PART 1

CONTEXT

CHAPTER 1

DESIGN AND STEWARDSHIP

> The standard for ecological design is neither efficiency nor productivity but health, beginning with that of the soil and extending upward through plants, animals, and people. It is impossible to impair health at any level without affecting it at other levels. The etymology of the word "health" reveals its connection to other words such as healing, wholeness, and holy. Ecological design is an art by which we aim to restore and maintain the wholeness of the entire fabric of life increasingly fragmented by specialization, scientific reductionism, and bureaucratic division.
>
> DAVID ORR

INTRODUCTION

What does stewardship mean, and what is the role of the design disciplines in furthering and developing this idea? The stewardship model of responsibility has its foundation in theological writings on the relationship between humans and the natural world—hence its prominent position in many of the mission statements of faith-based healthcare organizations. At many such organizations, stewardship of God-given natural resources has been reinterpreted in the modern era to include promotion of human health. Such an expanded view leaves the design industries a correspondingly broad role in terms of stewardship.

The concept of resource stewardship is pivotal in sustainable, or "green," design as it is currently defined and practiced throughout the design disciplines. The design of hospital buildings (as cultural artifacts) can be viewed as an important component of the larger practice of the design of habitats for humans—in this case, healing habitats. For the last half-century, however, the design of hospital buildings has been remarkably independent of the broader trends in architectural design. As a particular typology, healthcare architecture has evolved in a world apart, responding, for the most part, to industry trends in technology and ever-more complex life-safety regulations. Until recently, healthcare owners, architects, and engineers have been unaware of the impact that sustainable design concerns have had on the larger design industry.

Environmental stewardship is a defining principle of sustainable architecture, as the essayist and commentators in this chapter eloquently state. Architect Bill Valentine, FAIA, postulates below that "less is better" and challenges design professionals to reconsider scale and deliver better, healthier buildings using less. Designer and educator Pliny Fisk III presents an expanded definition of lifecycle design, one that postulates a "new ecology of mind," which joins together architecture and neuroscience. In his essay, designer Jason F. McLennan challenges design to redefine itself as no less than "living" for our buildings, our health, and the planet. Finally, architect Bob Berkebile, FAIA, challenges us to imagine a "restorative" and "regenerative" future, a concept further explored in the final chapter.

The sustainable design movement, through such leaders as Paul Hawken, Amory Lovins, and L. Hunter Lovins, has given us new lenses for viewing the economy: Natural Capitalism: Creating the Next Industrial Revolution (2000) and The Ecology of Commerce (1993). The parallel ideologies of "clean production" and William McDonough and Michael Braungart's "cradle to cradle" are having significant impacts on building materials science, from revolutions in the petrochemical components of our material economy to end-of-life ideas such as "waste equals food." Science writer Janine Benyus, in *Biomimicry: Innovation Inspired by Nature* (1997), points to a future when science will look to nature for inspiration and technology—and an impressive roster of corporations and designers who have adopted biomimicry principles in their research and applied them to products is testament to that future becoming reality (Biomimicry 3.8, 2012). Just outside the silo that defines the current practice of healthcare architecture, notions of planetary stewardship linked to health are fundamentally redefining the design and production of the built environment.

THE CASE FOR STEWARDSHIP

The scientific community is in general agreement that human activity now exceeds the global carrying capacity of the Earth's ecosystems, and that those ecosystems are rapidly degrading. The United Nations' Millennium Ecosystem Assessment, released in 2005, chronicles the continued degradation of the natural environment, amplifying the growing awareness that healthy people cannot live on a sick planet. The Ecological Footprint Atlas (Ewing et al. 2010) and the World Wildlife Fund's Living Planet Report (2010) estimate the world's economies are overshooting their capacity for natural resource regeneration by 50 percent (see Figure 1.1). While much of the discussion on finite global resources has focused on the depletion of nonrenewable resources, such as petroleum, it is increasingly evident that renewable resources, and the ecosystem services they provide, are also at great or even greater risk (Ewing et al. 2010).

Environmentalist and writer Bill McKibben (1989) contends that there are no longer any ecosystems on Earth uninfluenced by humans. "Anthropocene," a term introduced in 2000 by Nobel Prize laureate Paul Crutzen and ecologist Eugene Stoermer, describes our current geological epoch as fundamentally defined by the influence of human activities (Crutzen and Stoermer 2000). The Living Planet Report (2010) reports general decline in global biodiversity from 1970 to 2007 as follows:

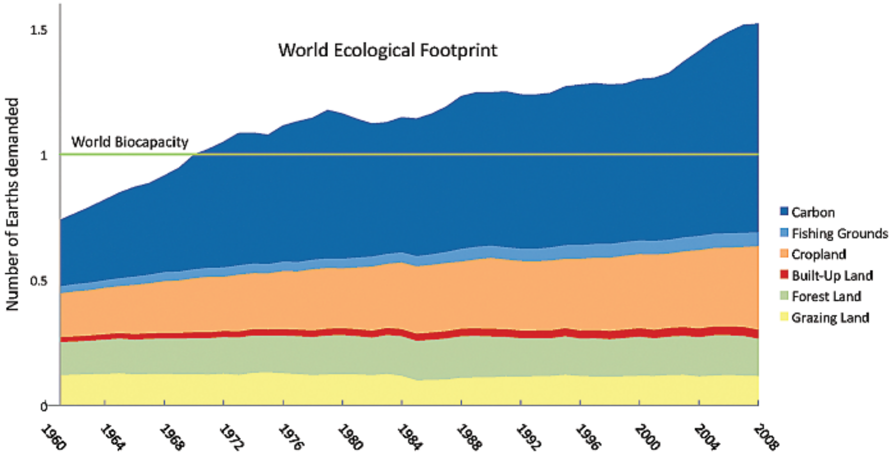

Figure 1.1 In 2007, humanity's total ecological footprint worldwide was 18.0 billion global hectares (gha); with world population at 6.7 billion people, the average person's footprint was 2.7 gha. But there were only 11.9 billion gha of biocapacity available that year, or 1.8 gha per person. This overshoot of approximately 50 percent means that in 2007 humanity used the equivalent of 1.5 Earths to support its consumption. *Source: Global Footprint Network and UNDP, 2010*

