Green Construction

An introduction to a changing industry

Alison Dykstra

See http://www.KirshnerBooks.com

Also by the Author

Construction Project Management: A Complete Introduction
LEED Certification: An Introduction to Certifying a Green Building

Copyright © 2016 Alison Dykstra

This book may not be reproduced, in whole or in part, including illustrations, photos, in any form (beyond that of copying permitted by Section 107 & 108 of the U.S. Copyright Law and excerpt by reviewers for public press), without written permission from the publishers.

Library of Congress Control Number: 2015960690

Printed in the United States of America 10 9 8 7 6 5 4 3 2 1

ISBN: 978-0-9827034-2-7

Cover design and cover photograph by Andrea Young Arts, Berkeley CA
Interior design by Lauren Woodrow Design, Chicago IL

Kirshner Publishing Company
Production Offices:
PO Box 14132
Santa Rosa, CA 95404
Editorial Offices:
San Francisco, CA
www.kirshnerbooks.com
www.kirshnerpublishing.com

See http://www.KirshnerBooks.com

3

A Changing Construction Industry

The construction industry is in a state of flux, due not only to the increase in green construction, but also to other long-term changes—in costs and the way projects are financed, in technology and the types of materials used, in the way projects are organized and delivered, in globalization. Industry demographics are changing too: the work force is aging and includes more women and minorities and, unlike in the past, fewer workers move up in the ranks without academic education. Workers interested in advancing their careers must be proficient in reading, writing, and computer skills, and today's project superintendent or manager is likely to have a degree in management or business, as well as years of field experience. Increased regulatory and health and safety requirements and the use of technology and other conditions have resulted in significant changes.

These and other trends are the result of both internal and external forces and affect virtually all aspects of the industry. One of the most important drivers of change is the growing emphasis on energy efficiency and the broader concerns addressed by green construction. In the last chapter, we looked at the ways in which green principles address flaws in the way we create our built environment. In this chapter, we'll explore how the incorporation of these principles is impacting the construction industry and its work force.

See http://www.KirshnerBooks.com

The impacts of green construction

Multiple studies show that buildings designed and built using sustainability as a standard cost less to operate, are healthier for the workers who erect them and those who use them, and provide significant benefits to the broader community and to the natural environment. Consumers are paying attention: every year the number of buildings that are certified under building assessment programs, such as **LEED** and Green Globes, grows substantially. During 2011, for example, floor area that was registered with a LEED green building rating system saw a 45% increase over 2010.[1] This statistic is, not surprisingly, reflected in the work of contractors and others in the industry: the number of architects, engineers, and contractors involved with green projects is growing substantially.

It's not just consumers who are demanding high-performance buildings; so are government entities. As we saw in the last chapter, one of the forces behind the increase in green construction, and the changes that accompany it, is the civic sector. Federal, state, and municipal governments own or lease more square footage of real estate and spend more on construction than any other entity. Because multiple economic arguments can be made for green construction, government entities are demanding high performance buildings and this demand is shaping construction practices in other sectors.[2]

High-performance buildings are all around us: green construction in the United States is now measured in billions of square feet and this figure is growing by more than 800 million square feet each year.[3] If we look at this in terms of building share, that, too, is impressive: by 2016, more than half of commercial and institutional and 38% of residential construction is expected to be green.[4]

These numbers represent a lot of building activity—enough to exert significant influence on the entire construction industry. Our understanding

Ethan Drinker, courtesy of Coldham & Hartman Architects

Bechtel Environmental Classroom, Smith College

See http://www.KirshnerBooks.com

about materials and products, the way we design and where we locate our buildings, the role and skills of general and **specialty trade contractors**, and construction procedures and attitudes about waste and efficiency are all shifting to accommodate this new type of building. The challenge for the American construction industry and its work force is to understand the opportunities presented by these changes.

Even if buildings aren't formally green—in other words, they aren't rated as such by a recognized organization such as the U.S. Green Building Council—green standards are influencing perceptions about buildings and their relationship to the health of people and the environment. Importantly, green standards are providing a new, higher benchmark for best practices in the industry. Both of these conditions—the increase in certified green buildings and the shift in public perception—are influencing industry change in everything from workforce skills to construction practices.

