Sustainable Construction

Sandy Hálliday

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Butterworth-Heinemann is an imprint of Elsevier

Butterworth-Heinemann is an imprint of Elsevier
Linacre House, Jordan Hill, Oxford OX2 8DP, UK
30 Corporate Drive, Suite 400, Burlington, MA 01803, USA

First edition 2008

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data
A catalog record for this book is available from the Library of Congress

ISBN 978-0-7506-6394-6

For information on all Butterworth-Heinemann publications visit our website at www.books.elsevier.com

Typeset by Charon Tec Ltd (A Macmillan Company), Chennai, India
www.charontec.com

Printed and bound in Slovenia

08 09 10 11 11 10 9 8 7 6 5 4 3 2 1

About the author

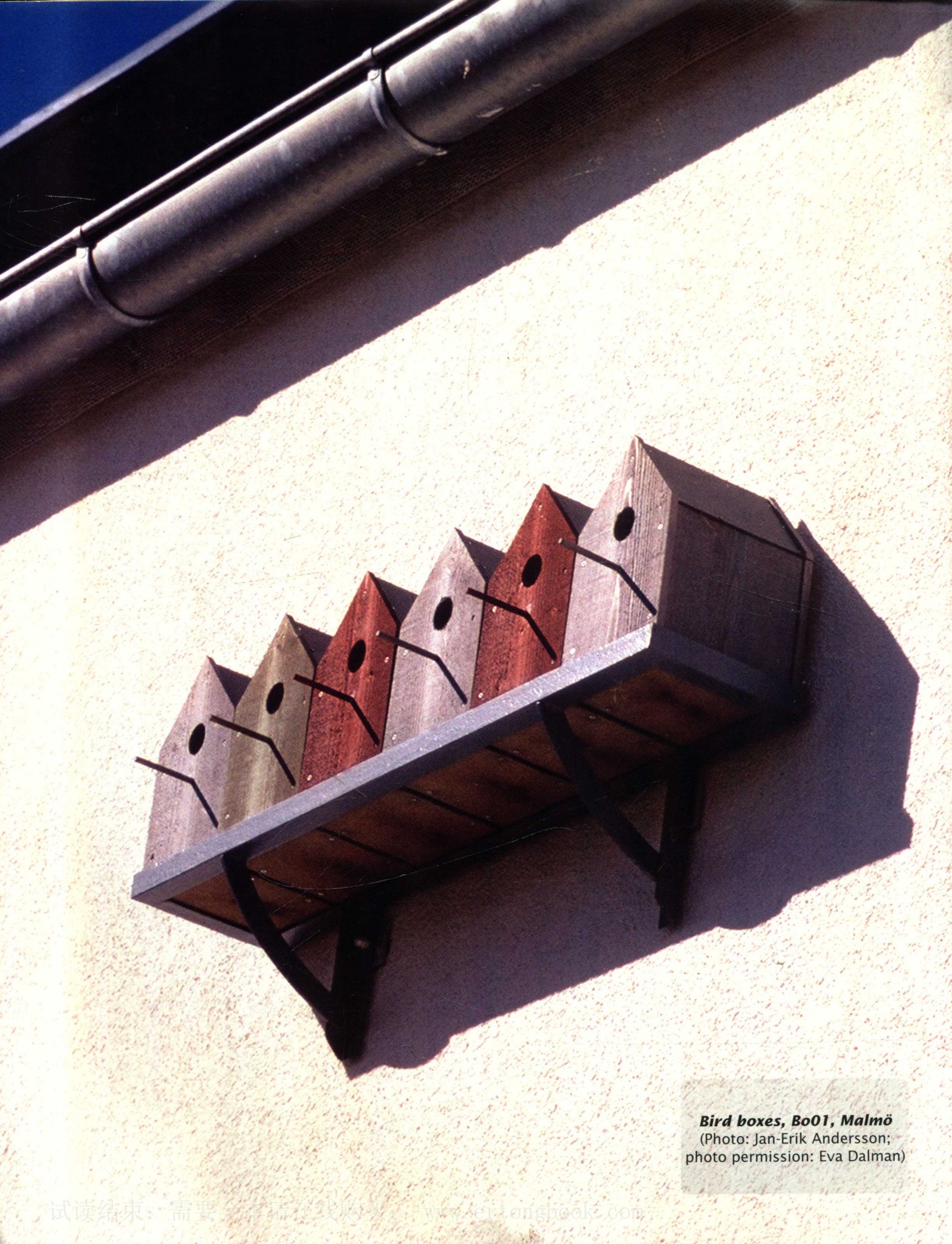
Sandy Halliday is Principal of Gaia Research, the practice she founded in 1996, and the Royal Academy of Engineering Visiting Professor in Engineering Design for Sustainable Development in the School of Architecture, University of Strathclyde.

