2004 SUPPLEMENT

Kaplan Architecture has acquired Architectural License Seminars (ALS), the oldest and most respected provider of Architect Registration Exam study material. Over the past 35 years over 50% of the registered architects in practice use ALS material for their exam preparation, which is the only complete centralized source of material for all nine divisions of the Architect Registration Exam (ARE). Kaplan, Inc. is the nation's leading provider of lifelong education, having served more than 30 million individuals over the past 60 years, and is a wholly owned subsidiary of The Washington Post Company.

As a result of NCARB's Architecture Practice Analysis Study conducted in 2000 it was determined that the Architect Registration Exam was in need of minor revisions. Beginning in February of 2004 these changes will be implemented in the ARE version 3.0. This is not a major overhaul of the exam, instead this one-step in the evolution of improvements to the ARE. In general terms, the content will not change. However, to eliminate some redundancy a few areas are being shifting/removed, a few strengthened, and a few new areas added.

Kaplan AEC is concerned about how the changes might impact the candidate's exam preparation. We are in process of revising all of our ALS material; condensing where needed, removing dated material and reorganizing topics to better reflect the nine divisions of the ARE (version 3.0). In February we expect revised materials to be available. In the interim we have published this supplement to address immediate concerns.

Below are details of the changes to the ARE per NCARB:

Multiple Choice Divisions

- The overall number of questions in each division is being reduced:

	Current ARE	ARE version 3.0
PRE-DESIGN	125	105
GENERAL STRUCTURES	125	85
LATERAL FORCES	90	75
MECHANICAL & ELEC. SYSTEMS	125	105
BUILDING DESIGN / MATERIALS & METHODS	125	105
CONSTRUCTION DOCUMENTS & SERVICES	125	115

- The content outline for each division is better organized, with more consistent titles.
- Questions that pertain to site design are being re-introduced into several divisions.
- Questions covering new content areas such as "green" architecture, sustainability, and new material technologies are being added.
- The Materials & Methods division is being renamed Building Design / Materials & Methods to better reflect its expanded scope.
- The portion of the Construction Documents & Services division that pertains to project and practice management is being expanded.
- The layout of the screens is being redesigned to prepare for new types of questions in the future.

Graphic Divisions

- The Site Section vignette is being eliminated from the Site Planning division.
- The Block Diagram vignette is being eliminated from the Building Planning division.
- The sequence of all three graphic divisions is being standardized with one mandatory 15-minute break occurring between the sections of vignettes.
- Access to the Practice Program at the Test Center during the examination is being eliminated, allowing for shorter appointment times.
    - The Practice Program remains available for downloading from the Council's web site for those candidates unfamiliar with the software.

These changes will effect how a candidate uses the Kaplan/ALS study material to prepare for the exam. Besides our existing products the only additional product you will need is this supplement. This supplement includes both additional material and preparation recommendations for the changes that are being made to the ARE.

Recommendations (changes from courses recommended on website)

- When studying for the Site Planning Graphic Division, do use the products listed on our website, however do not study the Site Section vignette, located in the *Site Planning* self study course.
- When studying for the Building Planning Graphic Division, do use the products listed on our website, however do no study the Block Diagram vignette, located in the *Building Planning & Technology* self study course.
- When studying for any of the <u>six multiple-choice</u> divisions, do use the products listed on the website. In addition, do study the "Sustainable Design" section in this supplement. This material is meant to prepare you for what NCARB is calling *"green" architecture, sustainability, and new material technologies.*
- When studying for the Construction Documents & Services division, do use the products listed on website. In addition, do study the Project and Practice Management section in this supplement.
- When studying for any of the <u>six multi-choice divisions (could change)</u> do use the products listed on the website, in addition, do study the *Site Design* self study course.

- Just because the number of multi-choice questions per division is being reduced do not omit any topics listed in our study guides.
- Do visit http://www.ncarb.org/are/tutorial2.html to download the Practice Program that is used for the graphic divisions of the exam. It is highly recommended to become familiar with this program before taking the graphic divisions.

For a complete list of ARE guidelines and specific details of the changes visit NCARB's website at www.NCARB.org. As always, please feel free to contact us any time if you have any questions or concerns.

SUSTAINABLE DESIGN

The following section is meant to prepare you for the *"green" architecture, sustainability, and new material technologies* topics that NCARB has introduced to several of the multiple-choice divisions of the ARE 3.0.

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HISTORY OF SUSTAINABLE DESIGN

What is *sustainable* design and how is it different from the ordinary process that architects have used for thousands of years?

In early human history, builders of human habitats used materials that occurred naturally in the earth, such as stone, wood, mud, adobe bricks, and grasses. With nomadic tribes and early civilizations, the built environment made little impact on the balance of natural elements. When abandoned, the grass roof, adobe brick, or timber beam would slowly disintegrate and return to the natural ecosystem. Small human populations and the use of natural materials had very little impact on a balanced natural ecosystem.

