

The background of the cover features a series of overlapping, colorful triangles in shades of purple, teal, olive green, red, yellow, and blue, creating a dynamic, star-like pattern.


LEED[®] Core Concepts Guide

An Introduction
to LEED and
Green Building

THIRD EDITION

Section 2

Sustainable
Thinking



Green building will change the way you think. Buildings that seem to be individual, static objects will reveal themselves as fluid parts of an environmental system that changes over time. Professionals who appeared only distantly related will become partners in a dynamic process that incorporates perspectives from different fields.



No problem can be solved from the same level of consciousness that created it.

Albert Einstein



This section reviews three major concepts that are integral to green building and sustainability: systems thinking, life-cycle thinking, and integrative processes. In systems thinking, the built environment is understood as a series of relationships in which each part affects many other parts. Systems include materials, resources, energy, people, and information, as well as the complex interactions and flows between these elements across space and through time. Green building also requires taking a life-cycle approach, looking at all stages of a project, product, or service. It requires asking, where do building materials and resources come from? Where will they go once their useful life ends? What effects do they have on the world along the way? Questions such as these encourage practitioners to ensure that buildings are adaptable and resilient and perform as expected while minimizing harmful consequences. Finally, to achieve results that are based on whole systems across their entire life-cycle, building professionals must adopt an integrative process. This approach emphasizes connections and communication among professionals and stakeholders throughout the life of a project. It breaks down disciplinary boundaries and rejects linear planning and design processes that can lead to inefficient solutions. Although the term “integrative design” is most often applied to new construction or renovations, an integrative process is applicable to any phase in the life-cycle of a building.

In green building, solutions are examined through different perspectives, scales, and levels of detail, and then refined. The lens of each discipline involved in a project contributes to an overall view that leads to more effective designs. For example, sustainable neighborhood design strategies might be analyzed by land-use planners, traffic engineers, civil engineers, infrastructure designers, public health experts, and developers. The more each team member understands the perspectives and strategies of the others, the more integrated the design. The iterative pattern of an integrative process can be used throughout the project as details come into focus. Far from being time consuming, the process can actually save time by encouraging communication up front and bringing people together for highly productive collaborative work sessions.

INTEGRATIVE DESIGN MEETS THE REAL WORLD

In the article “Integrated Design Meets the Real World,” the authors note that users of an integrated approach “... got better at the process over time, especially when they were able to work with the same team members more than once. Once they’d gone through the process, they found it valuable, and many couldn’t imagine doing design any other way.”¹⁴

This section addresses problem-solving approaches that can be applied throughout the green building process. Subsequent sections will explore how green building professionals can begin to incorporate these ideas into projects and professional pursuits.

SYSTEMS THINKING

Sustainability involves designing and operating systems to survive and thrive over time. To understand sustainable systems, we must further understand what we mean by systems.

A system is an assemblage of elements or parts that interact in a series of relationships to form a complex whole that serves particular functions or purposes. The theory behind systems thinking has had a profound effect on many fields of study, such as computer science, business, psychology, and ecology. Donella Meadows, Jørgen Randers, and Dennis Meadows, pioneers in the study of systems and sustainability, describe this discipline in their book *The Limits to Growth*.

A system can be physically small (an ant hill) or large (the entire universe), simple and self-contained (bacteria in a Petri dish) or complex and interacting with other systems (the global trading system or a forest ecosystem). Systems rarely exist in isolation; even the bacteria in the Petri dish are affected by the light and temperature of the laboratory. The boundaries of a system depend on what we are looking at, and most systems are actually systems within systems. For example, the human body is made up of many interlinking internal systems, such as the musculoskeletal system, which interact with external systems, such as the natural environment.

Our training taught us to see the world as a set of unfolding behavior patterns, such as growth, decline, oscillation, overshoot. It has taught us to focus not so much on single pieces of a system, as on connections. We see the elements of demography, economy, and the environment as *one planetary system*, with innumerable interconnections. We see stocks and flows and feedbacks and interconnections, all of which influence the way the system will behave in the future and influence the actions we might take to change its behavior.¹⁵

14 A. Wendt and N. Malin, Integrated Design Meets the Real World, *Environmental Building News* 19(5) (2010), buildinggreen.com/articles/IssueTOC.cfm?Volume=19&Issue=5.

15 Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, and William W. Behrens III. (1972). *The Limits to Growth*. New York: Universe Books.

Many systems in the modern world are designed as open systems, into which materials and resources are constantly brought in from the outside, used in some way, and then released outside the system in some form of waste. For example, in most urban American communities, water, food, energy, and materials are imported into the city from sources outside the municipal boundaries. In fact, many of our materials and resources are imported from around the world. After they have been used inside the city, they are released as waste in the form of sewage, solid waste, and pollution. In nature, there are no open systems; dead and decaying matter become food for something else, and everything goes somewhere. There is no “away.” By slowing the passing of materials and resources through the system and linking elements to form new relationships and functions, we can begin to mimic nature and design closed systems, which are more sustainable.