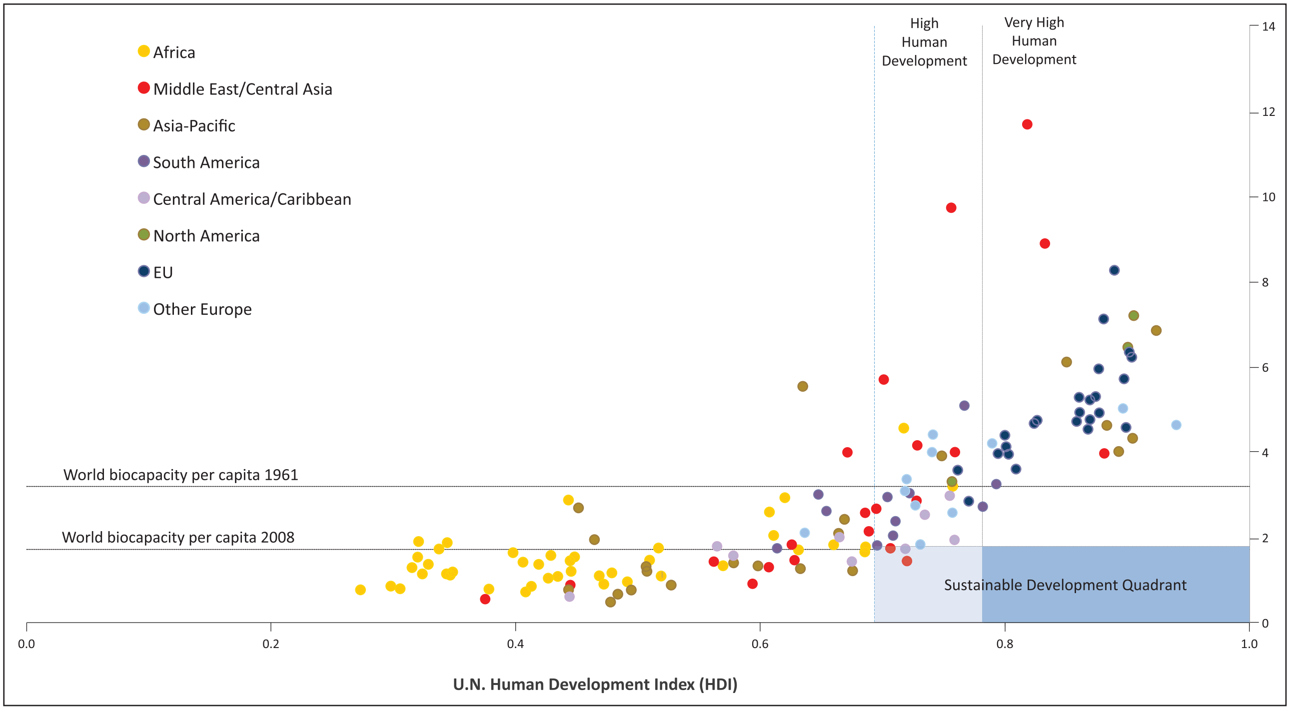

Figure 1.2 The Ecological Footprint of consumption for 2008 and Human Development Index by region. The HD values are linear interpolations between the 2005 and 2009 values from the Human Development Report 2011. Countries with an HDI score of 0.8 or higher and a footprint of 1.8 global hectares per person or lower meet two minimum criteria for global sustainable development. The graph indicates that countries consume vastly differing global resources to attain high human development. Countries living within planetary means also achieve radically different levels of human development. *Source: Global Footprint Network and UNDP, 2013*

- 37 percent decline in temperate and topical freshwater ecosystems
- 24 percent decline of marine life
- percent decline in terrestrial plant and animal species

From 10 to 15 percent of the Earth's land surface is dominated by agriculture and urban development. Close to 50 percent of the Earth's land mass has been transformed by humans. Humans consume more than 40 to 50 percent of all available freshwater (in the Middle East, consumption is estimated to be 120 percent); 25 percent of the Earth's land surface is cultivated. Furthermore, the globalization of nature—that is, the introduction of nonnative species in unfamiliar ecoregions—has disastrously weakened functioning ecosystems (Millenium Ecosystem Assessment 2005).

A key question is whether this increased resource consumption is required to meet basic human development needs. Given increasing global population, reliance on a growing level of consumption to attain sustainable well-being for all is unrealistic. The challenge of reaching a high level of human well-being while ensuring long-term resource availability is illustrated in Figure 1.2. High levels of human development, as measured by United Nations Development Programme (UNDP), are an HDI score of 0.8 or greater. The Global Footprint Network defines the average productive area available for each person on the planet as 1.8 global hectares.