But as human populations expanded and settlements moved into more demanding climates, natural materials were altered to become more durable and less natural. In fact, it is the remnants of archeology that demonstrate some of the human creations that are not easily recycled into the earth; fired clay, smelted ore for jewelry, and tools are examples of designs that will not easily reintegrate into the natural ecosystem. These materials may be reprocessed (grinding, melting, or reworking) into other human creations, but they will never be natural materials again.

As human populations expanded, there is strong evidence that some civilizations outgrew their natural ecosystem. When overused, land became less fertile and less able to support crops, timber, and domesticated animals necessary for human life. The ancient solution was to move to a more desirable location and use new natural resources in the new location, abandoning the ecologically ruined home site.

The realization that global natural resources are limited is an age old concept. The term *conservation*, which came into existence in the late 19th century, referred to the economic management of natural resources such as fish, timber, topsoil, minerals, and game. In the United States, at the beginning of the 20th century, President Theodore Roosevelt and his chief forester, Gifford Pinchot, introduced the concept of conservation as a philosophy of natural resource management. The impetus of this movement created several pieces of natural legislation to promote conservation and increased appreciation of America's natural resources and monuments.

In the middle of the 1960s, Rachel Carson published *Silent Spring*, a literary alarm that revealed the reality of an emerging ecological disaster—the gross misunderstanding of the value and hazards of pesticides. The pesticide DDT and its impact on the entire natural ecosystem was dramatic; clearly, some human inventions were destructive and could spread harm throughout the ecosystem with alarming speed and virulence. Birds in North America died from DDT used to control malaria in Africa. Human creations were influenced by the necessities of the natural cycles of the ecosystem. Human toxic efforts could no longer be absorbed by the cycles of nature. Human activities became so pervasive and potentially intrusive that there needed to be a higher level of worldwide ecological understanding of the risk of disrupting the ecosystem.

Architects, as designers of the built environment, realize the ecological impact of their choices of architectural components, such as site selection, landscaping, infrastructure, building materials, and mechanical systems. The philosophy of sustainable design encourages a new, more environmentally sensitive, approach to architectural design and construction.

There are many credos for the approach to a new, sustainable design. Some architectural historians maintain that the best architects (Vitruvius, Ruskin, Wright, Alexander) have always discussed design in terms of empathy with nature and the natural systems. Now it is evident that all architects should include the principles of sustainable design as part of their palette of architectural best practices.

PRINCIPLES OF SUSTAINABLE DESIGN

Why is sustainable design necessary?

Principles of the Scientific Laws of Nature.

1) In the earth's ecosystem (the area of the earth's crust and atmosphere approximately five miles high and five miles deep) there is a finite amount of natural resources. Mankind has become dependent on elements such as fresh water, timber, plants, soil, and ore, which we process into necessary pieces of our human environment.

2) Given the laws of thermodynamics, matter cannot be created or destroyed. The resources that we have been allotted to manage our existence are contained in our ecosystem.

3) All forms of energy tends to seek equilibrium and therefore disperse. For example, water falls from the sky, settles on plants, and then percolates into the soil to reach the subterranean aquifer. Toxic liquids, released by humans, and exposed to the soil, will equally disperse and eventually reach the same underground reservoir. The fresh water aquifer, now contaminated, is no longer a useful natural resource.

These laws of science indicate why it is necessary to maintain the delicate balance of natural ecosystems. There is a need to focus on the preservation of beneficial natural elements and diminish or extinguish natural resources contaminated with toxins and our destructive practices.

There are many credos for environmental responsibility. One, *The Natural Step*, was organized by scientists, designers, and environmentalists in 1996.

They were concerned with the preservation of the thin layer that supports human life in a small zone on the earth's surface: the ecosphere (five miles of the earth's crust) and the biosphere (five miles into the troposphere of the atmosphere).

Their principals are as summarized as follows:

> 1) Substance from the earth's crust must not systemically increase in the ecosphere.
> Elements from the earth such as fossil fuel, ores, timber, etc., must not be extracted from the earth at a greater rate than they can be replenished.
>
> 2) Substances that are man-made must not systemically increase in the ecosphere.
> Man-made materials cannot be produced at a faster rate than they can be integrated back into nature.
>
> 3) The productivity and diversity of nature must not be systemically diminished.
> This means that we must protect and preserve the variety of living organisms that now exist.
>
> 4) In recognition of the first three conditions, there must be a fair and efficient use of resources to meet human needs.
> This means that human needs must be met in the most environmentally sensitive way possible.

