

A methodology for the schematic design of sustainable buildings

SUSTAINABLE DESIGN BASICS

Sharon B. Jaffe • Rob Fleming
Mark Karlen • Saglinda H. Roberts

$Y = X \cdot \tan(\theta)$ where $(\theta) = 90 - \text{sun angle}$
Sun angle = 50degrees
 $\tan(40) = .83909963$

hi-transmission glass
Below 7'0" use lower transmission glass

Wind accelerates as it moves up and across elevation changes

Winds out of the Northwest

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Dedication

To my husband, my fellow adventurer, with whom I discovered everything is related to everything, and nature's delicate balance is both thrilling and vulnerable. No one can do everything, but everyone can do something; and I can make a start.

Sharon Jaffe

To my family, friends, and colleagues who endured a seemingly never-ending period of intense distraction, and to my co-writers, who endured my amazing ability to procrastinate. "Why do something today when it can be done next year"

Rob Fleming

To my wife for graciously accepting my too frequent distractions created by my writing tasks, and to my students and co-authors who are always a source of inspiration.

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To my family, friends and colleagues thank you for your wisdom inspiration and support, and never being tired of hearing "I'm sorry, I can't, I have to work." The built environment can be a powerful force for restoration at every level and it is my hope that this book will take us one step closer.

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Deficiencies, errors, or ambiguities found in this text, (as surely, we have missed one or two) are the responsibilities of the authors.

About the Authors

Sharon B Jaffe, LEED AP ID + C, IIDA, NCIDQ. Designer, educator, and sustainable re-developer specializing in the collaborative development of environmentally sustainable environments. She currently teaches at Thomas Jefferson University in Philadelphia.

Rob Fleming, AIA, LEED AP BD+C. Rob Fleming has been teaching, researching, advocating, and practicing sustainability for over 20 years in pursuit of a deeper and more meaningful understanding of sustainability. He is the founding director of and a professor in the master's in sustainable design program at Thomas Jefferson University.

Mark Karlen, Ph.D., AIA, NCIDQ Mark Karlen has been practicing, teaching, and writing about interior design and architecture for several decades. He has chaired interior architecture programs at the University of Cincinnati and Pratt Institute.

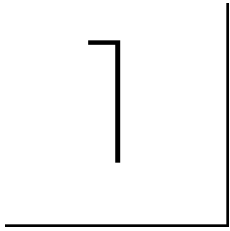
Saglinda H Roberts, IIDA, CID NJ, NCIDQ, LEED Green Associate. Saglinda Roberts is currently an Assistant Professor at Chatham University. She is the founder of a consulting firm which focuses on restorative and holistic sustainable design. She has over 30 years of extensive design experience and has won numerous local and AIA design awards. Passionate about architecture and its ability to transform lives, Saglinda has published several articles on the future of integral sustainable design and presented her research internationally.

About the Companion Website

Don't forget to visit the companion website for this book:
www.wiley.com/go/jaffesustainable.

The companion website to this book has a variety of tools, matrices, templates, SketchUp and AutoCAD files not found in the printed text, as well as:

- PowerPoint files with simple slides that review the materials addressed in the book.
- Narrated videos that review and augment concepts presented in the text.
- Simulation and validation assignments which require energy modeling software.



Why, How, Who, and What

Sustainability does not fit nicely under a single heading; it does not belong to a specific academic discipline or school subject. Nor is it the domain of any one sector—environment, education, business, or government. The quest to increase global sustainability involves many aspects of culture and a variety of disciplines that affect the world’s ecology, economics, ethics, and education. Sustainability is an issue beyond a given lifetime or location. It is everybody’s business and involves all aspects of how one lives in the modern world.

WHY USE THIS BOOK

This text is a basic primer focused on the design process for the sustainable built environment.

Buildings that are sustainably constructed and maintained contribute to the repair of the global ecosystem throughout their entire life cycle, while protecting the health and increasing the productivity of building occupants. The design of sustainable buildings requires that the architectural design process evolve into a new framework that promotes a transformation of the built environment globally. This framework must address the local context and apply to the full life cycle of the building.

Sustainable buildings are resilient buildings, mitigating damage to the environment and capable of adaptation. They are designed for longevity with low embodied energy requirements. Resilience requires a holistic approach to sustainability that extends to both lifestyle and the community beyond the buildings themselves.

Sustainable Design Basics presents design strategies that leverage renewable natural resources and innovative construction techniques to incorporate systems that conserve energy and resources. However, this book is more than a collection of sustainable strategies. *Sustainable Design Basics* is a methodology.