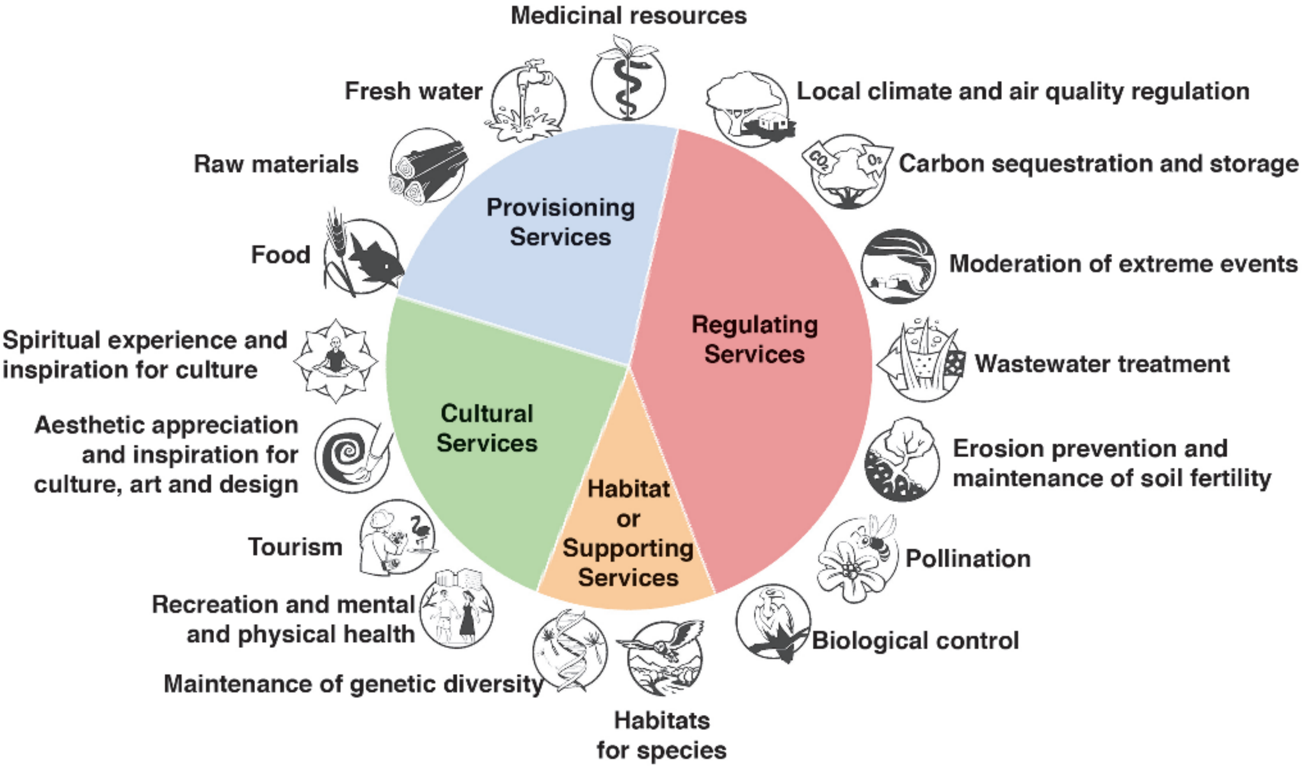

Figure 1.3 Ecosystem Services. These four types of ecosystem services are essential to support human life. *Source: TEEB, redrawn by the authors*

The concept of assigning monetary value to ecosystem services—i.e., the value of clean drinking water or pollinating insects—was first postulated by Vitousek and others (1997); at that time, they assigned a conservative value of approximately $33 trillion to these services. The Economics of Ecosystems and Biodiversity (TEEB 2010) is an ongoing project that reviews the science and economics of ecosystems and biodiversity and includes a valuation framework to improve policy decision-making. It defines four basic types of ecosystem services: provisioning services, regulating services, habitat services, and cultural services, as described in Figure 1.3.

In 1992, the Union of Concerned Scientists, on behalf of 1,600 scientists (including the majority of living Nobel laureates) issued the World Scientists' Warning to Humanity. It outlined the case for stewardship as essential to survival:

> We, the undersigned senior members of the world's scientific community, hereby warn humanity of what lies ahead. A great change in our *stewardship of the earth* [emphasis added] and the life of it is required, if vast human misery is to be avoided and our global home on this planet is not to be irretrievably mutilated (Union of Concerned Scientists 1992).

The principle of stewardship is intrinsic to the idea of sustainable development. This movement, global in scope while locally implemented, has broad implications for both medicine and the environments that support it.

> *The resilience of the community of life and the well-being of humanity depend upon preserving a healthy biosphere with all its ecological systems, a rich variety of plants and animals, fertile soils, pure waters, and clean air. The global environment with its finite resources is a common concern of all peoples. The protection of the Earth's vitality, diversity, and beauty is a sacred trust.*
>
> —EARTH CHARTER (2000)

SUSTAINABLE DEVELOPMENT

Sustainable development was defined for the first time in the United Nations'1987 Brundtland Commission Report as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." It quickly gained stature in the public lexicon. This definition both inserted an explicit value proposition into the international development domain and gave "green building" a broad conceptual foundation on which to grow.

In 1992, the first United Nations' Conference on Environment and Development (commonly referred to as the Earth Summit), convened in Rio de Janeiro, and resulted in Agenda 21, a blueprint for achieving global sustainability, and the Rio Declaration on Environment and Development. The Earth Summit produced some of the earliest statements on climate change and biodiversity. Adopted by more than 178 participating governments (including the United States) (UN 2004), its visionary declarations and action plans recognized the interconnections among all living systems on Earth.

Two of these declarations would prove to be pivotal for sustainable building in healthcare. Principle 1 of the Rio Declaration states: "Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature." Principle 15 advances the principle of precaution, an important construct in medicine:

> In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

As global resources become less available, this precautionary approach becomes both more important but equally more challenging to actualize. At Rio+20, convened in 2012, Principle 15 was extensively debated. A diminishing resource base presents both unique opportunities and constraints in the development of design and stewardship. But one thing is clear: A diminishing resource base has profound consequences for the built environment and the profession of architecture.

THE PROFESSION OF ARCHITECTURE

Early environmental design initiatives were disparate, focusing primarily on the reduction of energy demands. In response to the energy crisis of the early 1970s, the American Institute of Architects (AIA) established the Committee on Energy to develop tools and policies to address mounting public concern about the building industry's reliance on fossil fuels. Parallel federal initiatives included the creation of the Solar Energy Research Institute (now the National Renewable Energy Laboratory) and the cabinet-level Department of Energy. Absent a larger framework for sustainable design, these departments focused on energy technologies and conservation.

In 1989, the AIA Committee on Energy transformed itself into the Committee on the Environment (AIA/COTE), reflecting a broader view of sustainability. In 1998, AIA/COTE announced the Top Ten Green Projects annual award program to recognize design excellence in sustainable architecture.

Inspired by the Earth Summit, the UIA/AIA World Congress of Architects (UIA stands for "International Union of Architects" in French) issued its Declaration of Interdependence for a Sustainable Future in 1993. Signed by more than three thousand participants, it states: “Buildings and the built environment play a major role in the human impact on the natural environment and on the quality of life”—a bold challenge to the profession at large to put a broader sustainability agenda into practice (UIA 1993).

In 2005, the AIA issued this position statement on the responsibility of design professionals (AIA 2005):

> The AIA recognizes a growing body of evidence that demonstrates current planning, design, construction and real estate practices contribute to patterns of resource consumption that seriously jeopardize the future of the Earth’s population. Architects need to accept responsibility for their role in creating the built environment and, consequently, believe we must alter our profession’s actions and join our clients and the entire design and construction industry to change the course of the planet’s future.

The statement continues with a commitment to achieve a 50 percent reduction in fossil fuel consumption for new and renovated buildings by 2010 and target continuing reduction thereafter, a commitment to integrate sustainable design education into the curricula of architecture schools (and ultimately into the licensing process), and a commitment to promote research into lifecycle assessment methodologies.