Buildings consume at least 40 percent of the world's energy. Thus they account for about a third of the world's emissions of heat-trapping carbon dioxide from fossil fuel burning, and two-fifths of acid rain-causing carbon dioxide and nitrogen oxides.

Source: David Malin Roodman and Nicholas Lessen, "Building Revolution: How Ecology and Health Concerns are Transforming Construction." Worldwatch Paper *124 (Washington DC, Worldwatch Institute, 1995.*
Pg. 10, The HOK Guidebook to Sustainable Design, Sandra Mendler & William Odell, John Wiley & Sons, Inc., New York, 2000

The built environment has a monumental impact on the use of materials and fuels to create shelter for human beings. The decisions about the amount and type of materials and systems that are employed in the building process have an enormous impact on the future use of natural resources. Architects can affect and guide those decisions of design to influence the needs of sustainability and environmental sensitivity.

It is not a quick process. Like moving a large boat in a new direction, it must be done gradually and with awareness of the many natural forces that are acting on it. But, the process has started and architects should be aware of the philosophy of sustainable design in order to influence the results.

SUSTAINABLE SITE PLANNING AND DESIGN

Most architectural projects involve the understanding of the design within the context of the larger scale neighborhood, community, or urban context in which the project is placed.

If the building will be influenced by sustainable design principles, its context and site should be equally sensitive to environmental planning principles.

Sustainable design encourages a re-examination of the principles of planning to include a more environmentally sensitive approach. Whether it is called Smart Grow, sustainable design, or environmentally sensitive development practice, these planning approaches have several principles in common.

1.0 Site Selection

The architect and planner may assist the client in developing the criteria for site selection that reflects the proposed environmental goals of the complex of buildings.

The selection of a site is influenced by many factors including cost, adjacency to utilities, transportation, building type, zoning, and neighborhood compatibility. But, in addition to these factors, there are sustainable design standards that should be added to the matrix of site selection decisions:

• Adjacency to Public Transportation

If possible, projects that allow residents or employees access to public transportation are preferred. Allowing the building occupants the option of traveling by public transit may decrease the parking requirements, increase the pool of potential employees and remove the stress and expense of commuting by car.

• Flood Plains

In general, local and national governments hope to remove buildings from the level of the 100-year flood plain. This can be accomplished by either raising the building at least one foot above the 100-year elevation or locating the project entirely out of the 100-year flood plain.

This approach reduces the possibility of damage from flood waters, and possible damage to downstream structures hit by the overfilled capacity of the floodplain.

• Erosion, Fire, and Landslides

Some ecosystems are naturally prone to fire and erosion cycles. Areas such as high slope, chaparral ecologies are prone to fires and mud slides. Building in such zones is hazardous and damaging to the ecosystem and should be avoided.

• Sites with high slope or agricultural use

Sites with high slopes are difficult building sites and may disturb ecosystems, which may lead to erosion and topsoil loss. Similarly, sites with fertile topsoil conditions—prime agricultural sites—should be preserved for crops, wildlife, and plant material, not building development.

• Solar orientation, wind patterns
Orienting the building with the long axis generally east west and fenestration primarily facing south may have a strong impact on solar harvesting potential. In addition, protecting the building with earth forms and tree lines may reduce the heat loss in the winter and diminish summer heat gain.

• Landscape Site Conditions
The location of dense, coniferous trees on the elevation against the prevailing wind (usually west or northwest) may decrease heat loss due to infiltration and wind chill factor. Sites with deciduous shade trees can reduce summer solar gain if positioned properly on the south and west elevations of the buildings.

2.0 Alternative Transportation
Sites that are near facilities that allow several transportation options should be encouraged. Alternate transportation includes public transportation (trains, buses, and vans); bicycling amenities (bike paths, shelters, ramps, and overpasses); carpool opportunities that may also connect with mass transit; and provisions for alternate, more environmentally sensitive fuel options such as electricity or hydrogen.

3.0 Reduce Site Disturbance
Site selection should conserve natural areas, and restore wildlife habitat and ecologically damaged areas. In some areas of the United States, less than 2 percent of the original vegetation remains. Natural areas provide a visual and physical barrier between high activity zones. Additionally, these natural areas are aesthetic and psychological refuges for humans and wildlife.

4.0 Storm Water Management
Reduced disruption of natural water courses (rivers, streams and natural drainage swales) may be achieved by:

- Providing on-site infiltration of contaminants (especially petrochemicals) from entering the main waterways. Drainage designs that use swales filled with wetland vegetation is a natural filtration technique especially useful in parking and large grass areas.
- Reducing impermeable surface and allowing local aquifer recharge instead of runoff to waterways.
- Encouraging groundwater recharge.