HOW TO USE THIS BOOK

This text is an instructional tool that presents both basic technical information and sustainability strategies required for sustainability, and a methodology to facilitate the collection, analysis, and evaluation required to approach a sustainable building project.

Sustainable design is inherently a complicated process. It requires an understanding of influencing factors far beyond client preferences, program requirements, and construction methods. For the architect or designer first approaching sustainable building design, it can be overwhelming.

For this reason, *Sustainable Design Basics* (SDB) has simplified the process to its most basic design steps. SDB introduces a step-by-step methodology with a series of matrices and worksheets as decision-making tools, as well as a demonstration project that illustrates each step. The SDB methodology is a working tool intended for use in the design process, not merely a text to be read for information. While an individual learner may use the SDB methodology, it was conceived and is intended for use in a conventional studio classroom setting.

WHO SHOULD USE THIS BOOK

As a basics book, in the tradition of *Space Planning Basics* by Mark Karlen and Rob Fleming and *Lighting Design Basics* by Mark Karlen, Christina Spangler, and James R. Benya, *Sustainable Design Basics* is directed primarily to intermediate-level (sophomore or junior levels in a baccalaureate or first professional degree program) interior architecture, interior design, and architecture students. These previous “Basics” books are the inspiration for a precise, easily accessible methodology to address sustainable design. However, this particular subject matter asks a lot of the reader. Sustainable design is a far-reaching subject that touches every aspect of design and deals with a wide range of design variables. It is a challenging subject. In breaking down the topic to address basics, a few readers may find some topics too simple and other topics too complicated. Hopefully, the bulk of the text addresses the subject material with an easily accessible, informative, and applicable approach.

One of the critical aspects of sustainability is the interrelated nature of global society. That is true for the environment, marketplaces, and education. Readers may come to this text from all parts of the world. With that understanding, the language of this book is direct and straightforward. Complex matters are broken down to smaller basic concepts to avoid, where possible, multilayered, complex theory. The authors are based in the United States, yet the sustainable design principles and practices in this book have global application. Locations in the United States may dominate the examples and exercises, but the choice of specific site locations was a result of limited time to address an ambitious scope of challenging material and not an effort to exclude other people or countries.

WHAT ARE THE PARAMETERS OF THIS BOOK

The primary focus of *Sustainable Design Basics* is design, not technology nor terminology. Specifically, the focus is limited to interior architecture, interior design, and architecture. The methodology described applies to both new construction and

to renovation of existing buildings. For clarity, this text limits the number of variables with a focus on new construction variables, although renovation and building reuse are vital elements of a sustainable built environment. However, each existing building has unique characteristics of construction, materials, and existing systems, beyond what a basics text can competently address.

A site for a building is a complex and worthy topic for sustainable design exploration. Limited by time and textbook length, in-depth exploration of the landscape and the complexities and challenges presented to sustainable designers are beyond the scope of this book.

ORGANIZATION

Sustainable Design Basics is a step by step, how-to methodology. Sadly, books are by default linear. There is not a “spiraling” option for information in print. While the text flows in a direct linear sequence of information, understand that sustainable design is not a linear process. The sustainable design process is integrated and iterative, frequently looping back to revisit preceding design decisions.

EXERCISES

The concepts and strategies included in this text have direct application to interior design, interior architecture, and architecture. The exercises that accompany the text follow the step-by-step methodology allowing the reader to do work independently to develop sustainable design skills through project-based learning. A set of undeveloped sites and building “shells” in a variety of geographic locations in the United States provided for exercise project locations each have different geological, climatic, and cultural contexts. Completing assignments on different sites allows the exploration of the sense of “place” as a fundamental design influence, inspiring different design ideas. A variety of clients, users, and contexts ranging from rural to urban are provided as exercise variables. The study of hundreds of projects is possible by mixing and matching exercise variables. Projects can be explored in the studio classroom setting or independently.

Users of this text are expected to possess basic knowledge of design, drafting, and planning skills. Many of the exercises require the ability to open and print AutoCAD files or to download and print PDF files. Some of the exercises in Chapter 15 require software. There are also exercises that can be completed, with some variation, without software. Additional software information is available in the appendix and the companion website.