In January 2006, architect Edward Mazria, FAIA, launched the 2030 Challenge: to achieve zero emissions and carbon neutrality for all building operations by 2030, beginning with an initial 60 percent reduction of fossil fuel consumption by 2010, and continuing with an additional 10 percent incremental reduction in every subsequent five-year period (Architecture 2030 2012) (see Figure 1.4). Many U.S. organizations have adopted this bold initiative, including the American Institute of Architects (AIA); American Society of Interior Designers (ASID); the U.S. Green Building Council (USGBC); the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE); and the U.S. Conference of Mayors.

In addition, major firms such as Perkins+Will, HOK, and HKS have also endorsed its principles. The Oregon State Hospital Replacement, Salem, Oregon, completed in 2011 by HOK and SRG, was designed to achieve an Energy Use Index of 114.5 kBtu/sf/yr to comply with the 2010 energy target of 60 percent below regional average baseline; in operation, it is tracking just below 100 kBtu/sf/yr (see Figure 1.5). For the new Oregon State psychiatric hospital in Junction City, HOK projects an EUI of just below 100 (see Figure 1.6).

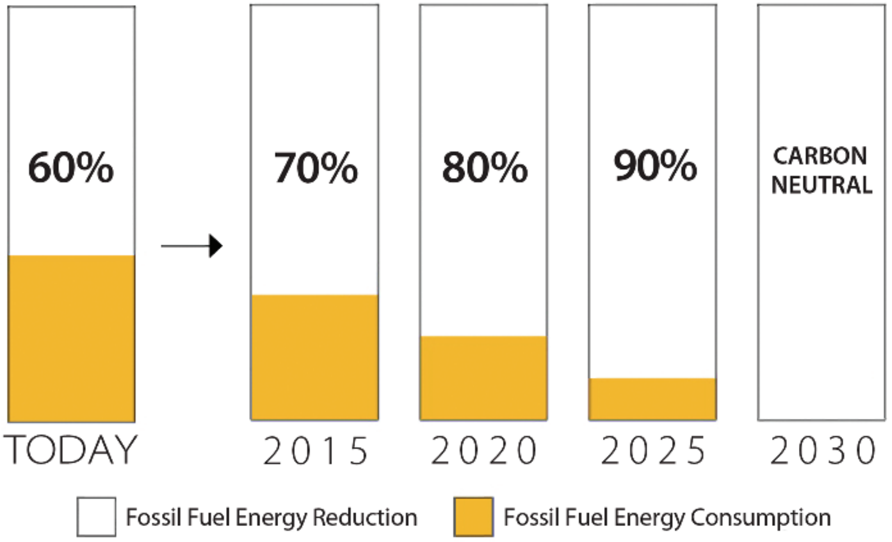

Figure 1.4 The 2030 Challenge goals. All new buildings, developments, and major renovations by 2015 shall be designed to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 70 percent below the regional (or country) average for that building type, increasing by 10 percent each five years. By 2030, all buildings will be designed to be carbon-neutral, operated with 100 percent renewable energy.

Figure 1.5 Oregon State Hospital at Salem, Oregon, is designed to meet the 2030 Challenge 2010 goal. *Source: HOK with SRG Architects*

Figure 1.6 Oregon State Hospital at Junction City is designed to meet the 2030 Challenge 2015 goal. *Source: HOK*

THE ETHICAL CHALLENGE FOR DESIGNERS

Ultimately, the built environment is the product of intentional design decisions, and waste signifies failure. *Metropolis* magazine editor Susan Szenasy (2004) sums up the challenge this way: “Designers today stand on the brink of being seen by society as essential contributors to its health, safety, and welfare. If you—together with the other design professions—decide to examine the materials and processes endemic to your work, as well as demand that these materials and processes become environmentally safe, you will be the heroes of the twenty-first century.” Or, as David Orr (2004) sees it, “The larger challenge is to transform a wasteful society into one that meets human needs with elegant simplicity.” As this change occurs, labels like “biomimicry” or “sustainable design” attempt to describe the efforts. The ethical challenge is, however, broad in scope. It is not simply about designing environmentally benign hospital buildings for an ever-expanding industrial-medical complex, but about formulating a system of healthcare that supports vital communities that nurture health and whole people “who do not confuse what they have with who they are” (Orr 2004). This broader vision of design can best be termed “ecological design.”

ECOLOGICAL DESIGN

Ecological design, Orr continues, “requires a revolution in our thinking.” He suggests changing the kinds of questions we ask about a design, from, “How can we do the same old things more efficiently?” to ones such as:

- Do we need it?
- Is it ethical?
- What impact does it have on the economy?
- Is it safe to make and use?
- Is it fair?
- Can it be repaired or reused?
- What is the full cost over its expected lifetime?
- Is there a better way to do it?

> *Architects have wonderful opportunities to make things better by enthusiastically promoting “less” in the buildings we design. This doesn’t mean stripping away the elements that make our buildings beautiful. But we can design structures in simpler, more thoughtful ways that work with, instead of against, nature. And by doing so we can prove to people that less can be better in many aspects of their lives. Though we can’t legislate less in our culture, we’re at a potential tipping point—that dramatic time popularized by Malcolm Gladwell’s* Tipping Point *(2000) when something that had once been unique becomes common. Using less can become the norm.*
>
> *My message actually goes far beyond buildings and, I hope, straight to the heart of our culture. I’d like to trigger a move toward less in the building industry that also spreads across our society and catalyzes a profound cultural shift toward simplicity. Let’s show people that all this stuff isn’t required to live “the good life.” Let’s change our habits and reclaim our culture by making less a virtue. If we can make the idea of using less fashionable and chic in the U.S., our success could send ripples all over the world.*
>
> —BILL VALENTINE, CHAIRMAN, HOK (2008)

Orr conceives of ecological design not so much as an individual art practiced by individual designers but as an ongoing negotiation between a community and the ecology of particular places. Ecologically designed buildings “grow” from the long-term knowledge that derives from intimate experience of a place over time; they “live” within a biotic framework established by an understanding of natural principles and man-made policies standing together.