Ecologically Sensitive Landscaping

The selection of indigenous plant material, contouring the land, and proper positioning of shade trees may have a positive effect on the landscape appearance, maintenance cost, and ecological balance. The following are some basic sustainable landscape techniques:

- Install indigenous plant material, which is usually less expensive, to ensure durability (being originally intended for that climate) and lower maintenance (usually less watering and fertilizer).
- Locate shade trees and plants over dark surfaces to reduce the "heat island effect" of surfaces (such as parking lots, cars, walkways) that will otherwise absorb direct solar radiation and retransmit it to the atmosphere.
- Replace lawns with natural grasses. Lawns require heavy maintenance including watering, fertilizer, and mowing. Sustainable design encourages indigenous plant material that is aesthetically compelling but far less ecologically disruptive.
- In dry climates, encourage xeriscaping (plant materials adapted to dry and desert climates); encourage higher efficiency irrigation technologies including drip irrigation, rainwater recapture and gray water reuse. High efficiency irrigation uses less water because it supplies directly to the plant's root areas.

6.0 Reduce Light Pollution

Lighting of site conditions, either the buildings or landscaping, should not transgress the property and not shine into the atmosphere. Such practice is wasteful and irritating to the inhabitants of surrounding properties. All site lighting should be directed downward to avoid "light pollution."

Open Space Preservation

The quality of residential and commercial life benefits from opportunities to recreate and experience open-space areas. These parks, wild life refuges, easements, bike paths, wetlands, or play lots are amenities that are necessary for any development.

In addition to the aforementioned water management principles, the following are principles of design and planning that will help increase open-space preservation:

7.1) Promote in-fill development that is compact and contiguous to existing infrastructure and public transportation opportunities.

In-fill development may take advantage of already disturbed land without impinging on existing natural and agricultural land.

In certain cases, in-fill or redevelopment may take advantage of existing rather than new infrastructure.

7.2) Promote development that protects natural resources and provides buffers between natural and intensive use areas.

First, identify the natural areas (wetlands, wildlife habitats, water bodies, or flood plains) in the community in which the design is planned.

Second, the architect and planners should provide a design that protects and enhances the natural areas. The areas may be used partly for recreation, parks, natural habitats, and environmental education.

Third, the design should provide natural buffers (such as woodlands and grasslands) between sensitive natural areas and areas of intense use (factories, commercial districts, housing). These buffers may be both visual, olfactory, and auditory protection between areas of differing intensity.

Fourth, provide linkages between natural areas. Isolated islands of natural open space violate habitat boundaries and make the natural zones feel like captive preserves not a restoration or preservation of natural conditions.

Fifth, the links between natural areas may be used for walking, hiking, or biking, but should be constructed of permeable and biodegradable material. In addition, the links may augment natural systems such as water flow and drainage, habitat migration patterns, or flood plain conditions.

7.3) Establish procedures that ensure the ongoing management of the natural areas as part of a strategy of sustainable development.

Without human intervention, natural lands are completely sustainable. Cycles of growth and change including destruction by fire, wind, or flood have been occurring for millions of years. The plants and wildlife have adapted to these cycles to create a balanced ecosystem.

Human intervention has changed the balance of the ecosystem. With the relatively recent introduction of nearby human activities, the natural cycle of an ecosystem's growth, destruction, and rebirth is not possible.

Human settlement will not tolerate a fire that destroys thousands of acres only to liberate plant material that reblooms into another natural cycle.

The coexistence of human and natural ecosystems demands a different approach to design. This is the essence of sustainable design practices, a new approach that understands and reflects the needs of both natural and human communities.

AHWAHNEE PRINCIPLES

In 1991, in the Ahwahnee Hotel in Yosemite National Park, a group of architects, planners, and community leaders got together to present community principles that express new, sustainable planning ideas. These principles are summarized below:

Preamble:
Existing patterns of urban and suburban development seriously impair our quality of life. The symptoms are: more congestion and air pollution resulting from our increased dependence on automobiles, the loss of precious open space, the need for costly improvements to roads and public services, the inequitable distribution of economic resources, and the loss of a sense of community. By drawing upon the best from the past and the present, we can plan communities that will more successfully serve the needs of those who live and work within them. Such planning should adhere to certain fundamental principles.

Community Principles:

1. All planning should be in the form of complete and integrated communities containing housing, shops, workplaces, schools, parks, and civic facilities, essential to the daily life of the residents.
2. Community size should be designed so that housing, jobs, daily needs, and other activities are within easy walking distance of each other.
3. As many activities as possible should be located within easy walking distance of transit stops.
4. A community should contain a diversity of housing types to enable citizens from a wide range of economic levels and age groups to live within its boundaries.
5. Businesses within the community should provide a range of job types for the community's residents.
6. The location and character of the community should be consistent with a larger transit network.
7. The community should have a center focus that combines commercial, civic, cultural, and recreational uses.
8. The community should contain an ample supply of specialized open space in the form of squares, greens, and parks, whose frequent use is encouraged through placement and design.

