Designing for Zero Waste

‘In a world where more and more people are consuming more and generating more waste this book is vital reading. In a society where most of us are consciously and sub-consciously detached from the reality of our own supporting ecosystems this book is vital reading. In an economy where precious resources are produced so cheaply that we can throw so much of them away this book is vital reading. In an environment being stripped of its resources, being polluted and made toxic on an industrial scale this book provides a real chance to re-connect and re-think our relationship with the supply and waste streams we take for granted in our unsustainable lifestyles. That re-connection is essential and this book shows us ways to make it happen. Please read it.’

Professor Susan Roaf, Heriot-Watt University, Edinburgh, UK

‘Designing for Zero Waste is a timely resource and guide covering basic principles to city and regional governance. The flows of the waste created in our daily lives and building processes are largely ignored, misunderstood, or misinterpreted. This book should inspire a better understanding of material efficiency, avoidance of waste, and re-thinking material flows at a variety of scales and professions.’

Professor Alison Kwok, University of Oregon, Eugene, USA

Materials and resources are being depleted at an accelerating speed, and rising consumption trends across the globe have placed material efficiency, waste reduction and recycling at the centre of many government policy agendas, giving them an unprecedented urgency. The complex nature of the problem requires an increasing degree of interdisciplinarity. Resource recovery and the optimization of material flow can only be achieved with behaviour change to reduce the creation of material waste and wasteful consumption. Designing for Zero Waste aims to develop a more robust understanding of the links between lifestyle, consumption, technologies and urban development.

Professor Steffen Lehmann, PhD, is the Director of the Zero Waste SA Research Centre for Sustainable Design and Behaviour at the University of South Australia. Steffen is a widely published author and scholar and is Founding Director of the s_Lab Space Laboratory for Architectural Research and Design (Sydney–Berlin), as well as editor of the US-based Journal of Green Building and an advisor to Australian and German governments, city councils and industry. See www.slab.com.au.

Dr Robert Crocker is a Senior Lecturer in the School of Art, Architecture and Design at the University of South Australia, and teaches both the history and theory of design and the School’s Master of Sustainable Design. With an Oxford doctorate in modern history (1987), Robert has published one monograph and two edited books. He is currently working on the role and idea of the national past in shaping Anglo-American domestic design and consumer culture in the 1920s and 1930s, and is developing another project on the role of technology in shaping consumer behaviour and attitudes towards waste. Find Robert’s homepage at www.unisa.edu.au.
All books in this series are authored and/or edited by leading academics and practitioners in the field of sustainable design.

Although there has been an immense amount of theory- and technology-focused writing published on the topic of sustainable design, many of these books have failed to introduce readers to the wider challenge of what the rethinking of design, production, operation and recycling of all products, buildings and cities really means.

Sustainability is not a passing fashion, and people are constantly searching for more information, ideas and products in this area. This new book series will aim to develop a more coherent theoretical framework for how different theories of sustainable design might engage with the practice of architects, designers, urban planners and related professions. The knowledge gained from this book series will equip the readers with the tools for realizing the full potential of the good intentions of sustainable design.

The aim is that these books will provide a novel alignment of interdisciplinary perspectives on the problems of global consumerism, sustainable design and strategies to avoid resource waste, on the scales of products, buildings, districts and cities.

The books will become essential reading for architects, industrial designers, urban designers and researchers/students in these disciplines. Potential readers for the books will also include industry and government agencies. Global relevance and the potential for use as textbooks will be essential.

The book series has been developed in coordination with UN-Habitat and will become a highly useful addition to the literature on sustainable design, urban development and city culture, focusing on the key topics encountered by students and scholars of urban studies, pointing towards related bibliographic material.

If you have an idea for the series then please contact the series editor.

**Series Editor of the Sustainable Design Book Series**

**Professor Steffen Lehmann**, PhD, is an internationally highly respected architect, urbanist and scholar, the Professor of Sustainable Design, Director of the ZWSA Research Centre for Sustainable Design and Behaviour (sd+b), at the University of South Australia. Steffen Lehmann has also been the UNESCO Chair in Sustainable Urban Development for Asia and the Pacific since 2008, the first such chair created with a particular view towards the rapid urbanization process in Asian cities. Since 1992, he has practised as a registered and licensed architect and urban designer in Berlin, where he established his own practice, the Space Laboratory for Architectural Research and Design (s_Lab).
Designing for Zero Waste

Consumption, technologies and the built environment

Edited by
Steffen Lehmann and Robert Crocker
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Editors

Robert Crocker is a Senior Lecturer in the School of Art, Architecture and Design at the University of South Australia, and teaches both the history and theory of design and the School’s Master of Sustainable Design. With an Oxford doctorate in modern history (1987), Robert has published one monograph and two edited books (in The International Archives in the History of Ideas series). He is currently working on the role and idea of the national past in shaping Anglo-American domestic design and consumer culture in the 1920s and 1930s, and is developing another project on the role of technology in shaping consumer behaviour and attitudes towards waste. For a brief publication list, see Robert’s homepage: www.unisa.edu.au.

Steffen Lehmann is the Professor of Sustainable Design and Director of the Zero Waste SA Research Centre for Sustainable Design and Behaviour (sd+b), at the University of South Australia. Prior to this, he held the Chair of Architectural Design in the Architecture School at the University of Newcastle (NSW). He has held a personal Chair in Australia since December 2002. He is the General Editor of the US-based Journal of Green Building and a member of the editorial boards of five academic journals. Steffen has held the UNESCO Professorship in Sustainable Urban Development for Asia and the Pacific since 2008. In 2009–10 he was the DAAD Professor at TU-Munich and a Visiting Professor at NUS in Singapore. He was also a Visiting Professor at the TU-Berlin and at Tongji University in Shanghai (2005). He received his doctorate in architecture from the TU-Berlin, an AA Diploma degree from the Architectural Association School in London, and a Masters degree from the University of Applied Sciences in Mainz. Between 1990 and 1993, he worked as an architect with James Stirling in London and with Arata Isozaki in Tokyo. In 1993, Steffen established his own ideas-driven, research-based practice in Berlin: the Space Laboratory for Architectural Research and Design (s_Lab), to pursue a more ethically correct practice. In 2010, he wrote The Principles of Green Urbanism and, in 2009, he edited Back to the City. For more information, see: www.slab.com.au.