She was educated in Engineering Design and Appropriate Technology in the early 1980s at Warwick University. It was an inspired course and a privileged learning opportunity at a time when the environment and development were largely considered to be luxury issues by those with no motivation to improve global equity and life quality.

Sandy seeks to improve the built environment through research, education and consultancy. In particular, she tries to promote construction ecology through advocacy, informed project management, interdisciplinary design and community engagement as a means of delivering quality buildings that spare other species, are efficient, healthy, affordable, and fit for individuals and communities now and in the future.

Sandy considers heartening the increasing understanding of appropriate development and design quality as fundamental aspects of social justice. She had humble beginnings. But she finds the widening gap between rhetoric and action takes the edge off any urgency for celebration.

Gaia's logo - from a French cave painting - in the snow
(Photo: the author)



Bird boxes, Bo01, Malmö
(Photo: Jan-Erik Andersson;
photo permission: Eva Dalman)

Acknowledgements

Many people have contributed to bringing this publication to print.

Friends at Gaia Research over the last few years – Cat Button, Sarah Worrall, Steven Downie, Janice May, Paul Jones, Gill Pemberton – have been terrific, always sharp, funny, kind, loyal and dedicated. I wish them every success and happiness in their diverse futures.

A close working relationship with past and present staff at Gaia Architects has been a bridge to sanity. Special thanks to John Kelly, Barbara Chapman, Leanne Campbell, Elaine Rainey, Sam Foster, Steve Malone, Robin Baker, Matt Fox, Kathryn Robinson, Henrietta Temple and Paul Woodville.

I am privileged to be part of the family of Gaia International, a federation of professionals who work internationally in pursuit of the ecological design of buildings and the built environment. In particular, my thanks for their help, inspiration and good company go to: Drew and Carole Mackie, Chris Butters and family, Kimmo and Maritta Kuismaanen, Joachim and Barbara Eble, Margrit and Declan Kennedy, Eva Dalman, Frederica Miller and Julio Perez, Varis Bokalders, Paul Leech and Sally Starbuck, Bjorn Berge, Rolf Jacobson and Marianne Leisner, Dag Roalkvam and Wenche Ellingson, Bruno and Eva Erat, Herbert Dreiseitl, Peter Schmidt and Gabriella Pal-Schmidt.

This book evolved from a training course part funded by the Department of Trade and Industry and the Ecology Building Society, to whom I owe enormous thanks. It aimed to bring together contemporary knowledge for architects, clients, engineers and cost professionals seeking to deal with the challenges and opportunities of designing a sustainable built environment. The modular training packages were a response to the evolving discourse that it was 'all holistic'. Whilst I am totally in agreement with this, there seemed a need for the parts to inform the greater sum that could result, and that became my resolve.

The course involved short summary notes which form the basis of this book, supplemented by lecture, workshop and masterclass sessions with contributions from many of my friends and contemporaries. In particular, I owe huge thanks to Bill Bordass for always being willing to talk, share and play out, to Nick Grant (who co-authored what has become Chapter 12), Clive Beggs (who helped with what has become Chapter 8), Adrian Leaman (who contributed much on post-occupancy evaluation), Roger Venables (who assisted on what has become Chapter 2), and Michiel Haas, Chris Weedon, Cath Hassell, Brian Darcy, Ben Gunn, Koen Steemers, Paul Littlefair, Phil Jones, Paul Jennings, John Gilbert, Fionn Stevenson, Gokay Devici, Max Fordham, David Loe and Tom Morton. I am immensely grateful for the support that they provided. I own the mistakes, errors and omissions.