COMPANION WEBSITE

A companion website to this book (www.wiley.com/go/jaffesustainable) has a variety of tools, matrices, templates, SketchUp, and AutoCAD files not found in the printed text, as well as:

- PowerPoint files with simple slides that review the materials addressed in the book
- Narrated videos that review and augment concepts presented in the text
- Simulation and validation assignments which require energy modeling software

2

Mindset

At the most basic level, designers of the built environment create the spaces and places that provide shelter from the elements, and thermal comfort while creating the surroundings of life. The quality of life is dependent upon the work designers, builders, engineers, and architects accomplish daily. It takes a lot of material and energy to construct and operate the buildings, interiors, and landscapes of the world. The use of these materials and energy sources affect the larger environment that humans rely on for fresh air, clean water, light, energy, and food. Such *ecosystem services* are fundamental to the continuance of civilization into the future. In other words, if society wastes energy and materials, if society carelessly releases pollution into the air and water, if humanity drives animals to extinction and forever alters the climate to produce uninhabitable conditions, humanity threatens its existence.

Put bluntly, the current pattern of life on earth is unsustainable.

The current distressed state of the planet is a direct result of how people think. Changing how individuals think can change the direction of society's thinking. With a mindset change, one can begin to imagine a sustainable future. This chapter deals directly with the "why" of sustainable design and the essential mindset for a capable, sustainable designer. Included in this chapter are significant historical events, prominent people, and notable frameworks that support an understanding of sustainability and sustainable design. The remainder of the book is the "what" and "how" of sustainable design, and the step-by-step methodology used to achieve a sustainable design project.

First, before delving into the methodology, a bit of historical context is appropriate, a brief journey through history that reveals our changing relationship with nature.

Sustainable design focuses on stabilizing the planet, cleaning the water and air, conserving energy resources, expanding renewable energy sources, preserving

biodiversity, and using materials wisely: all to save the planet. If the planet is “saved,” humanity is “saved.” Society may persist in the future—hence the word “sustainable.” However, it is not that simple. An overall holistic approach to sustainability must address the many economic, social, and aesthetic dimensions of human existence. Sustainable design is more than just the environment.

Sustainable design is a holistic *practice*. Physical objects, the built environment, and services are designed by responding to the goals and principles of sustainability as viewed from multiple perspectives across space and time. The triple bottom line is a phrase that expresses key concerns of sustainability:

- Social equity
- Economic prosperity
- Ecological protection

A fourth sustainability value, beauty, is added to make sustainable buildings more meaningful and more satisfying.

THE HOLOCENE AND THE AGE OF AGRICULTURE

To see the big picture and understand the threats the world faces, one must look back 12,000 years to the end of the last ice age. Earth entered what is called an interglacial, a period between ice ages when the planet was very warm. The most recent interglacial is called the Holocene. This period of warmth is rare and valuable. The Holocene set the stage for the Age of Agriculture, a population boom, and civilization as it is known today.

A few key points to remember:

1. The climate today is a rarity in the context of the four-billion-year history of the planet.
2. Humans have emerged as the dominant species on the planet primarily due to the advantageous conditions of the Holocene.
3. Humans have assumed it is a right to dominate other species and less powerful and less technologically advanced humans in the pursuit of power and resources.

THE INDUSTRIAL REVOLUTION AND THE ENVIRONMENT

As the agricultural age progressed, humanity continued to benefit from a warm climate and seemingly infinite natural resources. Technological advances continued to advance humanity’s dominion over the environment. It was also a time when the drive for power, profit, and comfort led to the oppression of millions of people through slavery and indefinable levels of environmental destruction. Humanity’s consciousness evolved, leading to great scientific discoveries, insight into how the universe works, and critical social innovations such as labor laws, public education, and democracy.

The seeds of today’s environmental and social problems originated during this fantastic time of human achievement. The Western industrial revolution saw the

introduction of efficient engines to power industrial production and generate electricity. Industry was powered mainly by coal resulting in air tinged by coal smoke casting a pall across European industrial cities. The pollution of the air with coal smoke became the primary environmental concern in London. In response, the early nineteenth century saw the rise of Romanticism with an emphasis on nature and natural beauty. By the late nineteenth century, the first European nongovernmental environmental organizations (NGOs) came into being in London, focused on mitigating air pollution. In North America, John Muir, an early environmentalist, urged the government to create a national park to preserve the natural beauty of the Yosemite Valley. The industrial society sparked increasing environmental and social concerns during the Enlightenment and Romantic movements.

The industrial revolution ended in what is called the “great acceleration.” This was a period during the twentieth century of rapidly increasing negative impact on the earth’s environment and systems from human activity, consumption of natural resources, and the unintended results of technological progress. “Progress” is a two-sided coin. The post–World War II boom led humanity to previously unequaled technical achievements and unprecedented population growth, yet the presumption of inexhaustible natural resources resulted in undisputable environmental destruction.