Contributors

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Sue Bigwood was raised on Kangaroo Island, South Australia. She discovered an innate passion for wildlife among a rural culture and strong community spirit. She graduated from Murdoch Veterinary School in 1989, and has spent her veterinary career largely at Zoos SA, in wildlife medicine and in situ conservation work. With developing interests in biodiversity, biosecurity, landcare and human health, her role at Zoos SA is now one of networking and coordinating the multidisciplinary, cross-agency core of wildlife health stakeholders. The benefits will be increased capabilities in the wildlife health sector through improved education, research and leadership. Her spare time is full of family and growing fine red wine, back on Kangaroo Island.

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Jaco Huisman is Scientific Advisor to the United Nations University Institute for Sustainability and Peace (UNU–ISP), a position he has held since 2006, focusing on electronics recycling in a global context. He leads UNU’s Electronics Recycling Group and co-coordinates the TaskForce Capacity Building and Knowledge Management of the UNU-based StEP Initiative (Solving the e-waste Problem; see: www.step-initiative.org). In this role, he is responsible for a large project to further quantify the amounts and problems of e-waste worldwide in cooperation with research institutes and universities in Europe, China, the US and the Middle East. He is also leading various international research projects related to e-waste, including the UNU study supporting the European Commission’s 2008 Review of the EU WEEE Directive. Jaco obtained a Masters degree in Chemical Engineering at Eindhoven University of Technology in 1999 and a PhD in 2003 from Delft University of Technology. Since 2004, he has run his own consultancy company, OsevenfortytwO (see: www.osevenfortytwo.com), and, as a consultant, he has given advice to a large number of producers, governments and recyclers in Europe, the US and China to improve eco-efficient operations, waste policies, system organization and product design. Since 2003, he has been an Associate Professor at Delft University of Technology, the Netherlands.

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Kurt Lushington graduated from the Flinders University of South Australia in 1998 with a PhD in Psychology and a Masters degree in Clinical Psychology. Associate
Professor Lushington has been an academic with the University of South Australia since 1996 and is currently the Head of the Discipline of Psychology and the Associate Head of the School of Psychology, Social Work and Social Policy. In addition to his clinical and research work in sleep medicine, he has a keen interest in all issues to do with sustainability and especially the role of e-books and e-book reading devices and the paperless office. He has published numerous peer-reviewed journal articles in psychology, eight book chapters (including several specialist chapters on sleep written for senior high school students studying psychology) and three review/research papers on e-book technologies.

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Stephen Pullen is a building scientist with twenty years’ experience in the study of the sustainability of construction materials, buildings and the urban environment. He teaches building science, performance of buildings, energy efficiency, building surveying and sustainability in assets and facilities, and is also a PhD supervisor in this area. His research interests include life-cycle energy analysis and the embodied energy of buildings and he has published numerous papers in these areas. He commenced research into embodied energy in 1993 and participated in the Australia Research Council (ARC)-supported project, Design of Environmentally Responsible Housing for Australia, at the University of Adelaide, South Australia. In 2003–4, he was a Chief Investigator in the ARC Linkage project at the University of New South Wales on Water and Energy profiles for Sydney: Towards Sustainability. As part of his PhD studies, he developed a model of the urban environment that spatially represents embodied energy consumption. He is currently a Chief Investigator in the
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Management of Construction. His interest in building legislation led George to establish the Centre for Building and Planning Studies at the University of South Australia in 1993, and this has resulted in several research projects dealing with the impact of legislation on development and, more recently, on bushfires and government policy responses to the impact of bushfires and organizational change. George is also a member of several professional bodies (including RICS, AIBS and ACCE) and serves on a number of their education and accreditation committees.

Jian Zuo has a PhD from the University of South Australia and a Masters degree in Engineering from Wuhan University, in the People’s Republic of China. Currently, he is a lecturer and researcher in the School of Natural and Built Environments. His main research interests relate to achieving a low-carbon built environment by means of innovation and behavioural changes.
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We hope this publication will become a useful resource for academic teaching, further scholarly research and policy formulation in the process of transforming the way we design, produce and recycle products, buildings and cities.

Steffen Lehmann and Robert Crocker
May 2011
Foreword
Designing for zero waste

Vaughan Levitzke

This book is for policymakers, designers, engineers, architects, sociologists, psychologists, recycling and waste practitioners, economists, resource developers, students, lecturers – and everyone who cares about how we use, reuse and value our resources in a resource-constrained world. For the first time we have a book that views the ‘zero waste’ concept from the perspective of four key interrelated areas – sustainability and behavioural change, consumption and technologies, the sustainable design of our built environment, and, finally, governance and material flows. Zero waste is a concept that ultimately envisages a thriving society that exists within nature’s resource constraints and its ability to assimilate waste.

This book brings together global leading-edge research about the achievement of zero waste and a more sustainable society. This is a truly collaborative and multidisciplinary approach – the type of approach we should use if we are to reduce our ecological footprint, combat global warming and make the best use of the resources we need to sustain our societies. The authors are passionate experts in their respective fields. They have been brought together to contribute through the persuasive and motivating powers of Professor Steffen Lehmann at the University of South Australia’s Zero Waste SA Centre for Sustainable Design and Behaviour.