It is my experience that many in the construction profession have treated sustainable design with cynicism, and even contempt, but that this is changing as increasing understanding leads to respect. So, in 1999, in parallel to the creation of the training programme, I pursued development of an evidence-based accreditation scheme in sustainable building design. I hoped to encourage recognition of the additional skills of those with the dedication to see the many barriers to sustainable design as a challenge to be overcome rather than an excuse for failure. My aim was to help clients, policy-makers and the profession to recognise the clear distinction between aspiration and delivery in sustainable design, in order to find the mechanisms to speed the latter.

With support from Sebastian Tombs at the Royal Incorporation of Architects in Scotland, a steering group chaired by Lord Willie Prosser, and an assessment panel chaired by Raymond Young, the world's first Accreditation Scheme in Sustainable Design was launched in 2005. It is a significant achievement, and one that should now be opened up to other professions and other countries. I am very grateful to all those who assisted in making it happen, but most particularly the dedication of the applicants to delivering sustainable design that made it possible.

Unlimited thanks are reserved for Howard Liddell, the Principal of Gaia Architects, a founder member of Gaia International, an ongoing contributor to the CPD throughout its development and delivery, a guardian of excellence and the only architect yet accredited A* in sustainable design. All of that would be enough, but in addition he has broad shoulders, genius, passion, wit and seemingly boundless capacity for love and unflinching support.

Introduction

Achieving sustainability requires us to live within the limits of the earth's capacity to provide the materials for our activities and to absorb the waste and pollution that our activities generate.

The built environment presents us with a major challenge. The construction, fit-out, operation and ultimate demolition of buildings is a huge factor in human impact on the environment both directly (through material and energy consumption and the consequent pollution and waste) and indirectly (through the pressures on often inefficient infrastructure). The built environment also has a crucial impact on the physical and economic health and well-being of individuals, communities and organisations. A good building is a delight and will enhance a community or organisation, enhance our ability to learn or increase our productivity. A poor building will do the opposite. Where buildings and built environments contribute to ill-health and alienation, undermine community and create excessive financial liability, they are undesirable and unsustainable.

Sustainable development is now the stated policy of local, national and international governments, and of much industry and commerce. More than three decades on from a recognisable start of the environmental movement – the establishment of World Environment Day by the United Nations General Assembly in 1972 – there appears at last to be a growing commitment to reverse unsustainable trends in development.

To meet the challenge we have to enhance quality of life for all by designing healthy buildings and environments fit for individuals and communities both now and in the future. We need to minimise resource throughputs, waste and pollution, and to fulfil our responsibility to protect other species and environments. Buildings and the built environment will therefore increasingly be required to satisfy a number of criteria, including that they should:

- ***Enhance biodiversity*** – not use materials from threatened species or environments and improve natural habitats where possible through appropriate planting and water use.
- ***Support communities*** – identify and meet the real needs, requirements and aspirations of communities and stakeholders and involve them in key decisions.
- ***Use resources effectively*** – not consume a disproportionate amount of resources, including money and land during material sourcing, construction, use or disposal; not cause unnecessary waste of energy, water or materials due to short life, poor design, inefficiency, or less than ideal construction and manufacturing procedures. Buildings have to be affordable, manageable and maintainable in use.
- ***Minimise pollution*** – create minimum dependence on polluting products and materials, management practices, energy, power and forms of transport.
- ***Create healthy environments*** – enhance living, leisure and work environments; and not endanger the health of the builders or occupants, or any other parties, through exposure to pollutants, the use of toxic materials or providing host environments to harmful organisms.
- ***Manage the process*** – stewardship of projects is a vital and overarching aspect in delivering sustainable projects, both in the first instance and also in ensuring their performance over time. Too many aspirations are undermined by failure to manage the design process, particularly at crucial handover points where responsibilities change. This requires us to identify appropriate targets, tools and benchmarks, and manage their delivery.