When designing buildings and communities, we must understand both the individual elements of the system and their relationships to each other as a whole. One decision may have a ripple effect. For example, improvements in the building envelope, the boundary between the exterior and interior elements of a building, can change the requirements for the mechanical system. Using better insulation or more efficient windows might allow for a smaller heating system. At the same time, reducing air infiltration can raise concerns about the indoor air quality. Envelope design can also be used to increase daylight into the space, affecting lighting design, heating, and air-conditioning as well as improving the quality of the indoor space. But envelopes designed for increased daylighting without consideration of glare and heat gain can create uncomfortable and less productive spaces. Even the interior finishes and furnishings can change the effectiveness of natural daylighting and ventilation strategies.



Optimizing components in isolation tends to pessimize the whole system—and hence the bottom line. You can actually make a system less efficient, simply by not properly linking up those components ... If they're not designed to work with one another, they'll tend to work against one another.

**Paul Hawken, Amory Lovins, and
L. Hunter Lovins *Natural Capitalism***



The concept of feedback loops helps explain how systems work. Feedback loops are the information flows within a system that allow that system to organize itself. For example, when a thermostat indicates that the temperature in a room is too warm, it sends a signal to turn on the air-conditioning. When the room is sufficiently cooled, the thermostat sends a signal for the air-conditioning to stop.

This type of feedback loop is called a negative feedback loop because embedded in the system's response to a change is a signal for the system to stop changing when that response is no longer needed. Negative feedback loops enable a system to self-correct and stay within a particular range of function or performance. Thus, they keep systems stable.

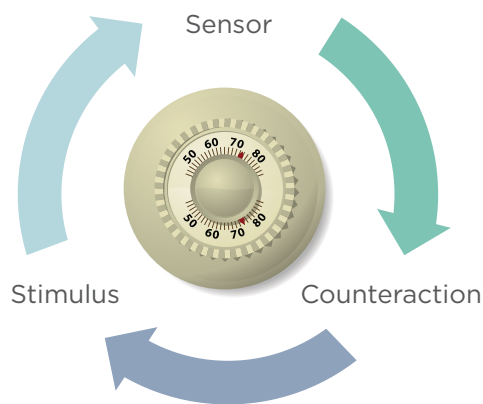


Figure 2.1. Negative Feedback Loop

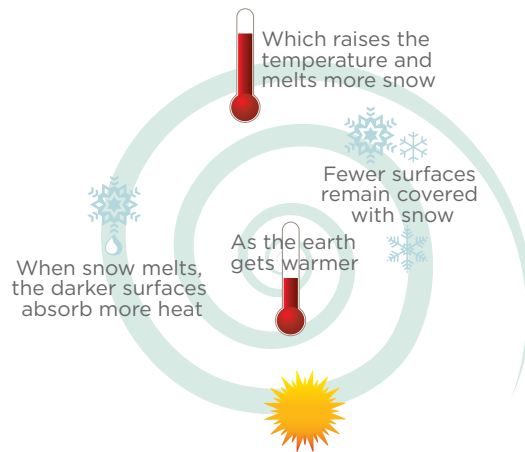


Figure 2.2. Positive Feedback Loop

POSITIVE FEEDBACK LOOPS, on the other hand, are self-reinforcing: the stimulus causes an effect, and the effect produces even more of that same effect. Population growth is a positive feedback loop. The more babies who are born, the more people there will be in the population to have more babies. Therefore, the population can be expected to rise until acted upon by another force, such as an epidemic or shortage of resources.

In the built environment, roads and infrastructure built out to the urban fringe often result in a positive feedback loop of increased development. This suburban growth can sprawl far from the urban core, requiring more roads and encouraging additional growth, as well as using more resources (energy, water, sewage systems, materials) to support that growth.

Climate change is another positive feedback loop. As the earth gets warmer, fewer surfaces remain covered with snow, a reflective surface that bounces incoming heat from the sun back into space. When snow melts, the darker surfaces absorb more heat, which raises the temperature and melts more snow. Similarly, in the built environment, the dark surfaces of roofs, roads, and parking lots absorb more heat from the sun. This heat island effect raises temperatures in urban areas several degrees above the temperature of surrounding areas, increasing the demand for cooling and the amount of energy that buildings use. The additional energy use can increase carbon emissions, which contribute to global warming, further raising urban temperatures and energy use, and the cycle continues.



Figure 2.3. Induced Growth Over Time

Unchecked, positive feedback loops can create chaos in a system. For example, if urban temperatures rise too high, local populations may suffer or abandon the area. In nature, positive feedback loops are typically checked by stabilizing negative feedback loops, processes that shut down uncontrolled growth or other destabilizing forces. Stability and resilience in the system return as the feedback loops begin to control the change. To design sustainable systems, we must understand the positive and negative feedback loops already in existence or those we set in motion, to ensure systems remain stable and habitable over time.

Feedback loops—positive or negative—depend on flows of information. When information about the performance of the system is missing or blocked, the system cannot respond. For example, buildings without appropriate sensors and control systems cannot adjust to changing temperatures and maintain a comfortable indoor environment. The information must be both collected and directed. Most buildings have thermostats to provide information and control temperature. However, there are many other parameters, measurable or quantifiable characteristics of a system, that are relevant to sustainability but do not get measured or reported in effective ways. For example, the amount of energy used by tenant-occupied buildings may be collected by an electricity or gas meter and reported to the utility company but not to the occupants, who therefore have no information about their energy consumption and no incentive to reduce it. If real-time information on energy use is delivered to them in a convenient way, they can use energy more efficiently. Some have called this the Prius effect, after the hybrid car that gives drivers information about fuel consumption so that they can drive in a fuel-efficient way.¹⁶ Installing real-time energy meters where operators can act on the information is an example of connecting elements of a system so that they can interact and respond to each other more appropriately in the feedback loop.