The concept underpinning this book is based on the idea that design and human behaviour are interlinked. Bad design results in waste throughout the life cycle of a product, from raw-materials extraction to its use and final recycling and disposal. Starting with an examination of behaviour and the psychology of our consumption and the choices we make, the book continues with articles exploring the newest waste issues facing us – electronic waste, energy consumption and life-cycle analysis. Next, the way we design our urban and household infrastructure, including green infrastructure, is discussed, and, finally, how we can bring these concepts together in our cities, where there are some extraordinary growth pressures and challenges.

The term ‘zero waste’ is believed to have first been used by chemist Paul Palmer when he created his company, Zero Waste Disposals, in California in the 1970s. Three decades later, Robin Murray’s book, Zero waste, was published by the Greenpeace Trust. The term is now being increasingly used throughout the community. It is shorthand for the better management of resources in an increasing number of corporations and governments around the world. Zero waste is a way of thinking and doing that will become even more commonplace and important as we attempt to deal with the big environmental, social and economic issues facing all of us. The concept of zero waste challenges the assumption that waste is inevitable or unavoidable. Zero waste shifts the focus from
‘end-of-pipe’ solutions and disposal practices, to promote the cyclical use of materials in the economy.

When Zero Waste SA was formed in 2003 as a government statutory authority in the state of South Australia, many commentators and waste-industry professionals thought that zero waste was impossible, and that the term was nonsensical because ‘humans will always produce waste’. Many of those deriders are still around today. However, there is an increasing global engagement around the concept of zero waste, with many large corporations adopting the principle as an aspirational goal.

Although our community effort has largely, until now, been about recycling, the reduction of waste and extending the life of goods remain the Holy Grail of the waste industry. Much of the waste we create need not be created in the first instance. While it provides benefits by extending the life of materials in our economy, recycling is of lesser value than not producing waste in the first place.

This leads us to question how we can expect to be able to do this in such a consumer-driven, economic growth-focused society. For many years we have understood that design and behaviour are linked. The ‘throwaway society’ is a product of these forces at work. Many products are not designed for reuse, use rare materials in their construction and have a short lifespan before the next model comes on to the market; electronic gadgets are probably the best example of this carelessness.

In 1999, the world’s population reached 6 billion. Just twelve years later, during 2011, the world’s population is expected to reach 7 billion, and it continues to grow. Most of these people will, for the first time in history, be living in urban environments, and it is expected that the city-based proportion of the world’s population will rapidly increase. The prospects of new employment opportunities and improved lifestyles will continue to encourage rural people to move to cities. These issues are not just the province of the world’s megacities, as the trend is for all principal cities to grow for the foreseeable future. Urban populations are growing much faster than rural populations.

Resource scarcity, increased resource demand, growing pollution, the use of more complex materials in manufacturing and the distances goods and materials are transported in our modern economy will, in all likelihood, exert significant upward price pressures on products and materials into the future, making it even more difficult for poor communities to be released from their poverty.

Greater urbanization places increased demands on urban infrastructure and services, to the extent that governments find it difficult to cope with these demands. How do we live more sustainable lifestyles in an urban context where we must import our food, clothing, shelter and other basic materials? How do we build an urban form that is sensitive to people’s needs, without further negative impact on the natural environment or human health?

The responses to this growth have been varied, depending upon local demands and circumstances. The lessons learned by one city are not necessarily transferred to others. Given these challenges and pressures, we can ill afford to replicate the mistakes of others, as this is inevitably both expensive and time consuming. In an interconnected world, these issues should be more easily overcome. We can use social media for political revolution; can we use the same media for sharing information and concepts in a more creative way, to bring about these other changes?

Increasing volumes of waste and the increasing complexity of our waste streams have also caused concerns about public health and the environment to grow. Increasing waste
volumes closely correlate with increased affluence, and the cycle of technological advancement quickly outstrips social and legislative reform. These challenges confront all of us, as we live in an increasingly resource-constrained world.

Zero waste requires new designs for the environment: designs that influence our behaviour to reduce our generation of greenhouse gases, reduce our consumption of materials and reduce our ecological footprint. Designs may include those that allow for disassembly for reuse; better insulation properties for buildings; lighter construction and fabrication materials; and the use of materials that can be easily recycled. Given that the built environment is created by major capital investment and is expected to last at least 30, 50 and preferably 100 years or more, it is fundamentally important to identify materials, techniques and systems that will last the distance and that can be reused or recycled when the structure is no longer needed or when it needs to be upgraded.

To achieve this we need data. Data about life-cycle assessment of products and materials are sorely lacking, as are data that reflect the amount and types of waste being collected and disposed of every day. Without this information, how can we expect to identify the better products and services and reduce our waste?

Maximizing the value of our resources focuses our attention on local infrastructure, economic interventions and incentives for change. It also aims to maximize the social and economic benefits from the resources we consume. Avoiding and reducing waste require a more thoughtful approach to the way we use resources and the choices we make as governments, businesses and individuals. Committing to zero waste is about making long-term choices based on behavioural change and principled engagement.

It is my hope that reading this book will change the way you approach your work, your home life, choices you make and the way you perceive, use and reuse resources.

**Vaughan Levitzke** is the Chief Executive of Zero Waste SA (ZWSA), a position he has held since the South Australian government agency’s establishment in 2003 within the Environment and Conservation portfolio. The objective of Zero Waste SA is to promote waste-management practices that, as far as possible, eliminate waste or its consignment to landfill, advance the development of resource recovery and recycling and are based on an integrated strategy for the state. South Australia is staying at the forefront of waste recycling and resource management in Australia and attracting international interest. Having helped reduce waste to landfill in South Australia by 16.1 per cent in six years, Zero Waste SA continues to stimulate investment in infrastructure, foster partnerships and collaboration and drive industry resource efficiency.