There is already a significant amount of information available to all professions on how to design buildings that are attentive to the needs of sustainable construction, but most practice still falls far short of applying even the most easily applicable principles in most projects.

Opportunities that could bring real advantage are being missed every day. The result is that buildings and the industries that supply building designers with products, materials and services are less efficient, less economical and more polluting than they might otherwise be. The positive impact on the environment and on quality of life from addressing these issues could be immense.

This book aims to summarise the existing sources of best practice guidance on the design of sustainable buildings and built environments. Each chapter provides information on critical aspects of a particular topic and sources of further guidance by way of an annotated bibliography. The case studies highlight experiences to date to improve understanding and encourage implementation. They are not all best practice solutions. It is intended that this will help the reader to access the guidance, tools and techniques available for staying abreast of choices and issues and to make informed 'holistic' decisions to assist in designing healthy, affordable, resource-efficient buildings fit for individuals and communities.

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Chapter 1
Sustainability drivers

In which we put forward something of the history of ideas that has brought about a shared understanding that it is necessary to implement checks and balances in pursuit of sustained genuine progress for all.

'The choice is simple, sustainable development, unsustainable development or no development at all.'

Sandy Halliday, Build Green (1990)

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The first modern building designed to be moisture transfusive
(Architects and builders: Dag Roalkvam and Rolf Jacobsen; photo: Dag Roalkvam)

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Toll House Gardens
(Architects: Gaia Architects; photo: Michael Wolshover)

Case studies

Sustainability drivers

Introduction

There can be few within the professions involved in the built environment for whom sustainability is a new idea. Recently, government policies, international politics and architectural responses mean that it is an issue rarely out of the press and the office. It is an increasingly important aspect of client briefs. Yet, for an issue this ubiquitous it remains poorly understood, and the source of much debate and disagreement.

There is a fundamental misconception that sustainability and the environment are one and the same issue. Whilst there is a lot of evidence that the natural environmental is a powerful driver of human creativity, the concept of sustainability is different. It evolved from a debate about how we develop.

The EcoCity project
A community consultation tool, developed by Gaia Planning and the TASC Agency, in which 10-year-old children plan the development of their community. It has been used to engage children, their teachers, their parents and their communities in sustainable urban design issues in Edinburgh, Glasgow, Halifax, Belfast, Johannesburg and Thessaloniki
(Photo: Gaia Architects)

It is not wholly surprising that the concept of sustainable development is difficult to communicate. Sustainability involves big issues and their complex interaction: the division of wealth and opportunity between the world's rich and poor, health, welfare, safety, security and useful work as basic needs of societies, and rights of individuals. Much is predicated on the rights of the young and future generations and of other species – a concept unimaginable a few generations ago – and much also on the rights of those in society least capable of looking after themselves. The state of the environment is a fundamental aspect because the unintended consequences of our activities impact directly on our current quality of life, impose burdens on others, and threaten other species both now and in the future.

The global, social and cultural issues with which sustainability is concerned are mostly a far cry from the sketchpad, design team meeting and post-tender cost review. We spend relatively little time thinking about what people really need.

As the values of equity and interdependence on the natural environment have rarely been integrated into education and training, they can be difficult to translate into the practicalities of what building design and cost professionals do on a daily basis. Appropriate and meaningful responses are genuinely hard to identify and we still know little about what responses are adequate.

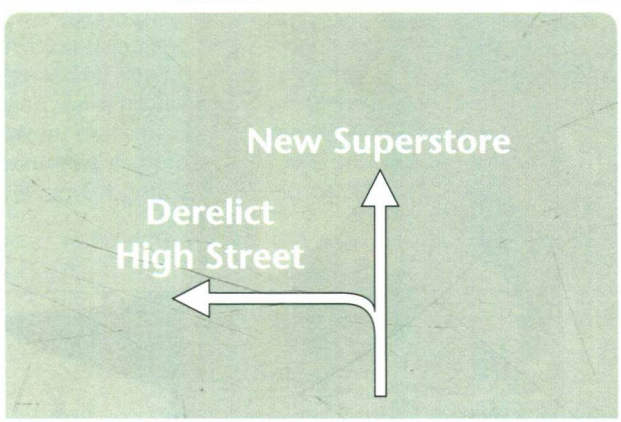
With evidence of massive environmental damage going on in the developing nations it can seem pointless to try to do anything about it, unless we appreciate that sustainable design is about delivering real benefits. We don't need to look any further than pedestrianisation to see that rules and guidelines on environmental impact reap instant rewards.