16 Brand Neutral, *The Prius Effect: Learning from Toyota* (2007), brandneutral.com/documents/Prius_Effect.pdf.

THE PRIUS EFFECT

Delivering real-time energy information in a convenient way by installing meters where operators can act on the information and make changes to use energy more efficiently.

In addition to elements, their relationships, and the feedback loops among them, systems theory explores the emergent properties of a system—patterns that emerge from the system as a whole and are more than the sum of the parts. For example, the pattern of waves crashing along the beach is an emergent property: the pattern is more than the water molecules that make up the ocean, more than the surface of the shore, more than the gravitational pull of the moon or the influence of the wind. The waves emerge as a result of the interactions and relationships among the elements.

Similarly, the culture of a company emerges from the people who work there, the buildings in which they work, the services or products they provide, the way they receive and process information, the management and power structure, and the financial structure. These elements and flows combine in both predictable and unpredictable ways to form a unique and individual organization. The elements of the system (people, buildings), the flows within the system (of materials, money, and information), the rules that govern those flows (management and structures), and the functions of the system (providing goods or services, generating a profit) determine whether the company is a good place to work and will be sustainable over time.

To influence the behavior of a system, it is important to find the leverage points—places where a small intervention can yield large changes. Providing building occupants with real-time energy information is an example of using a leverage point to alter behavior. Rather than changing the elements of the system—the envelope of the structure, the mechanical system, the building occupants, the electricity grid—the change focuses merely on delivering available data to a point where it can be acted on appropriately. This minor tweak can dramatically raise the efficiency of the system. Donella Meadows’s essay “Leverage Points: Places to Intervene in a System” provides an excellent summary of how to find and use leverage points to make meaningful change.¹⁷

In *Natural Capitalism*, Hawken, Lovins, and Lovins explore how capital markets can be used for—rather than against—sustainability, not by eliminating them or adding intensive regulation, but by using leverage points within the system. One leverage point they examine is the goals that govern the system. By valuing not only financial capital but also natural capital and human capital, existing systems and structures can lead to sustainability.

17 D. Meadows, *Leverage Points: Places to Intervene in a System* (1999), sustainer.org/pubs/Leverage_Points.pdf.



PROJECT CASE STUDY

CANNON DESIGN CHICAGO OFFICE RELOCATION

LEED PLATINUM

Cannon Design's Chicago office, certified under LEED for Commercial Interiors, relocated to Michigan Plaza, two adjacent mixed-use office towers in Chicago's central business district. The company's former longtime home spread employees and operations across four different floors, so this move marked a watershed: for the first time Chicago office employees are now able to occupy a single, contiguous 60,000 square foot floor that spans two buildings. Ultimately, this is a workplace designed to benefit the people that work in it. Prior to relocating to this space, the project team conducted an online survey open to all employees to estimate the percentage of time employees dedicated to formal and informal collaboration, learning, personal head-down work time and socialization. The space plan for the project responded to needs identified in this survey. In all, the design incorporates twenty different workplace setting types to encourage all employees to work in the manner that best suits each individual's style and the task at hand. Canon Design also valued an energy-efficient space, and used the site selection process to achieve their goals—the chosen building is certified under ENERGY STAR and achieved Gold under the LEED O+M rating system.

An interactive sustainability reporting dashboard occupies a prominent space in the heart of the office, immediately adjacent to the library and central gathering space. This dashboard tracks real-time energy consumption within the office and also displays other key annual environmental measures for the office, including waste management, water consumption and vehicle miles traveled. To learn more about the Cannon Design Chicago office visit usgbc.org/projects/cannon-design-chicago-office-relocation

LEVERAGE POINTS

Places to Intervene in a System (in increasing order of effectiveness):

12. Constant, parameters, numbers (such as subsidies, taxes, standards)
11. The sizes of buffers and other stabilizing stocks, relative to their flows
10. The structure of material stocks and flows (such as transport networks, population age structures)
9. The lengths of delays, relative to the rate of system change
8. The strength of negative feedback loops, relative to the impacts they are trying to correct against
7. The gain around driving positive feedback loops
6. The structure of information flows (who does and does not have access to what kinds of information)
5. The rules of the system (such as incentives, punishments, constraints)
4. The power to add, change, evolve, or self-organize system structure
3. The goals of the system
2. The mindset or paradigm out of which the system—its goals, structure, rules, delays, parameters—arises
1. The power to transcend paradigms

For instance, when carpet manufacturer Interface Flooring switched from being a producer of carpet to a provider of the service of floor coverings, it created a shift in the company's mission. Instead of buying carpet, customers could buy the *service* of the carpet, which would be owned by Interface. The company would be responsible for maintaining the carpet over time, replacing worn areas, and disposing of any "waste." This shift served as a leverage point to enable the company system to change radically toward sustainability, reducing waste, and improving performance of the product while maintaining profit. In other words, Interface Flooring moved from an open system to a closed system. The new mental model resulted not just in more efficient processes, but also in a radical restructuring of the company and all its operations.