At the Patrick H. Dollard Discovery Health Center (see sidebar), the first LEED-certified ambulatory building, the decision to construct a sustainable building was informed by an ecological viewpoint—the belief that the health vulnerabilities of developmentally disabled children are influenced by the health of the ecosystems and built environments within which they live and learn. Completed in 2004, this building demonstrates the power of stewardship in healthcare settings. It is as relevant today as the day it opened.

CLEANER PRODUCTION

The concept of stewardship requires a reexamination of materials, the units of production from which the built environment is created. Materials extraction and production processes as they evolved during the Industrial Revolution have come to be categorized as "beat, heat, and treat" methodologies. Industry thrived in an era of inexpensive energy, using industrial processes to replace human labor in an ever-expanding era of raw material usage. Waste was seen as an inconvenience rather than a measure of inefficient production. In the early 1990s, in response to growing recognition of environmental degradation and resource depletion, the United Nations Environment Programme (UNEP 1989) defined "cleaner production":

> Cleaner Production is the continuous application of an integrated preventive environmental strategy to processes, products and services to increase overall efficiency, and reduce risks to humans and the environment…
>
> For production processes, Cleaner Production results from…conserving raw materials, water and energy; eliminating toxic and dangerous raw materials; and reducing the quantity and toxicity of all emissions and wastes at source during the production process.
>
> For products, Cleaner Production aims to reduce environmental, health and safety impacts over their entire life cycles, from raw materials extraction, through manufacturing and use, to the "ultimate" disposal of the product.

Advocates of cleaner production have developed "tool kits" for reducing pollution by substituting safer, more benign materials for hazardous materials; by optimizing production technologies; and by closing loops in manufacturing processes to recycle and reuse what had been waste materials. Tools such as the Green Screen, Pharos, and the Health Product Declaration are being developed to assist designers and specifiers in accessing information and understanding the complex chemical components of building materials (see Chapter 5).

Pollution prevention programs, as defined by the healthcare industry, are examples of cleaner production initiatives in action. In some states, "toxic use reduction plans" are manifestations of cleaner production initiatives. Cleaner production demonstration programs have been launched all over the world and are now common not only in industrialized nations, but also in developing nations. Generally speaking, cleaner production "design" activities achieve both environmental benefits and economic returns—and demonstrate improved stewardship of both resources through the lifecycle.

The Patrick H. Dollard Discovery Health Center

Harris, New York

Architect: Guenther 5 Architects/Perkins+Will

This 28,000 sq. ft. (2,601 sq. m) project seeks to evolve a noninstitutional ambulatory medical facility nested within a rural, residential campus. It is the new front door for the Center for Discovery, a 350-acre residential facility that houses more than 250 developmentally disabled adults and children in a decentralized group home model.

The center emphasizes a nature-based program that includes community-supported agriculture manifested in its organic farm. Goats and horses pasture in the fields adjacent to the clinic building. The project site, a 9-acre (3.6-ha) former "industrial" egg farm, created significant pollution runoff to the adjacent organic farm. Although it might have been less expensive to develop on a greenfield parcel, the Center for Discovery realized that the ecological remediation of the project site would improve irrigation water quality on the farm and safeguard against future potential contamination. The plan prioritizes daylight and views, with a focus on visual connection to the adjacent farm (Figures 1.7–1.10).

Linking hydronic heating to ground-source heat pumps eliminated all onsite combustion, contributing to reduced airborne emissions (Figure 1.8). The center utilizes radiant heating systems in residential buildings because they provide superior thermal comfort, reduce maintenance, and improve resident safety, leaving no exposed heating equipment in the wheelchair zone. The project predates the 2030 Challenge but met the 2010 goal for 60% energy use reduction. It also captures and stores rainwater for irrigation, fire tank reserves, and ground source makeup. Excess rainwater is released to the farm irrigation system.

Source: Guenther 5/Perkins+Will

Figure 1.7 The Patrick H. Dollard Discovery Health Center. *Source: David Allee*

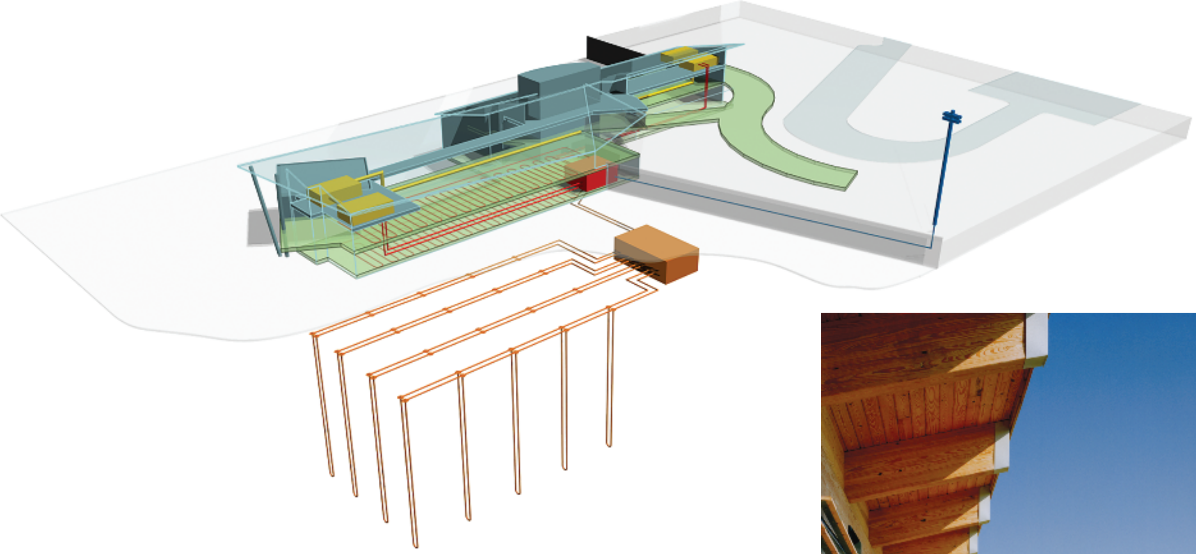

Figure 1.8 Ground source heat pump systems link to hydronic distribution. *Source: Guenther 5/Perkins+Will*

Figure 1.9 The deck overlooking the adjacent farm. *Source: David Allee*

Figure 1.10 The shallow floor plate ensures deep daylight penetration into waiting areas and exam spaces. *Source: Guenther 5/Perkins+Will*