Sustainability as vested self-interest has driven the international debate to date, more so than in individual countries, and will do so in the future. Alongside the environmental destruction in developing countries there are exemplar ecological towns being developed in South America, Taiwan, India and the USA. They will challenge people to think about what is appropriate development. Their ambitions and success or failure will probably determine life quality for the majority in this millennium.

The case studies in this chapter intend to highlight some early initiatives and exploration in sustainable design.

Development

'Sustainable development' has suffered from an image problem. It requires us to act in a sensitive manner towards natural systems and has been seen by those who would do otherwise as a restraint on 'development' per se. Astonishingly it has taken a very long time for sustainable development to be recognised as a justified restraint on 'inappropriate' development and a primary driver of improving quality of life for all.



Difficult decisions
Achieving sustainable development requires us to prevent inappropriate development

Many developing countries are adopting styles and scales of development that are now recognised as inappropriate and unsustainable. Only a few are making serious attempts to combine tradition with modernity.

There is ever increasing demand on the earth's limited resources, escalating pollution and growing awareness of moral responsibility favouring greater equity. It is increasingly attractive to some to put in place long-term policies that can reliably deliver social, environmental and economic improvements. It is equally threatening to others, but need not be so.

Human skills have transformed the environment. For the developed world and the wealthy in the developing world, access to sanitation, vaccination, health awareness and treatment, food hygiene and good diet have vastly extended the quality and quantity of life in recent decades. However, the extent to which our activities are unsustainable has become clearer over the same period. There has been an increasing realisation that changes in pursuit of progress can, and often are, accompanied by inadvertent consequences, such as inequity and hazards, that need to be recognised and avoided. A large proportion of the world still lives with the ever-present threat of drought, pestilence and starvation, often exacerbated by wars. Further billions are subject to scarcity, poor hygiene and unsanitary conditions, often within close proximity of abundance and pristine cleanliness. Some of this is in our nature and some of it is simply inadequate attention to appropriate development.

Humankind faces an awesome challenge to reverse unsustainable trends. Pollution of air, land, water and food that results from our activities threatens to crucially undermine the security, health and quality of life that humankind has pursued and sought to protect. There is now overwhelming acceptance that we face major global problems of climate change, ozone depletion, over-fishing, soil erosion, noise, resource distribution, chemical and electromagnetic pollution, deforestation, desertification, species loss and congestion. We also now know enough of history to appreciate that civilisations fail through abuse of resources.

With rising expectation and industrialisation, questions must at some time surface: can we maintain and improve life quality whilst radically improving the effectiveness in how we use all our resources, and reducing pollution and waste? Evidence suggests we can. It is a very positive agenda.

Penang – 2003
It has taken more than three decades for the sustainability agenda to be recognised not as a restraint on development but as a restraint on 'inappropriate' development. We do now have the basis of a common understanding from which to make progress
(Photo: the author)

Case Study 1.1:

Solar Hemicycle, Middleton, Wisconsin

Architect: Frank Lloyd Wright, 1945

The building was designed in 1945 by Frank Lloyd Wright on a hemicycle plan and is an early example of modern passive solar design. Earth is piled up against the northern wall for insulation.

The southern wall has two-storey glass windows and doors to maximise solar gain in winter and to take advantage of the elliptical solar path. An overhang on the southern façade is designed to provide shade from high-level summer sun.