Green construction is affecting several aspects of the industry, including:

- Changes to industry jobs
- Changes to construction operations and practices, including:
    - Project delivery
    - Site procedures and pollution control
    - Waste management
    - Close-out and green documentation
    - Tightening codes and standards
- Technology
- New materials, products, and systems
- Changes to liability concerns

Let's look at how each of these aspects of the industry is changing.

Changes to industry jobs

Typically, about seven million people in the United States are directly employed in construction as carpenters, electricians, plumbers, and so on. The shift to green construction requires varying levels of adjustment by workers. On most

See http://www.KirshnerBooks.com

green projects, most of the occupations involved already exist but require enhanced skills; HVAC installers, electricians, and plumbers are examples. Due to the emphasis on energy and water efficiency, and the installation of new types of assemblies and systems such as solar photovoltaic arrays, these specialty workers are likely to require additional skills. Sustainable buildings have requirements beyond the installation of solar or wind systems, however, such as the use of nontoxic or locally sourced materials. Most workers will need to perform tasks in new or different ways, often using new systems or materials. Even some off-the-shelf products such as adhesives, joint sealants, and drywall compounds may be disallowed and require alternatives with which the worker is unfamiliar.

Green construction requires workers to perform tasks in new and different ways.

It's not just specialty contractors with direct involvement in green systems who are affected. All builders on green jobs need to be up-to-date on changing building and energy codes, proper installation techniques for high-performance products, new site procedures, and recycling requirements. Beyond those in the field, estimators, product specifiers, facility managers, maintenance workers, manufacturers, and many others are also affected.

In addition to impacting industry jobs, green construction is changing the way projects are organized and run.

Changes to construction operations and practices

Maximizing performance and meeting green goals for either a renovated or newly constructed building are dependent upon effective construction operations and procedures. How the work is organized, coordinated, and carried out in the field is not the same on green and conventional projects and these differences occur in several areas:

- Project delivery
- Site procedures
- Waste management
- Close-out and green documentation

Let's look briefly at each of these.

See http://www.KirshnerBooks.com

Project delivery

Project delivery describes the organizational structure for completing a project. There are many ways that projects can be organized and successful projects of any kind require teamwork. (See Chapter 6 in the author's book *Construction Project Management: A Complete Introduction*.) On a green project, however, project delivery is marked by a level of cooperation at all levels—from design through construction—that is significantly higher than it is on most conventional projects. For many in the industry, the level of required cooperation may be unfamiliar and perhaps even uncomfortable.

Integrated Project Delivery (IPD) is a type of project delivery often utilized on green projects and which employs a highly collaborative approach (see *Project delivery*). The components that make up a project—durability, aesthetics and space planning, materials, assemblies and systems, the construction process—are conceived as a whole. Although it is true that every project requires teamwork, meeting stringent efficiency goals requires that collaboration begins early in the design process and continues throughout construction. On projects that utilize IPD, everyone's experiences and skills contribute to finding the best ways to meet the building goals. Conventional assumptions may be revised as the team analyzes and considers multiple ways of approaching a design problem.

How might such a collaborative process work? In a conventional approach, an upgraded building envelope (roof, walls, and foundation) that has increased insulation and air barriers, for example, might be rejected based only on up-front cost. But if the team is working together, with clear performance objectives, the mechanical engineer and contractor might determine that the upgraded envelope allows a smaller, more efficient HVAC system, with total cost savings that justify the envelope upgrade. Or the lighting consultant might determine that decreased artificial lighting—and reduced up-front and operating costs—will be sufficient if the designers can develop a way to get more natural light into the space. Similarly, the HVAC engineer and contractor might determine that a shift in how the building is oriented on the site will maximize solar thermal gains and therefore reduce heating loads and, consequently, the size of the heating equipment.

Technology has made collaboration easier through **Building Information Modeling (BIM)** software and several web-based management tools. The information provided by BIM, for example, allows team members to make

See http://www.KirshnerBooks.com

smart design decisions early in the process, identify problems before construction starts, schedule efficiencies into construction sequencing, and get accurate cost estimates up front.