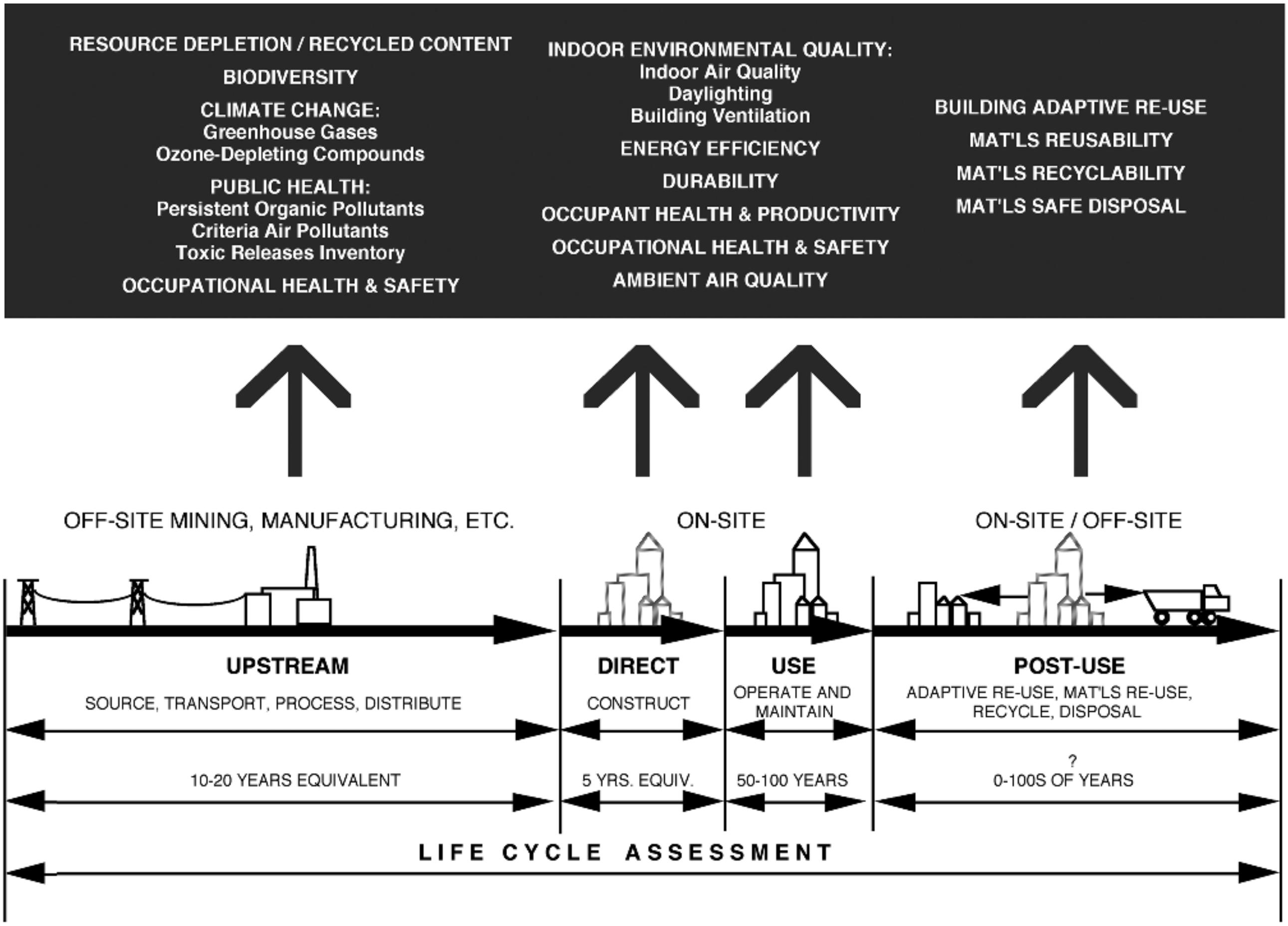

Figure 1.11 Life cycle diagram. Each building life cycle phase results in a range of environmental and health consequences—some of these are constants and some more variable based on building type, location, and programmatic focus. Using these indicators as evaluative criteria to compare material choices and design features leads to robust material specification and design decisions. *Source: Center for Maximum Potential Building Systems*

LIFE CYCLE THINKING

Healthcare building design and construction processes have usually been cradle to grave, with ever-shorter use life spans. While many late-nineteenth-century healthcare buildings remain in use, they have often been downgraded from acute care to ancillary facilities as the technology and the associated space requirements of acute-care buildings have escalated. After sixty years in service, the post–World War II Hill-Burton buildings throughout the United States are presently the target of replacement. At the same time, mid- to late-1970s facilities are being downgraded after barely thirty years in service. Because the vast resource base that supported the expansion of the built environment in the nineteenth and twentieth centuries is diminished, the processes associated with buildings at every stage of their life cycle are being fundamentally reconsidered (see Figure 1.11).

Broadly termed Life Cycle Design (LCD) thinking, the production cycle for building design and construction is expanded to include the extraction, production, and transportation consequences to ecosystems and human health that often, collectively, exceed the use-phase impacts of a building material. Within the discipline of sustainable design, the advantages of LCD have thus far been evaluated on a tangible level; for instance, reducing the distance a material must be transported to a building site creates quantifiable reductions in fuel, emissions, and economic cost. Incrementally more sophisticated effects of LCD might include the development of regionalized economic loops incorporating virgin and byproduct materials, local producers, and locally appropriate resources, or the advancement of a building vernacular based on such a regional network.

Architectural designer and educator Pliny Fisk III provides a brief introduction to both the principles that underlie current life cycle design concepts (see Life Cycle Design Principles) as well as a set of concepts that extend the reach of LCD into a behavioral realm (see Elements of an Ecology of Mind) and suggests that LCD has the potential to engage our perceptions and alter our behaviors related to the resources we use, reconnecting humans to nature and its processes.