9. Public spaces should be designed to encourage the attention and presence of people at all hours of the day and night.
10. Each community or cluster of communities should have a well-defined edge, such as agricultural greenbelts or wildlife corridors, permanently protected from development.
11. Streets, pedestrian paths, and bike paths should contribute to a system of fully-connected and interesting routes to all destinations. Their design should encourage pedestrian and bicycle use by being small and spatially defined by buildings, trees, and lighting, and by discouraging high speed traffic.
12. Wherever possible, the natural terrain, drainage, and vegetation of the community should be preserved with superior examples contained within parks or greenbelts.
13. The community design should help conserve resources and minimize waste.
14. Communities should provide for the efficient use of water through the use of natural drainage, drought tolerant landscaping, and recycling.
15. The street orientation, the placement of buildings, and the use of shading should contribute to the energy efficiency of the community.

Regional Principles:
1. The regional land-use planning structure should be integrated within a larger transportation network built around transit rather than freeways.
2. Regions should be bounded by and provide a continuous system of greenbelt/wildlife corridors to be determined by natural conditions.
3. Regional institutions and services (government, stadiums, museums, etc.) should be located in the urban core.
4. Materials and methods of construction should be specific to the region, exhibiting a continuity of history and culture and compatibility with the climate to encourage the development of local character and community identity.

Implementation Principles:
1. The general plan should be updated to incorporate the above principles.
2. Rather than allowing developer-initiated, piecemeal development, local governments should take charge of the planning process. General plans should designate where new growth, in-fill, or redevelopment will be allowed to occur.
3. Prior to any development, a specific plan should be prepared based on these planning principles.
4. Plans should be developed through an open process and participants in the process should be provided visual models of all planning principles.

Source: Local Government Commission's Center for Livable Communities, http://lgc.org/clc/

ARCHITECTURAL PROCESS

After the planning process has been concluded, and the site has been selected, the architectural team will begin to focus on the project, including the project's buildings and related infrastructure.

Traditionally, the architect is faced with four components to every design decision:

1. Cost
2. Function
3. Aesthetics
4. Time

The new, sustainable ecological paradigm adds one additional component to form a pentagon of concerns:

5. Sustainability

The ingredients of the normal process have been discussed previously, but the new ingredient, sustainability, changes the meaning of all these pieces of this architectural process.

1.0 COST

As architects put together budgets for their clients, they are always concerned with the first costs of the design components—the initial cost to purchase and install the design element.

Sustainable design has made the economic decision process more holistic. The decision to select a design element (such as a window, door, flooring, exterior cladding, or mechanical system) is now concerned with the "life-cycle" cost of the design.

1.1 Life-Cycle Costing

Life-cycle costing is concerned not only with the first cost, but the operating, maintenance, periodic replacement, and residual value of the design element.

For example, two light fixtures (A and B) might have different first cost: Fixture A has a 10 percent more expensive first cost than B. But when the cost of operation (the lamps use far less energy per lumen output) and the cost of replacement (the bulbs of A last 50 percent longer than the bulbs of

Fixture B) is evaluated, Fixture A has a far better life cycle cost and should be selected.

In this kind of comparison, the life-cycle cost may be persuasive; the extra cost of Fixture A may be recovered in less than two years due to more efficient operation and replacement savings. In this situation the architect justified Fixture A to the owner, who benefits from a more energy efficient lighting that continues to save the owner operating costs for the life of the building.

1.2 Matrix Costing

While designing a typical project, the architect faces numerous alternate decisions, a process that may be both intriguing and complex.

In nearly all projects, there is an established budget and program (including all the owner's functional requirements). The architect must balance the functional issues with the budgetary and aesthetic issues.

Sustainable design adds an ingredient to this matrix of decisions that may actually help the composition.

> For example, decisions that allow the improved efficiency of the building envelope, light fixtures, and equipment may permit the architect to allow the engineer to reduce the size of the HVAC system, resulting in a budgetary trade-off. The extra cost of the improved envelope may be economically balanced by the diminished cost of the mechanical system.

This type of economic analysis, which evaluates cost elements in a broad matrix of interaction, is a very valuable architectural skill. The ability to understand the interaction between different building systems in a creative and organized fashion can differentiate an excellent from a simply adequate architectural design.

2.0 FUNCTION

Functionality is one of the primary standards of architectural design. If the building doesn't perform according to the client's needs, then the building design has failed.

Sustainability adds a facet to functionality that even the Owner may not initially appreciate.

As previously mentioned, life-cycle costing will affect the decisions in which elements are finally selected to form the final design. However, the search for sustainability may increase the dimensions of functionality.

