, minerals and oil from the earth's crust to produce highly refined, high performance materials undermines the concept of truth to materials. While a craft artisan may draw deeply on knowledge of natural timbers or even manufactured materials, the same knowledge is somehow lost in the design of consumer good for mass manufacture. The amorphous plastic forms that encase our ubiquitous technologies provide consumers with a style statement that is a short term fix for a dependency on newness in ever shortening cycles. The true origins of technocentric materials are a world apart from the daily users who seek convenience and produce the detritus of westernised living.

Design and the design of design must surely be at the forefront of any discussion regarding the future stewardship of manufactured goods and services. The way in which we conceive systems for the production, consumption and disposal of artefacts has evolved over many hundreds of years, yet it is only in the past few decades that we have come to witness the consequences of our short term thinking. Humankind must question the very concept of design; that the design of design is the very thing that must engage lightness. This will require designers to undertake a rationalisation of the aesthetic and anthropocentric values that have defined the modernist and postmodernist eras, and to embrace the essence of what it is to create artefacts that supplement, nurture and improve all life during, and beyond our very brief stay upon this planet. There exists a certain irony in post modernist design's focus on function and form. The objects produced as part of this research project each represent the paradox between desirable, designed products and the potential crisis within. While I have attempted to use irony to portray the complexities and paradoxical dimensions of sustainable product design, this strategy has been, on reflection, only moderately successful. Examples for a truly sustainable product design process exist in the non-anthropocentric life-cycles of planet Earth yet designers seem only to embrace nature in terms of mimicking *form*: the step to embracing nature's *functional* lightness remains sadly elusive.



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## NOTES