Vaughan has been the ministerial representative on the board of Keep South Australia Beautiful for twelve years. He is currently on the advisory boards of two University of South Australia research centres and is a member of the management committee of the Zero Waste Centre for Sustainable Design and Behaviour. He is a former member of the national projects group established under Australia’s national packaging covenant. He is an *ex officio* member of Zero Waste SA and is a member of the Environmental Protection Authority board’s waste reform subcommittee. Prior to ZWSA, Vaughan spent ten years with the South Australian Environment Protection Authority. His role focused on regulation in the waste sector (recycling, tyres, composting), litter policy development and the expansion of container deposit legislation. He was also responsible for managing eco-efficiency and industry sustainability programmes and grant schemes.
Preface

Zero waste: towards a vision of a new model for humankind

Peter Brandon

This book is both timely and visionary. Human consumption is increasing ever more rapidly, and this book addresses how we might reverse the trend, particularly in the developed world. The aspiration to consume, however, is just as high among people in the developing world, and so this book is equally applicable to those countries and their populations. As consumption, and the resultant waste, requires an understanding of human behaviour, the technologies adopted and the way in which humans choose to live, it is an extremely broad canvas. It is to the credit of the editors that the assembled authors have explored so many important issues and thus improved our understanding of the topic. Good practice comes from good theory. This book provides an introduction to the underlying theory and knowledge on which the practices required to move towards the concept and vision of zero waste will be based. The way in which humans choose to accommodate their activities in buildings and cities is central to the issues raised. The United Nations’ Environment Programme’s Sustainable Buildings and Construction Initiative (2007) estimated that the built environment uses 20 per cent of the land, 20 per cent of the water, 30 per cent of the raw materials and 40 per cent of the energy in global resource usage. From this activity, it generates 20 per cent of global waste effluents, 30 per cent of solid waste and 40 per cent of human global carbon dioxide emissions. By 2040, it is estimated that two-thirds of the world’s population will be living in cities, with a consequent rise in the production of waste. This is not a trivial matter – it is at the very root of human existence and even survival.

Life context

Perhaps the greatest question we can ask ourselves is ‘Why are we here?’. Is there a meaning to life, or are we just the result of chance processes? Don’t worry; this essay is not attempting to answer these intriguing questions. There is, however, an observation that we can make and that does not seem especially contentious. If we look at life in general, and the human race in particular, all species want to survive. It appears that we are hardwired to procreate and to sustain our existence for as long as circumstances allow. When the context is benign, then all species will thrive and produce more offspring. This was brought home to me by the trailer for a new natural history documentary narrated by the veteran broadcaster David Attenborough. He started his narration by explaining that, during his working life (some six decades), the population of the world had trebled. This is extraordinary exponential growth, which has lead to some of the greatest challenges we face today.
In the spectrum of universal time, the last sixty years form a very short span indeed, and we can see that those decades have provided favourable circumstances for humans to flourish. The human ability to flourish, however, has not meant that other species have also found the environment conducive to expansion. In fact, the rise of human beings and their technologies has often resulted in the devastation of other species’ habitats and, consequentially, the demise of many, at a speed that this world has not experienced before, except in times of natural disaster. Much of this is related to humans’ consumption and the subsequent waste and pollution created. The loss of other species has already had an impact on the ability of human beings to provide our food and shelter.

**Survival**

In his 2003 book, *Our final century*, Martin Rees, a recent Astronomer Royal, posed the question as to whether the human race can survive for another 100 years. It is not so long ago that such a question would have been considered ridiculous, because the world was considered to be a stable entity, and the interdependence within nature was not considered to be a major problem.

Rees identifies disease, war, famine and, above all, technology as the major reasons for concern. Virtually all technologies have an upside and a downside. They provide a solution to one problem but at the same time create a problem elsewhere. In the hands of those perceived to be ‘good’, the technology can be a force for improvement, but, in the hands of those who are thought to be ‘bad’, the technology can create a monster that we find difficult to control. Nuclear fission, the internal combustion engine, genetic engineering, the Internet, global alliances or antibiotics can all be seen as either good or bad, depending on the lens through which we view them. If human beings are in charge of them, and human circumstances are such that they find a use to suit their own ends, then it is likely that both the good and the bad aspects of any technology will be found in our societies. Sometimes, human motivation is openly malevolent (as in war), but in most cases a new technology is adopted with the best of intentions, only to result in a by-product of its use having a detrimental effect on something else.

To take one example, the Aswan Dam in Egypt was built for two main reasons. First, to provide a substantial proportion of Egypt’s electricity by damming the River Nile and providing hydroelectric power. Second, to avoid the frequent flooding of the Nile and the inconvenience that event caused to communities along its length. The Aswan Dam did indeed provide electricity and it did reduce the river’s propensity to flood. Unfortunately, the lack of flood waters simultaneously prevented the rich silt associated with the floods from being spread across the land, and thus the land became less fertile. To counteract this, it was necessary to produce artificial fertilizer (requiring energy-demanding processes and transport), which eventually seeped into the river and polluted it. Consequently, the natural systems became unbalanced, and new problems arose. It has yet to be seen what trade-off was sensible in a complex ecosystem such as this, but the example does reveal the need to consider environmental problems in a holistic manner.

**Consumption, waste and values**

The urgent issue of human consumption is one of this book’s major themes. How do we avoid increased consumption, which leads to more waste being generated and more
pollution affecting the planet? Human population growth, and the increase in consumption that follows, is the root cause. It is the countries that industrialized first and that gained wealth accordingly which have created the problems being observed today. The aspirations of others to do likewise are beginning to cause similar concerns. The most populated nations of earth, namely China and India, have the potential to consume and waste more than any others. They, like those in the developed world, have been seduced by the desire to accumulate wealth, and the technology they are using to do so has been adopted from countries that now face major environmental problems.

To address such large questions, which engage nearly every aspect of human life and include our relationship to the planet on which we live, it is time to revisit some of the values upon which we have built our culture and which influence our behaviour. This requires a fundamental rethink, and some would say a ‘new world view’, to establish what we are trying to achieve and what we need to do to change our behaviour. Albert Einstein observed that we tend to look for solutions using the tools that caused the problem in the first place. We need new thinking and we need to adopt everything at our disposal that might lead to a reduction in the harm created by our own existence and behaviour.