Buildings are part of a world of nested systems that affect and are affected by one another. Once the project team understands the network of systems that affect a given project, the energy and matter that flow through the systems, and the relationships and interdependencies that exist, the deeper and more effectively integration can occur.

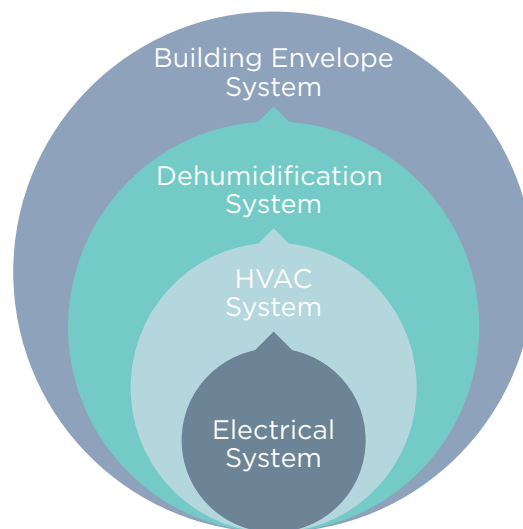


Figure 2.4. Nested Systems

When designing aspects of the built environment, consider the systems in which the project will be located and the systems the project will create. Learn about the relationships between the elements, the flows of resources and information, and the leverage points that can lead to dramatic changes. Before starting any project, the team can explore these systems by asking questions. Whether working in the planning, design, construction, or operations phase, these questions may provide insight into the systems context and ways to move more fully toward sustainability in an integrated way.

QUESTIONS A PROJECT TEAM NEEDS TO EXPLORE AS MEMBERS BEGIN WORKING TOGETHER, INCLUDE:

- Where is the project located, and who are its neighbors—locally, regionally, and beyond? What is the local watershed? The bioregion? What are the characteristics of these systems?
- How do resources, such as energy, water, and materials, flow into the project? Where do they come from, and from how far away? What other purposes or projects do those flows serve?
- What natural processes are at work on the site? How do resources, such as rainwater, wastewater, and solid waste, flow out of the system? Where do they go? Are there places on site where these flows can be captured, stored, or reused?
- What are the goals of the owner? What is the function or purpose of the project? How will the project meet those goals?
- What is the community within the project? Who are the people who come here, and where do they come from? Where do they go? What brings them together, and what might keep them apart? How will the project change their interactions?
- How does the project community interact with other, overlapping communities? What are the interrelationships? Are there sources of conflicts? What is the economic system within the project? How does it fit into larger or overlapping economic systems?
- What are the leverage points within the system? Are there places where small changes can produce big results?

In a linear design process, the solutions to one problem may cause other problems elsewhere in the system. When problems are solved through a systems-based approach, multiple problems can often be solved at the same time. This synergy is possible when we take the time to explore the interconnections and approach a project in a holistic manner. In the context of the built environment, systems thinking allows us to explore and support the rich interactions that make healthy, thriving, and sustainable communities.

LIFE-CYCLE APPROACH

Green building takes a life-cycle approach, looking at the entire life of a project, product, or service, rather than a single snapshot of a system. The dimension of longevity distinguishes green building from conventional building practice, which may fail to think across time, and helps create communities and buildings that are meant to last. For a building, a life-cycle approach begins with the initial predesign decisions that set goals and a program to follow. It continues through location selection, then design,

construction, operations and maintenance, refurbishment, and renovation. A building's life-cycle ends in demolition or, preferably, reuse.

In most cases in our industrial system, we treat the manufacture of products, the construction of buildings, and the operations of organizations as open systems. We take materials from outside the system, use them to make something, and then discard what remains. This throughput of resources occurs at every phase of the life-cycle, creating a constant cycle of consumption and waste. In addition to the upstream effects that happen before a material is used, there are downstream impacts associated with its operation and end of life. We need to consider both upstream and downstream effects in our decision-making processes.

Systems thinking relies on identifying and acting on opportunities to close this loop. Because we typically do not consider building elements as linked into a larger set of systems, this waste remains largely invisible. By incorporating the upstream effects into our analysis of alternatives, we can get a broader picture of the environmental costs and benefits of materials. The practice of investigating materials from the point of extraction to their disposal is sometimes described as cradle to grave—a term that suggests a linear process through an open system. To emphasize the cyclical aspect of a closed system, architect William McDonough and colleague Michael Braungart coined the phrase cradle to cradle. In a closed system, there is no waste, and all things find another purpose at the end of their useful lives.

A comprehensive, life-cycle approach improves the ability to address potentially important environmental and human health concerns. For example, a product may consist of material mined in Africa, manufactured in Asia, and shipped to the United States for purchase. By focusing only on the energy efficiency of this product during its use, we might miss the damage caused by its transport from the place of manufacture or by the extraction of its raw material. Or a window may have a high recycled content but not be highly efficient. By looking only at the percentage of recycled content, we might select a product that will compromise the project's energy-saving goals. In a green building project, the team must consider embodied energy—the total amount of energy used to harvest or extract, manufacture, transport, install, and use a product across its life-cycle—alongside performance and adaptability. The careful consideration of all attributes may lead to the selection of products that did not at first appear to be the most sustainable option.