Years ago, the design element could perform at the highest level regardless of its impact on the environment or energy use.

The fact that many industrial and residential buildings are operating in 2003 much more efficiently than 1960 is evidence that the building design and construction profession is learning how to tune buildings to a higher degree of energy operation. But, with diminishing natural resources and increasing pollution of the environment, even more efficient design is necessary.

Today, architects will include sustainability in the selection of optimal functional design components.

> For example, a roof system must be able to withstand a variety of weather conditions, be warranted to be durable a minimum of years, be able to be applied in a range of weather conditions, and have a surface with reflectivity that does not add to the urban heat effect.

3.0 TIME

The schedule of a project is always a difficult part of the reality of the design process. Time is a constraint that forces a systematic and progressive evaluation of the design components.

The sustainable component of the architectural process may add to the amount of time the architect will spend on the research for the project.

The architect may spend more time on a sustainable design with the result being a more integrated, sustainable project.

4.0 AESTHETICS

The aesthetic of a project is the combination of the artistry of the architect and the requirements of the project.

Sustainable design has the reputation of emphasizing function and cost over beauty and appeal.

It is the architect's responsibility to keep all the design tools in balance. A project without aesthetic consideration will fail the client, its user, and the potential client that may be deciding between the normal design and one that considers a broader, integrated, sustainable approach.

5.0 SUSTAINABLIITY

The fifth point in the calculus of the architect is a new component that leads to a new, holistic evaluation of the design process. Because a piece of any living element must be part of the cycle of nature in order to survive, all man-made elements should now consider the mantra, "do no harm and be designed to be integrated within the cycle of all living things."

Architectural designs should create by-products, be able to be recycled with other natural elements, and not cause depletion of natural resources necessary for the health of future generations.

Sustainable designs should have four goals:

1. Designs that use less

2. Designs that recycle components
3. Designs that have components that are easily recyclable
4. Designs that have components that are fully biodegradable

STANDARDS FOR EVALUATION

How can we objectively evaluate the quality of a sustainable project?

The architect is faced with responding to many standards and regulations in the course of assembling a design. Building codes, life safety standards, fire code, zoning regulations, and health and sanitary regulations are some of the many municipal, state, and federal standards that an architect must evaluate in the course of any project.

Sustainability is a new filter for the design process and there are several organizations that have offered checklists for evaluating the inclusion of environmentally sensitive elements into the project.

One of the measures of performance is LEED (Leadership in Energy and Environmental Design) which is sponsored by the USGBC (U.S. Green Building Council). This standard was developed in the 1990s by a consortium of building owners, architects, suppliers, engineers, contractors, and governmental agencies.

The goal of LEED and similar environmental design standards is to introduce new sustainable approaches and technologies to the construction industry. LEED is a voluntary environmental rating system that is organized into six categories:

1. Sustainable Sites
2. Water Efficiency
3. Energy & Atmosphere
4. Materials & Resources
5. Indoor Air Quality
6. Innovation & Design Practice

LEED covers the range of architectural decisions: including site design, water usage, energy conservation and production, indoor air quality, building materials, natural lighting, views of the outdoors, and innovative design components.

The LEED point award matrix is a mixture of teaching, persuasion, example, and incentive. It is good checklist for the entire project team to evaluate the quality of sustainable design decisions for the complete project—from initial planning through final construction, maintenance, and training procedures.

These categories combine *Prerequisites* (basic sustainable practices such as building commissioning, plans for erosion control, or meeting minimum Indoor Air Quality Standards) with optional *Credits* (water use reduction, heat island reduction, or measures of material recycled content).

Most of the credits are performance based—solutions based on system performances against an established standard such as American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE). ASHRAE has created one of most widely recognized standards of energy design that is used by mechanical engineers and architects.

For example, one credit (under the Energy & Resources category) is "Optimize Energy Performance."

The number of points for this credit depend on how the architectural and engineering team can optimize the design of the building's energy systems against the ASHRAE 90.1 standards.

The possible design solutions include optimizing the heating, cooling, fans, pumps, water, and interior lighting systems.

In the graduated point matrix for a new building, if the team improves the performance (against ASHRAE standards) by 15 percent they receive one point and if they manage to improve by 60 percent they would receive 10 points.

LEED describes suggested results but allows the architectural team to find a variety of solutions. The LEED certification awards range from Bronze at 40 percent compliance to Platinum at 81 percent compliance. The LEED certification is innovative and rigorous and currently there are fewer than a half dozen platinum buildings in the United States.

THE SUSTAINABLE DESIGN PROCESS

Is a sustainable design organized and implemented differently than a conventional design?

1.0 The Design Team

What kind of design team is necessary for a sustainable project?