The solutions could be in the technologies we employ, the behaviour we adopt, the policies we implement and/or the investments we make in research in order to improve our understanding. A good practical starting point is often thought to be to set targets that we can use to focus our efforts. However, the adoption of targets can often lead to a reductionist view of the world and also to sub-optimization of the kind that leads to the dilemma suggested by the Aswan Dam example. To avoid this, we need to espouse a philosophy that allows us to look at our cosmos as a whole. We also need to describe our values and make them transparent, to identify interrelationships and to provide direction for our thoughts. We need a common framework within which we can think, communicate and act, so that we can share experience and build knowledge. This, of course, is not an easy thing to achieve, but, if we could provide such a framework, share a common vocabulary and have a shared understanding of the values on which we can build, then just maybe we might be able to make a major advance in uniting our efforts for mutual advantage.

A common holistic framework

Such a common and holistic framework could be based on the writings of the Dutch philosopher Herman Dooyeweerd (Brandon and Lombardi, 2010). He argued for a ‘cosmonic idea of reality’. Dooyeweerd’s arguments are complex and in some cases difficult to penetrate, but in outline consist of a hierarchy of fifteen modalities (irreducible areas of the functioning of a system or entity) that are nested within each other (thus creating a platform for interdependence) and that express the strength of the dependence by the distance of the relationship of one modality from another. The hierarchy encompassed not only physical measurements and relationships, such as counting and scientific measurement, but also the human aspects that influence performance. The latter are central to the introduction of any policy or strategy for sustainable development. At the pinnacle of the hierarchy is the modality related to commitment and vision, without which no policy for change could be implemented. The vision would be based on the second modality, that of ethics, which is related to the perceived morality of the decision (and based on agreed values). This would be followed by the judicial or regulatory
framework that a society had chosen to express the parameters within which the values would be implemented. Following this would be the aesthetic considerations, the economic framework, the social framework and the manner of communication, all separate modalities but related to the others. Creativity, analysis and formal knowledge, plus the perceptions of people and their required health, biodiversity and ecology, followed before consideration of the physical aspects that can be measured using conventional methods. These last modalities relate to the physical environment, mass and energy, followed by transportation, space, shape and extension and finally numerical accounting.

This list can only give a flavour of Dooyeweerd’s thought and, at its simplest, offers a checklist for consideration of sustainability matters. It is, however, much richer and can be experienced at a number of different levels, which enable it to be intuitively accepted by all those engaged in making decisions about sustainable development. For understanding the movement and vision towards zero waste, it provides a framework that is much more comprehensive than traditional assessment and implementation measures and it prompts new thinking. All the matters raised in this book could be found within such a framework, and the likelihood of items being overlooked or not considered is reduced. Such a framework provides a useful basis for dialogue and debate, but much still needs to be done to make it an effective tool for evaluation.

The point is that the challenge of zero waste is not just one of measurement and reduction, but a much more fundamental understanding of the vision and its implementation within a holistic framework. This is bound to include the values and commitment to zero waste found within our culture.

**Complexity and rich knowledge**

Searching relevant websites, including those that list government initiatives on waste in developing countries, reveals an extraordinary number of activities attempting to make the issue of reducing waste part of the culture of many industries (particularly construction) and communities. These activities are creating a pool of rich knowledge that deserves collation, recording and analysis to provide information for current and future generations.

This book plays its part in revealing the diversity of these activities. It deals with behaviour change and the consumption culture, and also with the technologies that may help to reduce waste. In so doing, it does not claim that using technology is the only way to achieve zero waste. It also addresses the part designers can play in achieving the goal of zero waste, and the fact that every citizen, not just those formally employed to deal with it, shares responsibility for the management of waste. Finally, it engages with the politics of waste at individual, regional and urban levels to find the commitment that enables zero-waste policies to be developed and adopted.

Part of the problem is the complexity of a subject that has so many facets and that demands so many different skills and so much knowledge across so many conventional boundaries. Zero waste is not always prescribed by national or other physical boundaries. It is not dealt with by one profession’s repository of knowledge. It should engage both user and provider in an understanding of mutual benefit. It requires governments to be ahead of public opinion and not to respond reactively. It involves highly specialized research and yet also requires those who can bring these specializations together in a holistic way (and these ‘bridge builders’ are hard to find). It requires an understanding of values and a communication system that allows for democratic processes. In fact,
it needs a full and thorough understanding of human behaviour that is not yet available in any readily accessible form.

It is this complexity that makes it difficult for zero waste to become part of the thinking of every person and every institution involved in decision-making. However, its successful solution depends on a holistic view that all humankind can endorse, at least in principle. The past three decades have seen great progress in making the world sensitive to these issues, and it is to the credit of many governments that they are taking it seriously.

For designers, there is a need to have a simple creed that spells out their belief in sustainability and that includes waste management. In the 1960s, a simple saying was being promoted that, if followed, would have had far reaching consequences for the way designers think and behave towards the environment. The maxim was called the ‘three Ls concept’, and the Ls stood for long life, loose fit and low energy (Gordon, 1974). Even now, such a simple check in thinking as a design develops would have a profound impact on the eventual physical product. Long life would ensure better materials and more recycling, and would probably involve less waste. Loose fit would ensure flexibility in, and more resilience to, the building over time. Low energy would encompass the desire for zero carbon and a reduction in many of the pollutants we see today. All three would help to reduce waste. Of course, much more knowledge is required as to how to implement such a concept, but it would set the scene for a cultural change that should engage every designer. Many designers have already embraced this change, but many more could do so. What is encouraging is that the markets are at last seeing the need for the three Ls (McGraw Hill Construction, 2008), and this is likely to have greater impact than any other impetus to move towards zero waste.