ENVIRONMENTALISM AND THE AGE OF INFORMATION

1960s

By the 1960s some individuals started to understand that the environment was in trouble. Humanity’s very existence was at risk. The world started to study the environment in many ways, purposefully using scientific methods to prove that there was, in fact, a problem. This understanding was the beginning of environmentalism. The American marine biologist, writer, and ecologist Rachel Carson wrote a book called *Silent Spring*, which documented the negative impacts of pesticides on the general ecology. She observed that spraying poisonous insecticides that killed crop-damaging bugs also killed the birds that ate the bugs. No birds left to sing prompted the title, “silent spring.” Rachel Carson’s work called for a change in how the world viewed nature and its ecosystems. Her work, along with many others, led to the birth of the environmentalist movement.

The American civil rights movement, begun in the mid-1950s and building through the 1960s, heralded a new era of progressive thinking about the global condition of humanity and how social equity in society impacts sustainability. Around the same time a Scottish landscape architect named Ian McHarg wrote a book called *Design with Nature*, in which he outlined how designers can improve the environment using natural systems through ecological planning. The relationship between urban and natural environments can be synergistic and regenerative when the holistic, living nature of the earth’s systems and humanity’s impact on it are understood. Such understanding can be used to adapt human patterns and process into integrated ecosystems. McHarg’s design approach promoted incorporating the natural world into design projects functionally and aesthetically. He showed that the natural world can, and should, act as a partner and co-designer in the design process.

McHarg also taught people to think about how the environment of a specific place and time influence their experiences and how broad environmental context influences the design of the built environment. He asserted that projects could and should look different in places with different climates, cultures and geographies.

1970s

The 1970s saw the beginning of a response to environmental concerns. Laws were passed to protect the air, water, and endangered species in the United States. The Environmental Protection Agency (EPA) was founded to fight pollution. E.F. Schumacher, a British economist, examined the economic world, determining that the modern economy was unsustainable with natural resources managed as expendable income rather than nonrenewable capital. Schumacher presented a philosophy based on the appreciation of human needs and limitations in his book *Small Is Beautiful: A Study of Economics as if People Mattered*.

The 1970s also saw the beginning of the growing public awareness that energy sources such as oil, gas, and coal were limited and that these fossil fuels were a significant culprit in polluting the air and causing climate change. The release of carbon dioxide, methane, and other gases as a result of burning fossil fuel created a thicker than usual layer of greenhouse gases around the planet. Greenhouse gases trap more heat inside the earth's atmosphere, causing temperatures to rise higher than typical expectations.

1980s

Deindustrialization in the American Midwest resulted in the relocation of much of the industrial manufacturing and its accompanying pollution to China and India.

1987

The United Nations formed the Brundtland Commission in 1987 to address the now obvious need for a new model of development, one that would protect the environment and support a more equitable society, a new way forward that would remediate the negative impacts of the Industrial Revolution and conceive of a new way to think about progress. The commission produced a report, *Our Common Future*, which suggested a new spirit of cooperation. This report expressed the belief that the success or failure of civilization and the planet is a shared goal and responsibility of all nations.

The Brundtland Commission proposed a formal definition of sustainable development. "Sustainable development is development that meets the needs of the current generation without compromising the needs of future generations to meet their own needs."¹

This definition clearly articulates indigenous wisdom and traditional knowledge too often ignored in the name of progress: Humankind must care for the earth as stewards for future generations. The document demands long-term thinking even when making short-term decisions, such as designing a building.

¹World Commission on Environment and Development, *Our Common Future* (New York and London: Oxford University Press, 1987), p. 43.

1990s

By the early 1990s sustainability began to take more definitive shape as people like John Elkington developed new frameworks like the “triple bottom line” for thinking about sustainability, referencing society, environment, and economy as the more alliterative “people, planet, and profit.”

Figure 2.0 diagrams the triple bottom line sustainability framework as outlined by John Elkington. The three overlapping sustainability concerns—society, environment, and economy—are only fully realized when all three concerns are addressed.