The scope of a sustainable design invites an expanded team approach, which may include the following:

- Architects or engineers (structural, MEP) with energy modeling experience
- A landscape architect with a specialty in native plant material
- A commissioning expert (if LEED employed)
- An engineer/architect with building modeling experience

The design team for a sustainably designed project tends to have a larger pool of talent than a typical architectural project. Because the buildings will be more holistic, the sustainable design team will have additional consultants that bring a broader range of experience and innovation to the project. Wetlands scientists, energy efficient lighting consultants, native plant experts, or commissioning engineers are examples of the additional talent that may be added to sustainable design projects.

As with any architectural design, there is a hierarchy of design goals:

- Initial imperatives such as budget, timing, image, and program necessities

• Subjective goals such as a functionally improved and more pleasing work environment, pleasing color schemes, and landscaping that complements the architecture
• Specific goals such as more open space, more natural light, less water usage, and adjacency to public transportation

And with the inclusion of sustainability there may be additional goals:
• Initiatives that are specific to sustainability such as fewer toxins brought into the space, daylighting in all spaces with people occupancies, less overall energy consumed, less water usage, adjacency to public transportation, and improved indoor air quality
• Desire to exceed existing standards such as ASHRAE, USGBC, or American Planning Association (APA)

RESEARCH AND EDUCATION

Is there additional education and research necessary for a sustainable project?

Yes. Innovative HVAC systems, durable yet non-toxic materials, recycled materials, recyclable materials, native plant material, energy efficient lighting, and controls are examples of design components that are not normally designed and installed by general contractors and architectural consultants on typical projects.

In order to serve the client, the architect of sustainable projects has to be involved many research and education occasions.

1) Education of the Client

Sustainable design requires a new way of examining the architectural design process. Concepts such as life-cycle costing, recycled versus recyclable materials; non-VOC (volatile organic compounds) substances; daylighting; and alternate energy sources are among the several new concepts that the architect should discuss with the client before the design process commences.

It is critical that the client understands the sustainable process and is sympathetic to its potential economic and environmental benefits.

2) Education of the Project Team

Once the project has been assigned to an architect, but before the design process begins, the project team (architect, engineer, contractor, consultants, and owner) should assemble and discuss the project scope and objectives with all the project team members.

2.1 Establishing Project Goals

Among the many items included in the scope of work (including the extent of work, program elements, budget, and schedule) are the objectives for sustainable design.

For example, the architect and owner might establish goals for several environmental areas such as:

- X percent reduction of energy usage from the established norm (see “Benchmarking,” later in this section)
- Improved lighting (less energy used and more efficient dispersal of indirect light with less glare)
- Non-toxic and low VOC paint and finishes
- Increased recycled content in materials such as carpeting, gypsum wallboard, ceiling tiles, metal studs, and millwork
- High efficiency (energy star) appliances
- Wood elements are all certified wood products
- Daylighting in all work/occupied spaces

As the leader of the project team, it is the architect’s responsibility to include sustainable goals with the rest of the project scope of work.

A detailed explanation of the benefits of these sustainable design elements to all of the project team will ensure that they fully understand the design potential and economic implications of these concepts.

2.2 Verify Extent of Work

Sustainable design involves a more comprehensive approach to pre-project planning.

The LEED certification process will require record keeping and verification of the source of materials—a process that is beyond the normal design and construction work. For purposes of selecting a contractor and consultants, the team should be briefed on these additional obligations.

> For example, the demolition process (if LEED certified) will require verification that materials have been sorted and delivered to an approved recycling organization. By contrast, the normal demolition process does not require recycling nor verification that each material is sorted by type.

Clearly establishing the extent and type of effort required for each member of the sustainable design team is critical. The extent and type of effort will affect each member’s ability to participate and their fees for services and construction work.

3) Energy and Optimization Modeling

Building shape, orientation, fenestration location, roof color, envelope configuration, and HVAC system efficiency are some of the variables in sustainable design projects that can be fine tuned with DOE-2, (U.S Department of Energy’s building analysis program) and other computer energy modeling programs.

The “fine-tuning” of a project’s energy components are one of the elements in the architect’s design matrix that affects the final appearance, cost, and performance of the final design.

Energy modeling will not govern the final design. Issues such as compatible scale, color, texture, and functionality are still part of the architect's palette. But energy modeling is one additional factor that the architect will employ as part of the "best practices" approach to architecture.

In addition, modeling can assist in the cost analysis of a project. The fact that the modeling program is interactive helps the architect simultaneously adjust design elements to demonstrate alternate energy efficient solutions.

> For example, energy modeling might allow the architect to demonstrate to the team that a more durable, aesthetically pleasing, and energy efficient building skin could be economically justified by reducing the size and cost of the mechanical system.