Photo: Ezra Stoller

Optimism versus pessimism

Until recently, environmental concerns were often seen as scaremongering, more so in the UK than many other places in Europe, especially when the demands for urgent action preceded positive proof that the concerns were fully justified. The culture of technological optimism, particularly strong in the 1950s and 1960s, invited confidence in the ability of the earth to provide for human needs in perpetuity. Until quite recently it was widely believed that any action in the face of uncertainty was wasteful, expensive and obstructive to innovation. However, increasing awareness of the costs of postponing action – for instance, the potential costs imposed by global warming and escalating crime and disaffection – have moved opinion to favour precautionary and preventative actions. This precautionary approach is now enshrined in sustainable development principles, albeit scarcely applied.

	State of the World	
	Optimists Right	Pessimists Right
Optimistic Policy	High	Disaster
Pessimistic Policy	Moderate	Tolerable

Optimism–pessimism table
This matrix, which dates back to the 1970s, suggests that within any risk scenario if the optimists are right and there is little to worry about, and if we pursue a policy of optimism, then the potential gains are high. However, if the pessimistic scenario is accurate, following an optimistic policy leads to disaster. Prudent policies based on precautionary action are most sensible

Precautionary principle

A principle adopted by the UN Conference on Environment and Development (UNCED) 1992 that in order to protect the environment a precautionary approach should be widely applied. The Rio declaration interpreted this as:

'where there are threats of serious or irreversible damage to the environment, lack of scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation.'

Oversimplification

Too often the scope of concerns and complexity of issues regarding sustainability are over-simplified. Many so-called sustainability arguments equate it with climate change in particular, to the detriment of other considerations. Vitally important as carbon management is, we need action on many fronts. No amount of energy efficiency, nor any other single-issue campaign, will deliver sustainable development, although it will help. Oversimplification encourages one-dimensional solutions, short cuts, shallow questions and potentially bad laws. Oversimplification diverts attention from broader understanding and excludes people who need to be engaged. In terms of the built environment, single issues alienate designers, who are often more comfortable with the resolution of complex problems than with single issues. Hence an attempt in this book to introduce the broad picture of the problems that designers face.

Perhaps most importantly, we need to move from the present rhetoric that sustainability involves environmental, economic and social aspects to actively making and demonstrating those links. It is the lack of real belief in, and evidence of, the linkages that prevents politicians and others from providing long-term solutions to our most basic development problems.

An important aspect of the development of new affordable low-allergy housing in Perth was to look to research on the economic value of improvements in health. Research by Howieson on improvements to existing properties in Scotland indicated that the cost of providing an allergy-resistant environment could be paid back in 23 months from savings in medication. Projects now exist where patients with breathing disabilities are being prescribed housing improvements on the NHS.

Case Study 1.2:

St. George's School, Wallasey, Cheshire

Architect: Emslie Morgan, 1961

St. George's School at Wallasey, 1961, was designed by Emslie Morgan to provide each classroom with natural daylight and sunlight. A long, narrow-plan, two-storey building, it has large south-facing, double-glazed windows deriving maximum benefit from solar gain.

Diffusing glass was used to reduce glare and clear-glazed, openable windows, positioned at intervals, give the occupants control over the internal environment.

The heavyweight structural mass – concrete floors and ceilings – was intended to balance out fluctuations in heat demand, which was first reduced by high levels of insulation and low ventilation rates.

The remainder of the heating was to be met by a combination of the heat produced by the occupants, the solar wall and the heat output of the electric lighting. Conventional heating in the form of a single radiator beneath each of the openable windows was installed as a precaution against the failure of the passive approach.

The auxiliary system was rarely used. Using electrical inefficiency for heating was part of a now outdated approach to design, but the debate on whether well-designed schools need any heating continues.

Photo: Howard Liddell

Inertia

A contributing element to the shift in attitude is the recognition of the significant time lag between initial concerns and coordinated action on issues as diverse as desertification, climate change, ozone depletion, acid rain and asbestosis. These man-made disasters have all taken place with prior warning and very slow response. This generation is being starkly confronted by the failure to act of previous generations.

There is an increasing tendency to consider how our environment might be if, instead of foot dragging and talking down concerns, we had committed resources to respond to these threats when they were first identified. In many cases responses are still hugely inadequate.