Whether you are a designer, researcher, policymaker, businessperson or a concerned global citizen, please enjoy, digest and implement the knowledge within this book! Good luck!

Professor Emeritus Peter Brandon is the Director of the Salford Think Lab, researching sustainable development in construction management, with a focus on knowledge-based systems for sustainable development. Peter is the former Pro-Vice Chancellor for Research of the University of Salford in Manchester and has published more than twenty books. His latest book, co-authored with Dr Patrizia Lombardi, Evaluation of the built environment for sustainability (2010), offers a new structure for sustainable development based on the ‘Philosophy of the Cosmos’ by Herman Dooyeweerd, encouraging a holistic and integrated systems approach.

References
Introduction
People, policies and persuasion: the future of waste reduction and resource recovery in households and urban settings

Steffen Lehmann and Robert Crocker

Designing for Zero Waste is a timely, topical and necessary book. Materials and resources are being depleted at an accelerating speed, and rising consumption trends across the globe have placed material efficiency, waste reduction and recycling at the centre of many government policy agendas, giving them an unprecedented urgency. Although there is a considerable body of scholarly literature addressing consumption and waste reduction from different disciplinary perspectives, the complex nature of the problem demands interdisciplinary exploration. Resource recovery and the optimization of material flow can only be achieved alongside and through behaviour change to reduce both the creation of material waste and wasteful consumption.

Rethinking the way we deal with material flows and changing behaviour in regard to waste streams, we believe, can deliver significant improvements, curbing the threat of environmental degradation and global warming. We have borrowed from the planet for a long time, exceeding the planet’s carrying capacity, and if our societies and the global economy are not transformed we risk descent into unhealthy urban conditions and further depletion of virgin materials. Our current model of economic and urban growth is driving this unhealthy system, and, as a consequence, we have now passed the limits of our planet’s capacity to support us. Over the last twenty years, for example, the amount of waste Australians produced has more than doubled, and it is likely that this amount will double again between 2011 and 2020, because the amount of waste generated in Australia grows by 6 to 7 per cent per person, per year. In addition to this, 40 per cent of all food in Australia is not eaten; it is thrown out instead of being composted as organic kitchen waste to return nutrients as fertilizer to the soil, or recycled in a biogas plant to generate energy. Discarded television sets and outdated computers (known as e-waste) are another hazardous time bomb. For instance, around 32 million new television and computer products were sold in Australia in 2008, with an estimated 16.8 million units reaching end of life in the same year. However, only 10 per cent were recycled, well below the average rate of recycling for all waste in Australia of 52 per cent (2009 data, National Waste Report, 2010). Too much e-waste still ends up in our soil and rivers, polluting our drinking water.

Overall, things do not look good. In fact, endless consumption and growth are impossible. Everybody understands that, if you cut down more trees than you plant, at some point you run out of trees. In 1996, the German philosopher and urban planner Karl Ganser came up with the idea of ‘change and prosperity without growth’, something still unimaginable for most politicians and economists (Hannemann, 2000, p99). Passing the limits must have consequences, as we see in increasing global warming, changing
weather patterns and a change in the way the whole system of ‘Spaceship Earth’ (Buckminster-Fuller, 1973) behaves. Topics such as food security (possible solution: urban farming?), water scarcity (solution: storm-water harvesting?), rising energy costs (solution: decentralized energy production on roofs and facades?), depletion of virgin materials (solution: closing the loop of material cycles?) and increasing traffic congestion (solution: increased investment in public transport?) have emerged as major concerns, and researchers at universities worldwide are now looking into better ways for us to live together in more liveable and sustainable cities in the future.

It is clear that things are going to change, and we must make every effort to future-proof the built environment by designing and building more resilience into urban systems. By doing so, we will increasingly learn from nature’s complex ecosystems and natural ordering principles, in redefining our industrial ecology to change the way we produce, manufacture, package, transport and reuse products. We are embarking on nothing less than a silent green revolution, which has already started to transform our society, economy, energy and transport systems, waste-management systems and the way we design, build, operate, renew and reuse/recycle cities and buildings. New strategies for the reorganization of the urban landscape are emerging. It makes sense that the next step is to rethink industrial and urban systems and production methods. In 2009, sustainability activist Paul Gilding stated that we ‘have entered a period of global ecological crisis and economic stagnation that will lead to an economic and social transformation of significance in the history of humanity’. According to Gilding, this crisis is inevitable, because the fundamental causes are not public opinion or politics, but the established momentum of changes in the ecosystem. As a result, he suggests our current model of economic growth is finished, and a new one must be forged based on the principles of sustainability and with human relationships at its core. Gilding has an optimistic vision of our shared future: he believes that ‘we will break our addiction to growth, accept that more stuff is not making our lives better and focus instead on what does’ (Gilding, 2009, np).

At the same time, new research agendas are emerging as open platforms for collaboration and interdisciplinary exploration. Demonstration projects accompanied by relevant research are essential in this change process, as these have the potential to deliver more and better solutions to curb global warming. Universities are at the forefront of a meaningful, relevant search for such solutions. Advances in knowledge, together with an awareness of the complexity of today’s world, have led scholars to pursue multifaceted problems that cannot be resolved from the vantage point of a single academic discipline. Therefore, universities are increasingly engaged with industry, governments, community groups and other institutions worldwide to support multidisciplinary and integrated approaches to research in urban-systems thinking. Now is the time to scale up our scholarship in low-carbon urban solutions to match the size of the challenges we are facing and to support the development of appropriate policies. Collaboration across sectors is critical, because, in addition to influencing policy and legislation, collaborative research into low-carbon and zero-waste futures will help to develop a responsive plan for the transformation of existing cities as an important part of the solution. It is therefore critical that our efforts support long-term planning and research in line with agreed national priorities, for holistic, whole-of-life-cycle approaches. This book is the result of such interdisciplinary and cross-sector investigations.
We have arranged the following chapters in four parts. Part I is titled ‘Zero waste, sustainability and behaviour change: principles’, and Part II is titled ‘Zero waste, enabling technologies and consumption: policies’.