Life-cycle thinking can be applied to environmental considerations, in which case it is called life-cycle assessment (LCA), and to cost considerations, or life-cycle costing (LCC). These are distinct approaches with different methodologies but are often confused. Both can support more sustainable decision making, but they use different types of data and provide different kinds of information.

Life-cycle assessment attempts to identify and quantify environmental effects throughout the life of materials, products, or buildings. It identifies all

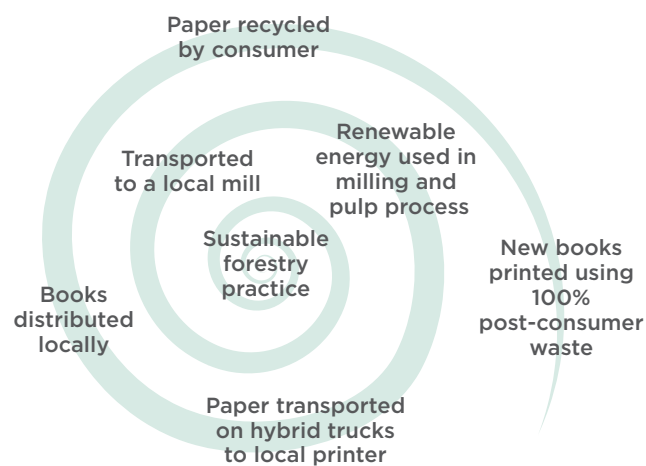


Figure 2.5. Considering a Product's Entire Life-cycle

the processes and associated inputs (energy, water, materials) and outputs (wastes, by-products), from the extraction and processing of raw materials and recycled feedstocks, the transportation of these materials, and the manufacturing and packaging of the product to its use, maintenance, and finally its recycling or disposal. These inputs and outputs are quantified and their effects on the environment and human health are measured. Although LCA does not address all potential effects, it provides a comprehensive picture of the life-cycle. This information can then be used to support decision making. Tools and databases used in conducting LCAs are available from sources in the U.S. government and the private sector.

Life-cycle costing looks at both purchase and operating costs as well as relative savings over the life of the building or product. It calculates payback periods for first costs, providing a context for making decisions about initial investments. For example, more efficient mechanical systems generally cost more than inefficient equipment, but by looking beyond the purchase price and calculating all the energy, maintenance, replacement, and other costs over the life-cycle of the equipment, we can better understand the true cost of the equipment—both to the environment and to the building owner.

LCC can be used in comparing alternatives with different initial and operating costs. For a building this usually includes the following costs:

- Initial purchase, acquisition, or construction
- Fuel
- Operation, maintenance, and repair
- Replacement
- Disposal (or residual value for resale or salvage)
- Finance charges
- Other intangible benefits or costs, such as increased employee productivity

Life-cycle thinking can be applied to all decisions in green building, not just products and buildings. Teams need to look for opportunities to evaluate the environmental impacts of design decisions and improve sustainability at all points in the project's life-cycle. Once decisions have been made at each phase, however, those opportunities can become limited. The key to sustainability is to establish goals and targets early in the process, understand the systems that are in play, and anticipate how those systems are likely to change and evolve.

Land-use and urban planners also draw on the concept of life-cycles because decisions about the location of roads and infrastructure can affect all future decisions about that land for centuries. Consider again the example from Section 1 of Rome's road structure: these roads were built for pedestrians and therefore remain walkable and pedestrian oriented even today. This does not mean that there are no opportunities to make vehicle-oriented development greener, but it does mean that the challenges of reducing transportation impacts, such as carbon footprint, are greater in projects where pedestrian access is not an initial goal.

With future implications of the built environment in mind, we must rethink the processes we use at all phases of the life-cycle. Assembling the right team, establishing goals, and understanding the systems and metrics for success will help ensure that we move closer to a sustainable built environment.

INTEGRATIVE PROCESS

An integrative process is a comprehensive approach to building systems and equipment. Project team members look for synergies among systems and components, the mutual advantages that can help achieve high levels of building performance, human comfort, and environmental benefits. The process should involve rigorous questioning and coordination and challenge typical project assumptions. Team members collaborate to enhance the efficiency and effectiveness of every system.

An integrative process goes beyond checklists and encourages integration during early design stages, when clarifying the owner's aspirations, performance goals, and project needs will be most effective in improving performance. An integrative process comprises three phases. The first—discovery—is also the most important and can be seen as an expansion of what is conventionally called predesign. Actions taken during discovery are essential to achieving a project's environmental goals cost-effectively. The second phase, design and construction, begins with what is conventionally called schematic design. Unlike its conventional counterpart, however, in the integrative process, design will incorporate all of the collective understandings of system interactions that were found during discovery. The third phase is the period of occupancy, operations, and performance feedback. Here, the integrative process measures performance and sets up feedback mechanisms. Feedback is critical to determining success in achieving performance targets, informing building operations, and taking corrective action when targets are missed.