On buildings with high performance goals, poor execution by one trade can compromise the entire project. For example, insulation that is not meticulously installed, has gaps, or is stuffed too tightly into walls will not provide the expected resistance to heat loss and may compromise the energy efficiency of the building. Similarly, the drywaller who slashes a vapor barrier with a utility knife to make drywall installation easier or the framer who leaves gaps in the sheathing that he assumes can just be covered by siding might be making their own lives easier but risking weather and air leaks that could cause moisture or mold problems later. When everyone on the team understands building performance goals, it helps create a collaborative environment that can result in project refinements and improvements all along the way.

This kind of collaborative project delivery is in sharp contrast to the conventional "silo" process, in which each participant works primarily in isolation. On a typical project, a designer and engineer draw up plans to meet an owner's requirements, the plans are turned into detailed construction drawings, and a **general contractor** is hired (typically after bidding on the drawings) and, in turn, hires **subcontractors** to complete most of the work. As buildings become more technologically complicated and costly, this isolated approach has been changing. High-performance projects magnify this change.

Site procedures

As with project delivery, site procedures may be different in green and conventional projects. Construction always includes some disturbance to the existing site; cutting, grading, paving, and the processes involved in constructing the building itself, plus many other activities, have the potential to cause severe damage. The general contractor should develop a management plan (which will include a catalog of existing vegetation and site features, such as creeks and trees) to minimize the negative impacts of construction activities such as:

- Traffic, including access and on-site parking
- The location of the field office
- Materials and equipment storage and staging

See http://www.KirshnerBooks.com

- Recycling area access
- The use of heavy equipment

Conservation of natural features extends to the protection of water both on and adjacent to the site. Stormwater runoff needs to be managed to prevent toxins from migrating off the site and contaminating lakes, rivers, and bays, and erosion control measures should also be installed to prevent the loss of topsoil and the build-up of soil sediment in water. Simple control measures, such as silt fence barriers, can be installed at the time of construction to reduce runoff both during and after construction, can effectively limit the entry of pollutants into surface water and groundwater, and protect water quality, fish habitats, and public health.

Conservation of natural features extends to the protection of water.

Green projects emphasize minimizing construction-generated pollution and providing a healthy work environment during construction. Pollution can be anything that is harmful and should be managed both for the safety of the workers and of the adjacent properties and neighbors. In addition to water contamination, there are multiple pollutants such as dust, noise, vibration, and airborne particles such as exhaust soot from heavy equipment that may be toxic and irritating to both workers and neighbors.

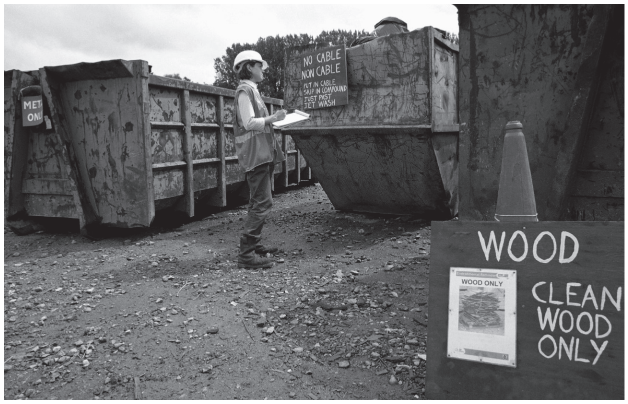
Some toxins also come from additives as a result of construction, such as heavy metals, oils, and debris from construction traffic and spillage. Pollution control efforts can include revising schedules to avoid work during sensitive hours, spill prevention and cleanup procedures, redirecting lighting, dust control, and more.

Site procedures on green projects extend to the management of indoor air pollution. Emission contamination such as through volatile organic compounds can be hazardous for workers as well as end users and requires ducting to bring in adequate outside ventilation. Air should also be forced through the finished building at the end of construction so that any pollutants will be flushed out, reducing future air quality problems.

Waste management

We know from Chapter 1 that building construction, renovation, and demolition generate large amounts of waste, some of which can be toxic and which

See http://www.KirshnerBooks.com



Tom Lee

Recycling station at a construction site

ends up in landfills or elsewhere. In addition to their traditional roles during completion of the physical work, contractors play a central role in meeting green goals through the reduction and proper handling of waste.