An important aspect of the discussion of zero waste is the analysis of consumerism, behaviour change, particularly at the household and building scale. Parts I and II of the book deal with these issues. These chapters explore the complexity of consumption and lifestyle, people’s motivations and attitudes, shifts of values and behaviours – and the dynamics of social change. Such an analysis requires the involvement of a series of disciplines, including sociologists, psychologists and researchers in cultural studies. It is obvious that sustainable consumption is still a controversial concept politically, economically, socially and culturally. Part I outlines the principles of behaviour change. It opens with Robert Crocker’s assessment of the connections between consumerism, zero waste and mobility behaviour. In Chapter 2, Natalie Skinner, Barbara Pocock, Pip Williams and Jane Edwards describe the difficulties of changing behaviour while balancing work, home and community. Sue Nichols looks at the relationship between early-childhood education and sustainable consumption in Chapter 3. Sandra Davison, Kirrily Thompson, Drew Dawson and Anne Sharp examine the psychology of consumption in regard to food waste in Chapter 4. Angelique Edmonds explores collaborative consumption and local resilience in Chapter 5. Part II introduces a debate on enabling technologies that will help us to live more sustainably: Robert Crocker explores the new mobile communications paradigm in Chapter 6, followed by Ab Stevels, Jaco Huisman and Feng Wang’s discussion of the issue of e-waste in Chapter 7. Alexander Walker contributes an important chapter on life-cycle thinking and analysis from the viewpoint of the designer in Chapter 8, and Jane Dickson and Victor Buchli discuss the ontology of the house (or household) in Chapter 9. In Chapter 10, Carla Litchfield, Kurt Lushington, Sue Bigwood and Wendy Foster present a different view by looking at wildlife habitat and its relationship to sustainable living.

Sustainability theorist Tim Jackson noted that ‘Consumption drives our economies and defines our lives; making it sustainable is an enormous and essential challenge’, and he observes that ‘the problem of changing consumer behaviour and making our lives more sustainable continues to challenge opinion-formers and policy-makers alike’ (2006, pp132–6). Household behaviour in everyday life is increasingly seen as the essential starting point for change. There is a complex interplay between policy initiatives and individual behaviour (for instance, the difficulty of mobilizing shifts in attitudes, lifestyle values and consumption patterns). Our behaviour in our own homes – our recycling habits, consumer choices and transport preferences – has a huge impact on the environment locally and globally. This is clearly visible in household behaviour in regard to waste and recycling, food consumption and food waste, and transportation patterns and mobility choices. Among the researchers who have explored these links is Patrik Söderholm, who explains that, ‘We need to gain a better understanding of how environmental policy enters the private, domestic sphere, and how it influences household behaviour, to generate behaviour change at the household level and the move towards sustainable societies’ (2010, p28). Designers Tom Fisher and Janet Shipton offer the view that ‘the home is a system in which objects are processed’ (2009, p127).

Part III of this book is titled ‘Zero waste in sustainable architecture and design at the household and building scale’, and Part IV is titled ‘Zero waste in cities, urban
governance and material flows’. The chapters in these parts explore the complex problem of sustainable materials and their embodied energy, the enabling of low-carbon technologies and the principles of sustainable design. The chapters in Part III explore this multifaceted topic at the micro level of individual households and buildings, and those in Part IV examine zero waste at the macro scale of integration: the city.

The urbanized environment of the city is increasingly the place where solutions for waste reduction must and will be found. In this effort, every city will have to find its ideal set of particular solutions, or ‘localized responses’, to resolve questions of material flows and the management of waste streams (Lehmann, 2010, pp261ff.). However, local responses to globalizing forces depend partly on the nature of the interlinkages in governance from international structures, through multilateral organizations to nation-states, regions and localities, as these are mediated through social–local identity. This complex includes the transformation of production processes, green infrastructures and systems, as well as concepts of resource efficiency (especially material efficiency), decoupling concepts (decoupling the raise of consumption from the use of materials), clean technologies, and design for sustainability, industrial ecology and life-cycle analysis. Industrial production as a whole has to be transformed. In their book *Natural capitalism: the next industrial revolution*, Paul Hawken et al (2000) clearly set out the path that we must take to ensure the future prosperity of our civilization and our planet. A decade ago, *Natural capitalism* rocked the world of business and manufacturing with its authors’ innovative approach – an approach that fused ecological integrity with business acumen via the radical concept of natural capitalism.

Part III of this book analyses the opportunities for zero waste in building and the construction sector. In Chapter 11, Steffen Lehmann explores sustainable building design and material efficiency, and Stephen Ward describes the many advantages of adaptive reuse of entire building structures in Chapter 12. In Chapter 13, Alapana Sivam and Sadasivam Karuppannan look at the densities and design of residential development, and Nicholas Chileshe, Jian Zuo, Stephen Pullen and George Zillante evaluate the potential for zero waste in construction management in Chapter 14. In Part IV, zero-waste concepts are related to urban planning and governance. Steffen Lehmann explores material flows and the metabolism of the city in Chapter 15, and Michael Taylor and Michelle Philp look at sustainable transport systems in regard to behaviour change in Chapter 16. In Chapter 17, Lou Wilson uses the city of Adelaide as a case study in urban planning for the sustainable consumption of urban resources. Simon Beecham presents concepts of multifunctional urban land uses and water-sensitive urban design in Chapter 18.