> The hypothesis is based on an understanding of how humans engage with their environments through life cycle events—when we directly encounter the life cycles of water, energy, food, air, and materials often remote from our everyday experience. This reflects our lack of knowingly playing a role with life cycle "events," such as how oxygen is produced or carbon is absorbed by a certain quantity of vegetation and soil systems. The fact is that approximately 5000 sq. ft. (465 sq. m) of temperate forest is needed to support an individual's oxygen needed for breathing, and 7500 sq. ft. (697 sq. m) is needed for carbon sequestering—these essential life-giving threads have not been part of our "event" vocabulary, but should be. In the model outlined here, buildings are designed to mimic and illuminate the life cycle events around us, causing humans to experience resource flows and cycles, understand resource dependencies, and adapt their behavior accordingly (Fisk 2008).

Life Cycle Design Principles

- Recognize the resource flows on which a building depends, and identify them and their multiple boundaries, from the building scale through to neighborhood, city, regional, and global scales.
- Evaluate and apply the source, transport, process, use, and re-source life cycle sequence in all resource-flow areas when considering the scales above, including energy, materials, water, and air. (In healthcare projects, food and medical waste are examples of operational resource flows that might be considered as well.)
- Increase resource-flow efficiency by basing decisions first on the scale of the building and site, progressing upward to tap into larger life cycle scales only as necessary.
- Support regionalized economic loops by respecting tight-knit regional integration. Each stage of the building life cycle supply chain should become a part of a regional economy.
- Plan for the extended use of a building through the separation of utilities, structure, and shell. Designing for flexibility extends the use phase of the building's life cycle.
- Create regionally relevant benchmarks throughout the world through comparisons with similar industrial bases, climates, and material conditions, as well as similar flora and fauna, using patterns supplied by the internationally accepted biome system.
- Reduce the size and complexity of the life cycle to enable it to relate more directly to people, involving the user with the resources associated with their everyday activities.
- If possible, incorporate both an input-output life cycle assessment and a process life cycle assessment, one supplying the perspective using national data, the other homing in on the low-hanging fruit identified.

Source: Pliny Fisk III (2008)

Elements of an Ecology of Mind

- Consider life cycle events in a building—direct interactions with the natural life cycles of water, air, energy, and materials—as microcosms of the life cycle events around us, and treat them with the same awe and respect as natural life cycle events, eliciting engagement with and response to these cycles through design.
- Identify the full range of ecosystem life cycles and life cycle events in and around our buildings, and consciously cover all environmental life cycle phases (or in behavioral terms, "events") from source (e.g., rain) to re-source (e.g., drinking water).
- Conceive of the life cycle as successions of resource events that can be balanced and the user part of the balancing act, so that people understand both the parts (i.e., the individual events) and the whole.
- When designing, differentiate between building elements that stimulate human brain activity at the circadian and interval scales, so that life cycle involvement can occur at both levels.
- Go beyond circadian brain rhythms by engaging the interval time function of the brain's neocortex through the miniaturization of the life cycle.
- Synchronize the scale of everyday life cycle events with the interval time of the neocortex through two- and three-dimensional means and miniaturization.
- Project from past to future and from locus to region the effects of our actions, not just at the individual scale but also at the community, regional, and global scales. Consider simulation and gaming environments so the neocortex is enticed to participate with the life cycles that support us.

Source: Pliny Fisk III (2008)

According to Fisk, this represents a new LCD framework not driven solely by the physical and engineering manipulation of resources and analyses of building phases, but instead by the idea that our relationship with life cycle events might be related to behaviors based on the evolution of the brain itself. In this new conception of LCD, miniaturizing the life cycle—for example, bringing the cycle of water (from capture to use to waste treatment) within the site boundary so that the processes are no longer removed and abstracted—is recognized to trigger brain functions that may better connect us to these significant environmental sequences. Buildings, then, extend our perceptions and connect us to the resources we use on a deeper level than previously imagined.

CRADLE TO CRADLE DESIGN

Informed by ecological design approaches, industrial designers are beginning to use an alternative framework for reengineering both products and processes as a response to the limits of "cradle to grave" ideology. Architect William McDonough and chemist Michael Braungart (2002) developed the cradle to cradle (C2C) design paradigm based on three key principles (see sidebar).

CRADLE TO CRADLE PRINCIPLES

- ***Waste equals food.*** In nature, one organism's waste is food for another.
- ***Use current solar income.*** Plants use sunlight to manufacture food. In fact, fossil fuels are "ancient sunlight"—past solar income. Both energy and material inputs are renewable rather than depleting.
- ***Celebrate diversity.*** Nature's diversity provides many models to imitate in the design of systems and processes: biomimicry.

Source: McDonough and Braungart, Cradle to Cradle 2002

Biologist Janine Benyus (1997) suggests nine principles that define natural systems (see sidebar). These design axioms provide a roadmap for how we might further broaden and re-vision an approach to Life Cycle Design, an idea that is explored in Fisk's work. As industry redesigns material production in accordance with C2C and biomimicry principles, it remains the task of designers to reimagine buildings based on similar tenets.

NATURAL SYSTEMS

Nature runs on sunlight.

Nature uses only the energy it needs.

Nature fits form to function.

Nature recycles everything.

Nature rewards cooperation.

Nature banks on diversity.

Nature demands local expertise.

Nature curbs excesses from within.

Nature taps the power of limits.

Source: Janine Benyus, Biomimicry (1997)

LIVING BUILDINGS

What would ecological design mean for the typology of healthcare buildings? "In the century ahead we must chart a course that leads to restoration, healing, and wholeness" (Orr 2004). Architect Bob Berkebile and designer Jason F. McLennan (1999) define the future of architecture as a future of living buildings, operating on the following six principles. This is not a future predicated on less, but rather one inspired by doing more—and doing better—with less. Living buildings will:

1. Harvest water and energy needs onsite.
2. Be adapted specifically to site and climate and evolve as conditions change.
3. Operate pollution free and generate no wastes that aren't useful for some other process in the building or immediate environment.
4. Promote the health and well-being of all the inhabitants, as a healthy ecosystem does.
5. Comprise integrated systems that maximize efficiency and comfort.
6. Be beautiful and inspire us to dream.

In 2006, the Cascadia Region Green Building Council, led by Jason F. McLennan, launched the Living Building Challenge, a "global vision for lasting sustainability" that embodies these six principles in a third-party certified green building rating system. Now held by the independent nonprofit International Living Future Institute, the Living Building Challenge, comprised of seven performance areas, Site, Water, Energy, Health, Materials, Equity, and Beauty, defines priorities on both a technical level and as a set of core values. The performance areas are subdivided into a total of twenty Imperatives, each of which focuses on a specific sphere of influence (ILFI 2012). In the following essay, Jason F. McLennan expands upon his aspirations for the system.