Waste management on green jobs begins with reducing or eliminating waste. This includes using fewer materials, recyclable materials, and materials that are durable and therefore produce less waste over the long term. The general contractor is responsible for developing a waste management plan including sorting instead of comingling waste to maximize the amount that can be recycled. Everyone working on a green project will be involved with responsible waste management procedures and expectations.

Close-out and green documentation

An important aspect of construction is **close-out**, the tasks at the end of construction (that must be tended to before the contractors can all get paid and move on. These tasks include ensuring that all items are complete, the site is clean, and paperwork has been properly submitted. On a green job (and increasingly on others), a process called is typically completed as well.

Commissioning is the process of measuring and verifying that all systems and equipment are installed as specified and that the building is operating at optimum performance. Although we're discussing this as part of close-out, commissioning can occur throughout the life of a building: starting at design, extending through construction and close-out, and, ideally, during the functioning of the building to resolve problems and keep the systems fully functioning. A commissioning agent is hired early in the design process and works

See http://www.KirshnerBooks.com

with the architects, engineers, and builders to ensure that systems are maximized for performance. The agent assists in developing performance goals and a quality assurance process that delivers preventive and predictive maintenance plans.

In addition to fewer product and installation errors, commissioning is recognized as a mechanism for saving operating costs for owners as well as providing buildings that perform as expected. Failures to commission have resulted in multiple examples of "green" buildings that don't operate as intended (or advertised) and there is now an understanding of the important link between commissioning and performance. Commissioning is required for buildings being certified under several of the green building rating systems and, increasingly, federal and state governments are requiring commissioning services for their projects.

Commissioning ensures that a building operates at maximum performance.

Documentation of green measures and procedures, called **green documentation**, may be required. If a project team decides to pursue green certification (or it is taking advantage of incentives tied to meeting green commitments), the contractor, as well as subcontractors, will have to provide varying degrees of verification that the building and its materials, products, and systems meet the green program requirements.

Documentation processes are varied: some certification information is submitted during the design phase and might consist of a drawing to identify where the recycling area will be located, for example; some information may be required during construction to show, for example, that stormwater is being appropriately managed; other documentation is submitted at close-out to verify the recycled content of materials, that wood was properly sourced, or that the HVAC system is sufficiently efficient. For some rating systems, performance data must be compiled and submitted for a predetermined length of time after the building is occupied as post-occupancy performance data.

A discussion of liability issues follows, but it is worth noting here that green documentation can become grounds for dispute. A case filed in a California court is an example. In 2014, the City of Palo Alto fired the general contractor responsible for construction of a local library, a project that was supposed to be certified as a green building under the voluntary LEED

See http://www.KirshnerBooks.com

assessment program. The parties ended up in court; Palo Alto contended that the terminated contractor failed to turn over the documentation that was necessary for the city to pursue LEED certification. Included in the documents that were allegedly withheld was documentation verifying the source and types of materials, and the methodologies employed by the contractor to reduce waste. This case highlights the potential conflicts over and importance of documentation.

Another critical close-out task is owner education. A green building is likely to have special features with which the owner or facility manager may be unfamiliar, for example, a solar photovoltaic array or a high-performance heat pump. The **Operations & Maintenance (O&M) Manual**, put together by the contractor, provides the owner with product data, maintenance, repair, and cleaning information. Comprehensive manuals provide guidance for operating facilities in a sustainable manner by reducing the use of energy, water, and toxic chemicals. The O&M manual helps facility managers identify any special handling and tracking requirements (such as for chemicals), equipment maintenance and operation procedures, and any other special record-keeping protocols such as the requirement for post-occupancy performance data). Inspection requirements and warranty information are also included in the manuals. In buildings with complicated or unfamiliar systems, the general contractor will be responsible for training facility managers. Educating maintenance personnel on the long-term care of materials and systems will be part of the procedures at the conclusion of construction.

There are several other areas, in addition to jobs and construction operations and procedures, that are changing: codes and standards, technology, materials and products, and liability.