To identify holistic approaches of the kind discussed in these chapters requires the involvement of scholars in a range of disciplines, including economics, design and materials, working together to enable the systemic environmental restructuring of consumption and provision in energy, water and waste systems. In the context of this change process, designers – architects, urban planners, industrial, interior or product designers – axiomatically play a major part. In short, to advance the subject of design one has to engage in the activity of designing. In his book *Sustainable by design*, Stuart Walker (2006) offers a design-centred approach and a new understanding of the complexity and potential of sustainable design, extolling the contribution of design to the creation of a more meaningful material culture. As Peter Stasinopoulos and his colleagues point out, it is possible to apply a ‘whole system design’ approach alongside a more integrated
approach to engineering. They argue that ‘Whole System Design is increasingly being seen as one of the most cost-effective ways to both increase the productivity and reduce the negative environmental impacts of an engineered system’ (Stasinopoulos et al, 2008, pp2–10). Consequently, the focus on design is critical, as the output from the design stage of the project locks in most of the economic and environmental performance of the designed system throughout its life cycle, which can span from a few years to many decades. Indeed, it is now widely acknowledged that all designers – particularly engineers, architects and industrial designers – need to be able to understand and implement a whole system design approach, because, as Stasinopoulos and his colleagues explain:

Advances in energy, materials and water productivity can be achieved through applying an integrated approach to sustainable engineering, to enhance the established systems engineering framework, from passenger vehicles and computer systems, to the temperature control of buildings and domestic water systems.

(2008, p10)

Designing with an eye to resource or energy efficiency, however, is not a straightforward solution. In The myth of resource efficiency, John Polimeni et al (2009) describe what is known as the ‘Jevons paradox’, which was first identified in 1865 by Australian engineer William Stanley Jevons in relation to the use of coal. The paradox Jevons observed is that an increase in the efficiency of using a resource frequently leads to an increased use of that resource rather than to the desired reduction. This effect is also called the ‘rebound effect’, where previous gains in efficiency are absorbed and lost. The paradox has subsequently been proved to apply not just to fossil fuels, but also to other resource-use scenarios, including material and water usage. Polimeni and his co-authors point out that, for example, doubling the efficiency of food production per hectare over the last fifty years (owing to the green agricultural revolution) did not solve the problem of hunger. Instead, this increase in efficiency increased production and, paradoxically, worsened hunger because of the resulting increase in population. This has substantial implications for today’s world. Many scientists and policymakers argue that future technological innovations will reduce consumption of resources; the Jevons paradox, however, explains why we have to examine such an assumption carefully, as it may be a false hope.

But how do you engage with those who cannot or do not want to imagine a different future? What are the main drivers towards sustainable consumption? What are the determinants of consumer behaviour? Behaviour change has frequently been listed as the number one hurdle to a more energy- and material-efficient, low-carbon future. If we could only plan better cities and design better buildings and products that needed less energy, water, materials and other resources, thus generating less waste, and facilitating positive behaviour change simply through their design; for instance, enabling people to be less dependent on air conditioning and car driving, by offering attractive new housing typologies in the city centre based on passive design principles. The most successful research projects related to sustainability and behaviour change are probably those in which the community is involved and those that enable participants to identify with the outcomes of their activities. However, changing the behaviour of a community or building occupant is not easy; it usually starts with greater awareness (e.g. through
visualization of carbon emissions or energy use based on smart metering systems) and involves incentives. Education to raise awareness is essential. Equally important is that the rules and benefits of waste separation, resource recovery and recycling are well explained. This suggests that the real problem is not technology, but social acceptance and behaviour change.

Understanding reuse is increasingly important, but designing for reuse in the domestic (household) context is still under-researched and little understood. We can reuse and recycle products, packaging and even buildings (through adaptive reuse). The common slogan is: every reused item is another item not purchased. A good example of the problem is the proposed legislation to reduce packaging and introduce extended producer responsibilities recently introduced by the Australian government. Packaging is seen as ephemeral; its purpose is to be ‘wasted’ once the product it contains has been removed. Alternatively, Fisher and Shipton have explained that ‘the reuse of packaging has a significant effect on the quantity of material that enters the waste stream and the energy and consequently carbon that is expended in its production’ (2009, p127). Most of the factors influencing the potential for reuse relate to the specifics of the design, including the types of material used, the flexibility and adaptability of a building’s plan and section or the symbolism of the product’s branding. Other factors are more social: for instance, the effects of reuse on the perception of different consumer orientations. Fisher and Shipton point out that ‘understanding consumers’ behaviour is significant for moving towards sustainability through design’ (2009, p127ff.). Although research into consumption patterns and behaviour change is still in its infancy, no doubt it will continue to grow in importance.

Short-term and long-term strategies capable of implementation in the developed and developing world are required to bring about the desired change towards zero waste. How can it be achieved? In their report State of the world 2010: transforming cultures from consumerism to sustainability, the Worldwatch Institute (2010) lists many of the environmental and social problems we face today as symptoms of a deeper systemic failing, a dominant cultural paradigm that encourages living in ways that are often directly counter to the realities of a finite planet with finite resources. Consumerism has already spread to cultures around the world, and ‘hyper-consumerism’ has led to consumption levels that are vastly unsustainable. If this pattern spreads further, to rapidly developing and rapidly urbanizing societies in China and India, there will be little possibility of solving climate change or any of the other environmental problems that are poised to disrupt human civilization. The Worldwatch Institute’s programme director, Eric Assadourian, notes soberly ‘It will take a sustained, long-term effort to redirect the traditions, social movements and institutions that shape consumer cultures towards becoming cultures of sustainability’ (Worldwatch Institute, 2010, p20ff.). If we can bring about a cultural shift to make living sustainably as ‘natural’ as today’s consumer lifestyle, we will not only address urgent environmental crises, we will also contribute solutions to other problems, such as extreme income inequity, obesity and social isolation, that are not usually seen as environmental issues. To this end, Designing for Zero Waste aims to develop a more robust understanding of the links between lifestyle, consumption, technologies and urban development. It’s not too late to change.
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