A fully integrative process accounts for the interactions among all building and site systems. By understanding building system interrelationships, project teams will ideally discover unique opportunities for innovative design, increased building performance, and greater environmental benefits. By identifying synergies between systems, teams will save time and money in both the short and the long term while optimizing resource use. Finally, the integrative process can avoid the delays and costs resulting from design changes during the construction documents phase and can reduce change orders during construction.

Through the integrative process, project teams can more effectively use LEED as a comprehensive tool for identifying interrelated issues and developing synergistic strategies. When applied properly, the integrative process reveals the degree to which LEED credits are related, rather than individual items on a checklist. As a result, solving for one problem may create other problems elsewhere in the system. For example:

- Separating residential and commercial uses and failing to connect them with alternative transportation means that people will drive cars to reach their destinations, generating air pollution and traffic
- Filling a landscape with ornamental plants not appropriate for the local climate means that large amounts of water may be required throughout the life of the project
- Creating air-tight buildings for energy efficiency without providing adequate ventilation results in poor indoor air quality for building occupants

When an integrated, systems-based approach is used, the solution to one problem can lead to solutions to many problems. The process of planning a project's water use might lead to the design of systems that capture rainwater and greywater to meet water supply and irrigation needs while reducing runoff and protecting water quality. More broadly, by thinking about the system across the entire life-cycle, integrative strategies can be developed synergistically.


FOR EXAMPLE:

- Locating homes near jobs and shops and designing safe, pedestrian-friendly streets can encourage people to walk, both reducing vehicle emissions and improving their health
- Designing landscapes that use native species can both reduce water consumption and provide habitat for local fauna
- Orienting buildings appropriately on a site and designing them to catch sunlight for heating and illumination and natural breezes for cooling and ventilation can save energy, improve indoor air quality, and even increase workers' productivity
- Composting improves the quality of the soil and reduces greenhouse gas emissions related to trash hauling

Practitioners of an integrative process must develop new skills that might not have been required in their past professional work: critical thinking and questioning, collaboration, teamwork and communication, and a deep understanding of natural processes. An integrative process is a different way of thinking and working, and it creates a team from professionals who have traditionally worked as separate entities.

The integrative process requires more time and collaboration during the early conceptual and design phases than conventional practices. Time must be spent building the team, setting goals, and doing analysis before any decisions are made or implemented. This upfront investment of time, however, reduces the time it takes to produce construction documents. Because the goals have been thoroughly explored and woven throughout the process, projects can be executed more thoughtfully, take advantage of building system synergies, and better meet the needs of their occupants or communities, and ultimately save money, too. The specific steps involved in the integrative process will be addressed in Section 3.

Nature has much to teach us about applying systems thinking, a life-cycle approach, and integrative processes to our work. By observing natural patterns, such as how heat flows, water moves, or trees grow, we can learn to design systems that use resources effectively. The fields of biomimicry and permaculture provide two different and innovative approaches to solving problems by following nature's patterns and strategies. Both of these fields of practice ask: how would nature solve this? Similarly, green building practitioners can use the core concepts addressed in this section to determine the nature of the systems in which they are working, meet the needs of the community, and set goals and priorities for the project.



Green building requires a new way of thinking and approaching the design, construction, operation, and renovation of buildings and communities. Basic elements of this approach were presented in Section 2. The concepts of green building are valid for many types of buildings at all stages of development and questions will likely arise as you begin to apply them. How do teams organize as part of an integrative process? How does systems thinking change the way sites are developed? How does life-cycle assessment affect materials selection? In short, how does this new approach work in real life?

This chapter focuses on the processes surrounding green building—*how* these concepts can change the way you do things—and describes successful approaches to green building, with case examples of actual projects. The strategies and technologies of green building—*what* is done—will be discussed in Section 4.

GETTING STARTED

SEVERAL PRINCIPLES FORM THE FOUNDATION FOR SUCCESSFUL PRACTICE:

PROCESS MATTERS. How you approach projects is crucial to what you do and are able to accomplish. In other words, a good process is essential to good outcomes.

GET IN EARLY. The commitment to green building should be made as early as possible so that it can assist in framing effective goals. Trying to add green features to a project late in the process is the most expensive and least effective approach. For community or neighborhood projects, the commitment should be made at the beginning of the land-use planning phase so that it can inform land-use decisions and zoning, design of transportation systems, and layout of infrastructure. For new construction, early means before the site is selected and before the team is selected, if possible. For operations and maintenance projects, commitments need to be established before any action toward change is taken.

FOLLOW THROUGH. The commitment to green needs to continue throughout the life of the project. The green building process does not end when the project team hands the site over to the owner, facility manager, or tenant. Follow-through is needed at all stages to ensure that the strategies and technologies are maintained or adapted as necessary to remain effective. Additionally, ongoing training ensures knowledgeable operation and maintenance of these strategies and technologies, as well as an opportunity to provide feedback on the challenges faced and lessons learned.

same way—perhaps by asking how they might approach a problem. Sometimes the iterative process involves looking deeply at why or how a specific idea would work; at other times the team will compare one strategy with others to explore synergies and trade-offs.

Defining critical milestones, assigning champions, and clarifying goals up front will enable projects of all sizes and types to incorporate sustainability more effectively. Over the course of a project, especially a long and complex one, goals and targets evolve. Through the iterative process, a team can be ready to address changes and make deliberate decisions by using information from smaller group meetings.