LIVING BUILDINGS AND A RESTORATIVE FUTURE

Jason F. McLennan LEED Fellow

> Do not follow where the path may lead. Go Instead where there is no path and leave a trail.
>
> —Harold R. McAlindon

Back in the nineties, before LEED was even released, Bob Berkebile and I began to work on an idea called "the Living Building." The idea was based on a simple premise—that nature was the ultimate measuring stick for success for our buildings and other built infrastructure. Why couldn't we build things that were as elegant and efficient as nature's architecture? Buildings that generated their own energy collected and treated their own water and waste and did so without the use of toxic products. It was an idea a bit early for a market that still viewed "green" as a fad. LEED changed all that by introducing structure and requirements to define sustainable design in the early part of the last decade—and launched a movement that grew from fringe to mainstream in a few short years. Suddenly LEED Gold and Platinum was a widely achievable goal.

In 2005, emboldened by the success of LEED and urged on by the increasing evidence of the effects of climate change, I worked to translate our early vision of Living Buildings into a pragmatic, yet aspirational tool—the Living Building Challenge, the world's most stringent, yet progressive green certification program. It was decidedly simple and focused on ultimate proven performance rather than predicted modeled outcomes. It embraced the measurable like net zero energy and water—and the hard to measure—things like beauty, inspiration, and issues of equity. It worked not on a model of incremental improvements, but rather on defining the "end game" and urging people to move as quickly as possible to this ideal state.

We launched the first version at the end of 2006 and weren't sure what to expect. Would anyone be crazy enough to push building performance this far? It was a challenge to the industry, and the industry responded. Fast-forward a few short years and the Living Building Challenge has become a "meme": a powerful idea with a life of its own beyond what we could have predicted. Dozens of projects have sprung up in countries around the world. Thousands of people share the tool, our research and our case studies, and we now have the world's first fully certified Living Buildings up and operating—proving that this level of performance is possible already, with today's technology and know-how. Each project is a beacon of hope—buildings that will never have an energy or water bill again and where nearly all the specifications have been scrubbed of red list chemicals. Healthier buildings that outperform any other structures built today.

A powerful example is the new Hawaii Preparatory Academy on the Big Island (see Figure 1.12). This beautiful school building exemplifies the power of the Living Building Challenge to create a new kind of academic infrastructure. The building is a powerful pedagogical tool where students are immersed in an experience and learn the connections between the built and natural environments. It feels better than a conventional building somehow, and we know it performs better in multiple ways environmentally.

Living Buildings are now emerging in every market sector and in all shapes and sizes. Projects range

Figure 1.12 Hawaii Preparatory Academy on the Big Island is a certified Living Building. *Source: Matthew Millman Photography courtesy of Flansburgh Architects*

from 200,000 sq. ft. (18,581 sq. m) to 2,000 sq. ft. (186 sq. m)—new buildings and retrofitted existing buildings. It's a quiet revolution. Jumping scales is next as we ask what's possible at the neighborhood and campus level. Along the way we've revealed systemic regulatory hurdles that need to change, especially around water. We've helped encourage the reformulation of new products to be nontoxic yet high performing. We've looked how to change economic and institutional barriers that are essential to tackle. The positive impacts are creating ripple effects everywhere.

The healthcare industry is an exciting next place for this level of paradigm shift. It should be obvious that places of healing should be our healthiest buildings—both directly to occupants through improved air quality and nontoxic materials and also indirectly through reduced energy and resource use that has been proven to have significant health impacts as well. This directly aligns with the goals of the Challenge.

We define healthy building both very broadly and deeply within the Living Building standard. We focus on physical health directly through ensuring great indoor air quality. We focus on the elimination of the sources of indoor contaminants rather than merely minimizing them. We don't allow combustion energy sources and require IAQ testing prior to occupancy and throughout construction. Our materials red

Figure 1.13 Omega Center for Sustainable Living. *Source: Copyright ©2009 Farshid Assassi; courtesy of BNIM Architects*

list for all building materials within a structure ensures the elimination of the most toxic substances in our buildings with only a few exceptions. Zero carcinogens is a better goal than 10% less carcinogens!

The Challenge also focuses on psychological well-being through its emphasis on access to natural systems and biophilia, with strict standards for access to operable windows, natural systems, and beauty. These elements benefit patients and staff alike. Given the strong focus on transportation, habitat preservation, and zero emissions, indirect adverse upstream and downstream health impacts are also reduced or eliminated. We believe that a Living Building is currently the healthiest building you could possibly build today.

Hospitals and clinics should also be places of refuge for the public—part of a resilient system of decentralized infrastructure that is immune to most natural disasters and other infrastructure challenges. A "Living Hospital" will have its own energy and water infrastructure—where quantity and quality are controllable and systems are flexible to operate with or without municipal energy or water grids that may become unreliable.

Ultimately the Living Building Challenge is about promoting life and reconnecting people to natural systems in a world that has lost touch with the things that keep us healthy long-term. Healthcare institutions should lead the way in adopting restorative and regenerative structures that manifest through the Living Building Challenge.

CONCLUSION—THE NEXT GENERATION

Physical manifestations of this expanded vision of design are already being realized. Peace Island Health Center (Case Study 3, Chapter 5) is the first hospital project to attempt to meet the Living Building Challenge. The Omega Center for Sustainable Living (see Figure 1.13), the first certified project, is an example of living building principles applied to a wellness/health management typology. While we have not yet seen the first generation of climate-neutral healthcare buildings, the projects in this book suggest a radical reconsideration of energy use as well as new approaches to bioregionalism and specific adaptations to location and site context. They embrace the goals of promoting the health and well-being of all inhabitants. These buildings are integrating systems in innovative ways. Many are beautiful and inspire us to dream.

CONTRIBUTOR

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Jason F. McLennan serves as the CEO of the International Living Future Institute—a leading NGO that focuses on the transformation to a world that is socially just, culturally rich, and ecologically restorative. McLennan is the founder and creator of the Living Building Challenge, widely considered the world's most progressive and stringent green building program and the winner of the 2012 Buckminster Fuller Challenge Award. McLennan is the author of four books, and is an Ashoka Fellow.

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