> **'If we suspect a problem we should talk it up, not talk it down.'**
>
> Bill Bordass

The construction industry, its designers and its suppliers are central to the issues. The construction industry did not start to implement controls on chlorofluorocarbons (CFCs) until the mid-1990s despite significant evidence of the adverse effects. The industry continues to design resource-inefficient buildings, utilises polluting materials, overspecifies inefficient equipment and undertakes developments highly dependent on polluting forms of transport, with poor attention to the long-term communities. The majority of construction activity transforms natural habitats into environments where species other than humans struggle to exist. None of this is necessary. It is just bad design.

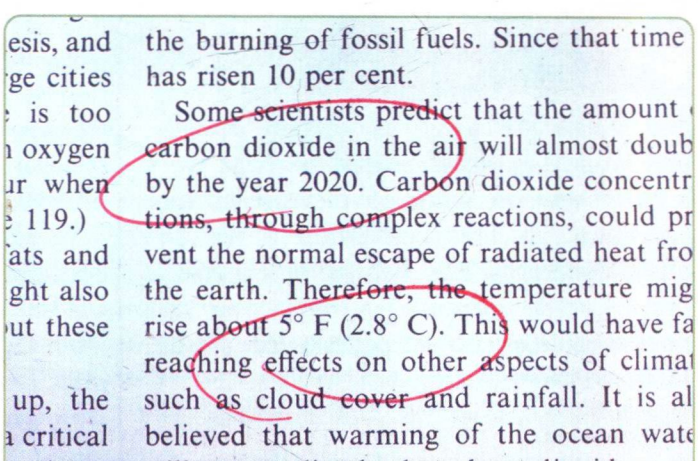
In 1974, two independent scientific papers suggested that chlorine atoms were ozone destroyers and that CFCs were breaking up in the stratosphere, releasing chlorine. The devastating consequences were clear. In 1978, a campaign in the USA led to a ban on CFCs for their primary use as propellants. By the mid-1980s, CFC production was surpassing its previous peak as manufacturers sought alternative markets and found uses in the construction industry as cheap refrigerants and blowing agents for insulation materials.

In 1984, a 40% drop in stratospheric ozone was measured in the Antarctic and the ozone hole in the Southern Hemisphere was identified. In 1987, stratospheric chlorine was eventually confirmed as the problem and the Montreal Protocol was signed. Major manufacturers Du Pont agreed to phase out CFCs in 1988. The northern ozone hole was identified in 1991.

If the international agreement was fully applied, CFCs would be gone from the atmosphere in 100 years – but currently the illegal trade in CFCs from South to North America exceeds in cash value the trade in cocaine. North America, it seems, is addicted to air-conditioning and it seems incapable of processing the consequences.

Current predictions for global temperature change as a result of greenhouse gases are not very different from those predicted 40 years ago.

The Swedish chemist Arrhenius is credited with first recognising, and quantifying, that increases in CO_2 would lead to global warming. Scientific papers appeared from the 1930s, but there was little real interest until the 1970s and no consensus until the late 1990s.



esis, and the burning of fossil fuels. Since that time
ge cities has risen 10 per cent.
is too Some scientists predict that the amount
oxygen carbon dioxide in the air will almost doub
ur when by the year 2020. Carbon dioxide concentr
119.) tions, through complex reactions, could pr
ats and vent the normal escape of radiated heat fro
ght also the earth. Therefore, the temperature mig
ut these rise about 5° F (2.8° C). This would have fa
reaching effects on other aspects of climat
up, the such as cloud cover and rainfall. It is al
critical believed that warming of the ocean wate

Impact of greenhouse gases
(Ecology, Basic Biology in Colour, Vol. V, 1972)

Internationally the issue is now very high on the political agenda, but intransigence from the major polluters undermines the will and effectiveness of actions by the global majority. Improved effectiveness in the use of resources sadly remains an unattractive proposition and instead proposed solutions currently include carbon sequestration (not sensibly in tree growth but in underground caverns!) and nuclear power (despite the fact that the lack of a waste management resolution makes it a fundamentally unsustainable solution).