An experienced facilitator can encourage people to voice their thoughts. A facilitator assists the team in expressing new ideas and ensuring that varying perspectives are valued. Additionally, this person brings the group back to explore how proposals will either further or hinder achievement of the project goals.

Careful documentation helps capture the lessons learned on the project so that they can be applied in the future—either within the timeline of that project or on subsequent green building projects.

Many different types of meetings may be useful in an iterative process. Although approaches will vary based on the specific project and team, the process often includes charrettes, team meetings, small task groups, and stakeholder meetings.

Charrettes are an important tool in an iterative process. Named after the carts that carried French architecture students' models to their final review (often as the students frantically completed their work en route with the help of friends), charrettes are intense workshops designed to produce specific deliverables. A charrette brings together the project team with stakeholders and outside experts as needed for creative thinking and collaboration. Generally held at the beginning of the project, charrettes assist in establishing goals. These sessions can also be held throughout the project at major milestones for focused, integrated problem solving. They energize the group and promote trust through productive dialogue. Additionally, they ensure alignment around goals, objectives, and actions. Although we typically think of “design charrettes,” charrettes can be used for all types of building projects.

STAKEHOLDERS

The term stakeholder encompasses more than just decision makers and includes those who must live with the decisions and those who must carry them out. This cross-section of perspectives depends on the type of project. Participants in a design-build project might include the building owner, developer, client, design team members, facility managers, community representatives, local regulatory agencies, local environmental groups, ecologists, and tenants or other building users. Building operations projects might also include cleaning contractors, waste management contractors, landscape contractors, local real estate and leasing specialists, and salvage and resale companies.

Charrettes derive their value from the collaboration of people from different disciplines and perspectives. When setting up charrettes, then, include all relevant stakeholders and experts. Those outside the project

issues, concerns, and ideas. Local residents frequently bring a deep understanding of the place—the local context, culture, and history, as well as the strengths and needs of the community.

In most communities, it is essential to win the trust of local residents and organizations, which may involve one-on-one and small-group meetings. It is easy for a project team to underestimate the value of this step and instead call an evening meeting with the community to present the proposed project. Effective stakeholder meetings involve both careful listening and openness to determine the most feasible and effective solutions for the community.

As with any break with tradition, barriers and obstacles can arise when a team uses an iterative process. In the article “Integrated Design Meets the Real World,” authors Wendt and Malin highlight the benefits of the integrative design process but also discuss some of the obstacles:

- Meetings can be expensive to run and hard to schedule
- Communication between meetings often breaks down
- People may be resistant to green goals
- Participants can balk at the iterative, integrative process
- Traditionalists may resist the up-front loading of modeling, testing of assumptions, and analysis
- People may be reluctant to embrace new technologies¹⁸

Importantly, experts interviewed for the article noted that they got better at the process over time, especially when they were able to work with the same project team members on more than one project.

TEAM SELECTION

One defining element of the green building process is the project team, a broad, inclusive, collaborative group that works together to design and complete the project. This team differs from the group of stakeholders who participate in the charrettes. The members of this group are highly invested and involved across all stages of the project. They are deeply involved in the problem-solving and decision-making processes at every step.

Individual projects require different blends of expertise. For example, the appropriate team for developing a sustainable operations program would likely involve the facility owner, facility management team, vendors, occupants’ representatives, and a sustainability expert. Additionally, the expertise of individual project team members will be more critical at different points in the project. For example, an ecologist might be most relevant during the initial stages of the project, to help the team understand and work with the site, but could bring forward valuable ideas and find synergies throughout the process.

The team process favors a design-build or integrative project delivery (IPD) contracting process rather than traditional design-bid-build, in which the contractors are brought in after many elements of the project have been determined. Design-build and IPD enable team members to participate from the early project stages, including goal setting and initial brainstorming.

¹⁸ A. Wendt and N. Malin, Integrated Design Meets the Real World, *Environmental Building News* 19(5) (2010), buildinggreen.com/articles/IssueTOC.cfm?Volume=19&Issue=5.



PROJECT CASE STUDY

VILLA ALEGRE

LEED PLATINUM

Santa Fe Civic Housing Authority has completed the first affordable LEED for Homes units in the Santa Fe area: 111 units in Villa Alegre Phase 1 and 2. Phase 1 of the project consists of 60 units plus a community center; phase 2 consists of 50 senior housing units, one caretakers' unit, and a community center. The project team succeeded in making 97 of the 111 units affordable, despite the difficult economic conditions at that time. Redevelopment financing ultimately featured two Low Income Housing Tax Credit allocations (family, 9%; senior, 4%) that received 2009 tax allocations and two American Recover and Reinvestment Act (ARRA) grants, through the Tax Credit Assistance Program (TCAP) and the Capital Fund Recovery Competition (CFRC).

As an infill project in a historic district, Villa Alegre needed a context-sensitive design that could achieve neighborhood acceptance. Active engagement with the community proved to be invaluable when the project team headed into rigorous Santa Fe City approval meetings with neighborhood support rather than opposition. Engaging the community via design charrettes also focused the team's efforts on energy and water efficiency—important in a fragile high desert environment with less than 12 inches of rain per year. This focus would achieve goals on multiple levels and make the most appropriate use of the grant money. The project team's collaborative approach to solving problems contributed to its successful achievement of LEED Platinum certification. You can learn more about Villa Alegre at usgbc.org/projects/villa-alegre-phase-1-2-0.