Tightening codes and standards

As broad understanding of the flaws in current building practices has grown, so too have the number of related **codes** and regulations designed to address these flaws, particularly energy and water inefficiencies. As discussed in detail in Chapter 4, codes define minimum standards for many aspects of construction; plumbing codes, electrical codes, and building codes are examples.

See http://www.KirshnerBooks.com


Andrew Schulman

The adoption of new codes and tightening of existing codes, especially related to energy and water use, are happening rapidly. Sometimes these codes are in conflict with voluntary green building certification programs or existing regulations. For example, San Francisco had to reconcile the existing requirements for certification of commercial buildings through one of the voluntary green building assessment programs with new state-mandated building codes.[5] This incompatibility can lead to confusion and conflicts among designers, builders, and owners. (See the later discussion on liability.)

The federal government is in the forefront of efforts to tighten **standards** (guidelines developed to establish best practices), and has issued multiple rules, regulations, and policies related to green design and construction. Some federal initiatives are mandatory (such as protection of natural habitats and wetlands and the reduction of energy use in buildings) and some are guidelines (such as the adoption of a green building assessment program for federal buildings). Federal regulations are likely to tighten further. *The Strategic Sustainability Performance Plan,* from the General Services Administration, for example, commits to designing buildings that produce as much, or more, energy than they use—zero net energy buildings.[6] (The reader is urged to review the concept of ZNE in Chapter 2.)

It's not just the federal government that is issuing new regulations: states, municipalities, and local jurisdictions are also adopting green codes and regulations. California is leading efforts at the state level; in 2014, its updated Green Building Standards Code (CALGreen), a statewide green building code, went into effect. The majority of states and many local jurisdictions have adopted energy codes, although none are as comprehensive as California's efforts.

As always, construction workers are responsible for understanding how codes, regulations, and best practices impact their trade. With increasing efficiency requirements, this understanding must extend to green regulations, codes, and incentives.

See http://www.KirshnerBooks.com

Technology

New technology enters the workplace almost daily and has impacted many aspects of the construction industry. Changes in how information flows on a jobsite, the ability to design and construct very complex forms, and the development of **smart buildings** and sophisticated systems controls are just some examples. Various types of building modeling software (Building Information Modeling or BIM, noted previously) that create 3D models from which both graphic and non-graphic information can be extracted have been in use for 20 years. As designers and builders have gained familiarity with modeling software, its use has increased. Drawings can be produced quickly and accurately, and embodied data let designers and contractors analyze code and installation requirements, including the optimum sequence for installing building components. Manufacturers' specifications, cost data, and scheduling information are embedded in the software and when changes or adjustments are made, the model and the accompanying data change too. This has resulted in more effective communication, better work flows, tighter cost control, and more.

Technology is also playing an ever-increasing role in the development of new materials and products. Buildings are becoming "**smart**": computers can control access, lighting, and communication and make it possible to incorporate green components, including recycled products, into structures of all sizes. Technology has also made it possible to create buildings that, until recently, would have been impossible to design or construct. The massive curvilinear buildings by Frank Gehry are examples of structures defined by innovative forms and materials that did not exist or would not have been possible to utilize in the pre-computer world. The Walt Disney Concert Hall shown here is an another example. New types of materials and unfamiliar application of existing materials are requiring changing work-force skills.

PD Photos

Exterior elevation of Walt Disney Concert Hall in Los Angeles

See http://www.KirshnerBooks.com

Technology has also revolutionized management: how designers and contractors plan and organize for construction, and then manage, track, and control the process. There are software programs for developing estimates and monitoring costs, preparing and updating schedules, standardizing information, tracking labor and other performance indicators, and communicating with those working to complete the job. The tendency for each trade to operate isolated from other trades is changing because of technology. BIM, cloud computing, mobile apps, and more are creating interconnections among those on a project resulting, ideally, in improved decision-making, creativity, and speed.

The wide use of electronic technology in construction has made it mandatory for today's construction managers to be computer literate. The rapidly changing nature of systems and products in the industry also requires informed and sophisticated builders. The days are fast disappearing when the contractor was just a guy with a tool belt.