Triple bottom line framework provides an expansive accountability method by which people and organizations can evaluate performance beyond the immediate and direct financial bottom line or profit. Profit, the traditional bottom line for many years, has not accounted for the true project costs. To be sustainable, decisions made by organizations must meet environmental and social bottom lines, not just the economic bottom line. Equal consideration of all three goals by aligning business

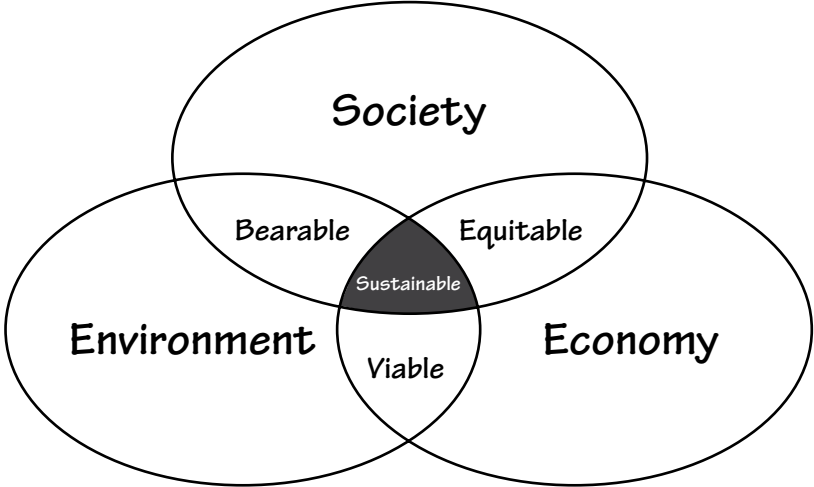


Figure 2.0 John Elkington’s triple bottom line framework
Source: Rob Fleming

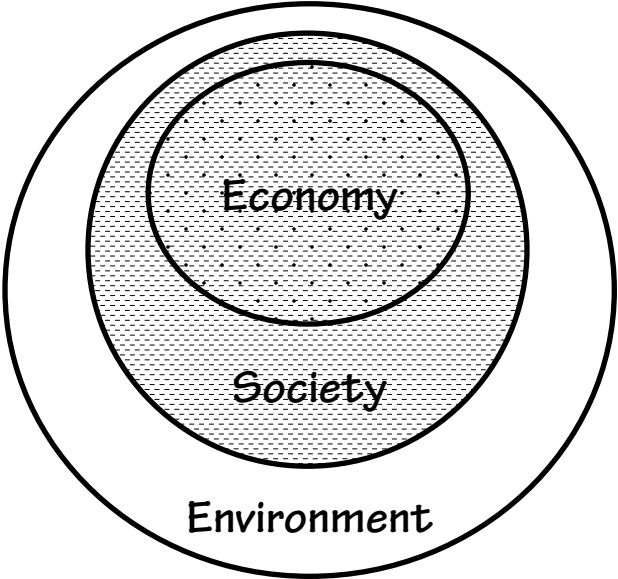


Figure 2.1 Nested triple bottom line diagram
Source: Wikipedia; redrawn by Rob Fleming

thinking with social and environmental considerations achieves greater value, by establishing a clearer pathway toward a sustainable future.

The framework of the triple bottom line makes a few assumptions that raise questions. Are all three sectors—the economy, society, and environment—always of equal weight? Can individual sectors be compartmentalized to operate with autonomy? How does an accounting framework deal with the invaluable, irreplaceable aspects of natural resources? While the accountants and politicians may prioritize the economy, it is the environment that is the limiting factor. Consider that the economy exists as a construct of society. Society, human beings, cannot exist without the environment. The nested circles of sustainability in Figure 2.1 better reflect the relationship of the economy as a subset of society and the dependence of society on the environment.

1993

In 1993 the design community formally entered into the sustainability movement. Four significant events occurred that fundamentally shaped sustainable design:

1. William McDonough wrote *Design, Ecology, Ethics and the Making of Things*, commonly known as the Centennial Sermon, which charged the design community to pursue design as an environmental imperative, leading to an ethical foundation for design rather than the more conventional aesthetically driven creative process.
2. Hillary and Bill Clinton “greened” the White House by adding solar panels to the roof and by using “green” practices in the restoration of the building.
3. Susan Maxman became the first female president of the American Institute of Architects, championing sustainability as her platform during the election.
4. The United States Green Building Council was formed in 1993 and developed the LEED Rating System. LEED stands for Leadership in Energy and Environmental Design. This framework for green buildings is used by thousands of designers, engineers, and clients to achieve projects that minimized environmental damage and increased energy efficiency of projects.

The race toward a sustainable future was accelerating and most Fortune 500 companies, eager to become stewards of the environment, incorporated LEED metrics for green buildings as part of their triple bottom line initiatives. By 2005 thousands of green buildings were constructed all over the world. The green design movement was a success.

2005

In 2005, another series of events occurred signaling society that “greening” was not enough. The environmental problems were bigger and more threatening than previously imagined. The sustaining warm climate of the Holocene had now become hotter, so much so that environmental conditions were changing in dramatic ways. It is not good practice to say that one environmental disaster or another is the result of climate change, but over time, a correlation was starting