Team members should understand green building and have experience participating in a team. The experience and commitment to sustainability needs to extend to subcontractors and trades as well. Requests for proposals and interviews should include questions about experience in green building and sustainability. Ideally, evaluation of bids is based on the *best low* bid rather than the *lowest* bid. Even when this is not possible, as on many public projects, prerequisites identified in the RFP can help ensure that teams are qualified. Specific qualifications to look for might be past participation in integrative design processes, experience on green or LEED-certified projects, and LEED professional credentialing, from LEED Green Associate to LEED Accredited Professional. If inexperienced people are on the team, some training and orientation to the process will be necessary.

For a design-build project, the team usually includes the following people:

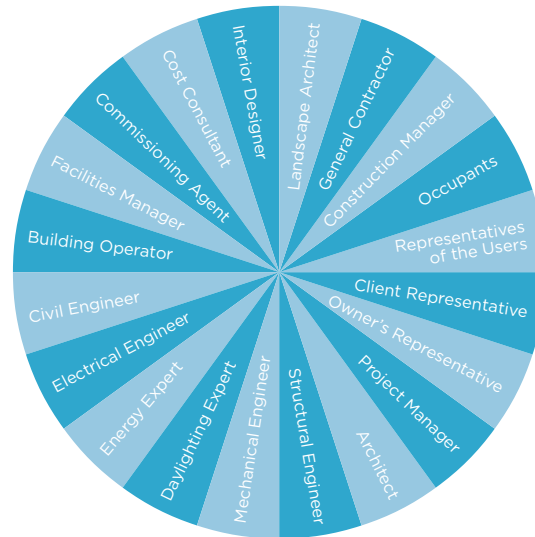


FIGURE 3.2. Members of an Integrated Team

GOAL SETTING

This guide repeatedly emphasizes the importance of project goals; every green building project needs to be grounded in strong goals and set a clear pathway to ensure they are achieved. Clear goals articulate what the project will be designed to accomplish, by:

- Making sure that the vision is clear
- Providing a frame of reference for the whole project
- Defining the sustainability targets and keeping the project on track to meet them

Setting lofty-sounding general goals can be tempting; however, such goals may not provide enough information to guide a project. For example, saying that a project should be “healthful” may be appealing, but what does that really mean in the project context? How will you know if you are on the right track? This type of high-level goal needs to be accompanied by *metrics*, things that can be measured, and *targets*, levels of achievement that should be reached. Each goal may have multiple metrics and targets. For example, if by “healthful” the team means that the project should protect indoor air quality, one metric for that might be the amount of volatile organic compounds (VOCs) in building materials. A target associated with that metric might be that all paints have zero VOCs. There are many attributes to indoor air quality, so in addition to addressing the potential sources of pollutants (such as materials that emit VOCs), the team must develop metrics and targets for proper ventilation.

Project goals and their associated metrics and targets can be both quantitative and qualitative. For example, if a goal is that a neighborhood project be walkable, a team might consider as a quantitative measure the



PROJECT CASE STUDY

RECERTIFICATION: ADOBE SF 601 TOWNSEND

LEED PLATINUM

Adobe's San Francisco office is an adaptive reuse project that retrofitted a building completed in 1905 to operate at a high level of performance. In 2008 the project team earned a LEED platinum certification for Existing Buildings: Operations & Maintenance. The team recently recertified the project at the platinum level under LEED v2009. Cutting energy use in a plant with 900 workers, 1,800 personal computers, and continuously-operating data servers was a challenge. To meet energy goals, the project team used a web-based monitoring system, developed partly with Adobe software. The software permits energy and water use to be tracked—and adjusted—in detail, and also reports total CO₂ emissions. To date, 41 energy conservation measures and related strategies have been implemented, resulting in an ENERGY STAR score of 100, the maximum possible score. Electricity usage has been effectively reduced 63% over a seven-year period.

Water use at 601 Townsend has been reduced by 62%. Faucet and shower head aerators reduce maximum water flow to just two quarts per minute. Restrooms feature a mix of high-efficiency flush toilets, dual flush toilets, and waterless urinals.

The diversion of solid waste from landfill through composting and recycling has risen from 23% to 98%. Every desk now has a second, smaller "side-saddle" wastebasket so that compostable and recyclable items stay separated. Adobe's standards mandate that all products from copy paper to carpet must contain high recycled content. Even take-out food service products (paper plates, napkins, cups, etc.) are compostable. For more information about Adobe's 601 Townsend offices visit usgbc.org/projects/re-certification-adobe-sf-601-townsend.

SUCCESS DEPENDS ON THESE ESSENTIALS:

- Start early
- Find the right team and process
- Understand the systems across space and time
- Develop clear and measurable goals
- Follow an iterative process to ensure achievement of goals
- Commit to continuous improvement

The next section will review specific concepts and strategies for different aspects of green design, planning, and operations. Each of these concepts and strategies should be viewed within the context of systems thinking, using integrated processes. This framework encourages green building practitioners to view projects as an interconnected system and thus find the best solutions for the built environment.