New materials, products, and systems

New green products and materials are flooding the market. This is in response to growing consumer demand for sustainable products, changes in technology, expectations regarding best practices, and regulatory requirements. Some of these new materials are upgrades to familiar products such as high-performance windows and plumbing fixtures. Other products are entirely new and others are futuristic: solar arrays, light-weight high-strength carbon materials, energy-harvesting glass, panels made from sorghum stalks, and paint that helps clean the air are examples. There are even building materials, such as bricks, that are being produced by 3D printing.[7]

The choice of materials and products that perform successfully in the field and truly meet sustainability goals can be a challenge. While sustainability criteria are increasingly part of the product-specification decision process, sorting through all the contradictory information can be both complex and confusing. There are certain principles that are used to assess the environmental value of materials and products, including:

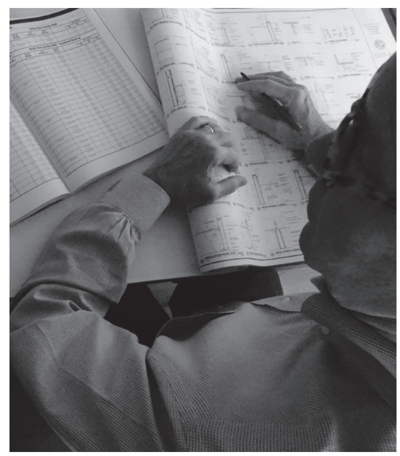
- Product durability
- Embodied energy contained in the product

See http://www.KirshnerBooks.com

- Percentage of recycled content
- Source
- Product's ability to be recycled after useful life
- Whether a product has been certified by a third party

There is no agreement, however, regarding how to weigh these (sometimes contradictory) criteria. For example: you want to use a pair of beautiful, used French doors in your new house addition. The problem is that the doors will either require extensive and expensive upgrades or, once installed, they will be drafty and energy inefficient. Is it better to reuse the old doors or buy new, tight, doubled-glazed doors?

Beyond the issue of product selection are the estimating challenges presented by new and unfamiliar materials and products. Designers and contractors need to project accurately what something is going to cost, usually in dollars or time, before a project is built. The builder's goal is to predict costs accurately and still have this estimate low enough to be awarded a contract. As is true of any construction project, the best estimates are derived from experience: how long it's taken in the past to install a certain assembly or product, what is the expected lead time, special warranty issues or costs, and so on. With new products and materials, it's more difficult to assess purchase and installation costs accurately.


Andrew Schulman

The multiple issues around green materials and products will be covered in detail in Chapter 5.

Changes to liability

Contractors should be aware of the legal issues that can arise on green projects, where new materials, products, and construction processes are used. According to the American Bar Association,[8] so-called green risks are similar to issues traditionally associated with construction projects—uncoordinated drawings,

See http://www.KirshnerBooks.com

construction delays, and noncompliant construction, to name a few. But other risks can be specifically related to sustainable design and construction practices, primarily because of the use of green materials, systems, and procedures. These risks include:

- **Failure to meet client anticipations regarding operating costs or comfort.** If a project fails to live up to the expectations of the owner, this can cause disputes and possibly litigation. For example, an owner may have expectations regarding long-term energy savings that are not realized. This situation is more likely with products or assemblies that are new to the market and, sometimes, experimental. Another risk is higher-than-projected operating costs due to inadequate design, construction, operation, or maintenance.

- **Problems associated with conflicting standards.** As noted previously, public codes are changing rapidly and may not be compatible with voluntary certification requirements of a building assessment program such as LEED. If conflicting standards or requirements exist at the time a project is undertaken and they are not identified and resolved until after construction is under way, the potential for delays, significant cost overruns, and accompanying litigation is heightened.

- **Risks due to project delays.** Although delays are common sources of conflict, these risks are increased on green projects, sometimes with unexpected consequences. For example, a contractor in Maryland was sued because project delays (not necessarily directly linked to the green nature of the project) resulted in the loss of a green tax incentive for the owner. Other risks can include delays caused by green material shortages or lack of familiarity with green practices such as commissioning guidelines that may be required as part of a building certification program. (See Table 4.2 for examples.)

- **Failure to meet green certification standards.** Because most green standards are new, there is increased risk that designers and builders may fail to meet program requirements. In a case in New York, for example, the owner was forced to pay back taxes because the completed project failed to meet the green commitments on which tax-exempt bonds were issued.

See http://www.KirshnerBooks.com

- **Performance or durability failures of materials and equipment.** Some products that are configured with nontoxic materials to meet stringent air quality standards may not hold up as well as the product they replace. A goal and expectation for green construction is an *increase* in durability, not a reduction. Another risk is potential moisture problems arising from air-tight buildings, which may cause warranty and other problems for the contractor. Other risks for contractors include potential delays caused by installation of unfamiliar products or processes required by green codes, and how the installation of a high-performance system might interfere with existing warranties. For example, you're a contractor who has been hired to install a solar photovoltaic array on an existing roof. There are multiple issues that will need to be addressed: will the array impact the existing roof warranty? Are you going to penetrate the existing roof and assume liability for future roof problems? Will the array impact the existing drainage or will its maintenance reduce the life of the roof?

- **Conflicts over documentation.** Legal issues can surface regarding the ownership of green documentation such as with the city of Palo Alto as discussed previously. This case highlights the importance of contract language that clarifies all documentation related to green building certification.[9]

Summary

We have seen in this chapter that the construction industry is in the midst of change in the way that buildings are conceived, planned, designed, and built. An older work force, globalization, higher costs, and new technology are some of the forces exerting stress on the industry. The concern in this chapter has been the increased constraints brought about by economic forces, regulatory requirements, and public demand, especially constraints related to energy and the environment. The consequences of these constraints impact how workers must approach their jobs, and the skills they require; the rapid (and sometimes confusing and conflicting) tightening of codes and standards; the specification

See http://www.KirshnerBooks.com

of unfamiliar materials and products; and new expectations for what constitutes best practices on a jobsite.

The reader has been introduced to the role of regulations and standards. The next chapter will discuss these in more detail, as well as the emerging importance of green building assessment programs. These programs, such as the U.S. Green Building Council's LEED, seek to develop standardized measures of the ongoing environmental and social impacts of a product or building.

Glossary

Building Information Modeling (BIM)—a process of gathering and managing information that uses 3D virtual models as a tool for design, construction, and facilities management.

C**lose-out**—the process of completing the terms of a contract; includes completion of the physical work (construction close-out), completion of fulfilling the terms of the construction contract (contract close-out), and final evaluations by the contractor (contractor close-out). On a green project, close-out includes submittal of required documentation.

Codes—laws put into place to promote safe practices in design and construction; compliance is enforced through whichever agency has jurisdiction over the project.

Commissioning—a process of verifying that a building systems and equipment are installed as specified and the building is operating at optimal performance. Commissioning can occur during design, construction, and operation.

Construction Management project delivery—a delivery method in which a contract manager (CM) is hired early in the process and acts as the owner's representative. During construction, the contract manager may either manage (but not physically complete the work) or perform as a general contractor.

Green documentation—verification that a building and its materials, products, and systems meet green program requirements.

See http://www.KirshnerBooks.com

General contractor—an individual or firm hired by and responsible to an owner for coordinating the completion of a project. The GC hires subcontractors and suppliers.

Integrated Project Delivery (IPD)—a project delivery system that is based on a highly collaborative approach to project design and construction.

LEED (Leadership in Energy and Environmental Design)—a voluntary green building certification program developed by the U.S. Green Building Council and administered by the Green Building Certification Institute (GBCI) that recognizes best-in-class building strategies and practices. LEED includes a suite of green building rating systems as well as professional credentials.

Operations & Maintenance (O&M) Manual—A manual provided to the owner at the completion of the work that gives critical operation, maintenance, repair, and replacement information.

Project delivery—the organizational structure for completing a project. Also called delivery method.

Smart building—a building that uses technology to integrate its systems to optimize services, costs, and operation.

Specialty trade contractor—a contractor who is an expert in a specific area of construction.

Subcontractor—an individual or firm that has a contract with another contractor. In construction, subcontractors are typically specialty trades.

Waste management—the processes of dealing with and controlling construction and demolition debris.

Ichijo

zHome, Issaquah WA

See http://www.KirshnerBooks.com