The ability to visually and numerically quantify the efficacy of trading certain design elements may be an effective tool for the architect when discussing the building design with the consultants and owner.

4) The Bid and Specification Process

The requirements of a sustainable design will often vary from a normal project.

For example, the millwork section of bid documents will normally specify the finish material, configuration of the design and methods of attachment, delivery, and installation. But the requirement of non-VOC glues and non-VOC substrate may confuse a potential bidder and cause him to unnecessarily increase the bid price.

To facilitate the bidding and construction process, the architect should include:

- Simple definitions of sustainable elements:
  For example, what does "VOC," "certified" wood product, or "daylighting" mean.
- Explanations of specific characteristics of sustainable elements:
  For example, specifically state the standard that must be met (e.g., Green Label Testing Program Limits, carpet's total VOC limit: formaldehyde 0.05 (mg/m^2).
- References of specific regulatory agency's information (name, address, email, phone, etc.)
  For example, the Carpet and Rug Institute, *www.carpet-rup.com*, (800) 882-8846.
- Examples of suppliers that could meet the sustainable standards indicated. In the case of sustainable products, there are at least two approaches to a list of suppliers for products:

1. Limit the installer to 3–5 suppliers of a product that are known to satisfy the sustainable design specifications.

This approach assures the architect that the product will meet specified standards.

But, with the constantly changing nature of the emerging sustainable design market, a limited list could limit competition and the diversity of creative alternatives.

2. Identify a list of qualified suppliers, but permit the bidder/ contractor to submit alternative suppliers who satisfied the sustainable design criteria.

This approach creates a more competitive environment, but it will require more effort of the architect to properly review and qualify the bids.

4.1 Changes and Substitutions

Every project is faced with the reality of time and budgetary pressures. And, in those instances, there may be situations when one product or design element may not be available in the form originally specified.

Sustainable designed projects require more stringent architectural supervision to ensure that original design standards are met.

For example, in the rush to project completion the installer may claim that paints used for "touch-up" of damaged areas are so small that they may be installed with normal, higher VOC paints. The minor transgression might jeopardize the integrity of the project and the ability to receive certification for LEED credits in certain areas.

ENERGY EVALUATION

In the climates of North America, buildings need some form of purchased energy (electricity, natural gas, oil) in order to operate. The architect works with his or her team to design strategies that may reduce the amount of purchased energy, reduce operating costs, and reduce the nation's dependence on imported fossil fuels.

The following are some design strategies that the sustainable design approach might employ to improve a building's energy performance. These elements are listed and briefly described. For more detail, consult the specific study guide sections which cover Site Planning or Mechanical and Electrical Systems.

Solar Design

Solar design is the age-old system of using sunlight or solar radiation to supply a portion of the building's heat energy. By a combination of techniques such as window and skylight design, location of internal thermal mass, and internal organization of the building's functions, solar design may replace some of the fossil fuel needed for heating and cooling buildings.

Solar design for buildings is usually classified into two categories:

1)Passive solar systems are those systems that permit solar radiation to fall on areas of the building that benefit from the seasonal energy conditions of the structure.

For example, some North American buildings are designed to reduce solar radiation gains from sunlight in the summer. Passive solar design relies on inherent qualities of the building's fenestration, massing, and orientation to capture sunlight.

Passive solar systems are usually categorized into direct or indirect gain systems:

Direct gain systems, as the title implies, are those systems that allow solar radiation to flow directly into the space needing heat.
A process, commonly known as the "greenhouse effect" allows much of the sunlight which passes through the glass of the fenestration to be retained in the material it strikes (stone, concrete, wood, etc.) inside the building. Thus, south facing windows allow solar radiation to be directly gained and used inside the building.

Indirect gain systems operate when the sunlight first strikes a thermal mass that is located between the sun and the space. The sunlight absorbed by the mass is converted to thermal energy (heat) and then transferred into the living space.

There are basically two types of indirect gain systems: thermal storage walls and roof ponds. The difference is essentially the location—roof verses wall materials.

Passive solar design might include several architectural strategies to facilitate the design:

• **Overhangs or shading devices** that have been designed to permit winter solar radiation from entering the building interior while blocking the higher angled, summer solar radiation from entering the building.
Deciduous trees often will perform the same function of permitting winter sunlight to enter and blocking much of the summer solar radiation with branches and leaves. Examples of architectural sun control devices include:

- shutters
- vertical projections or fins
- shutters

• awnings
• trellises (especially with shading vegetation)
• sunscreens (some with PV panels that both gather sunlight to convert into electricity and shade unwanted radiation from interior space in the warm months)

• **Install light color roof systems.** Lighter colored roofing materials reflect sunlight and reduces the amount of radiation that is absorbed through the roof into the interior space. Colors with higher reflectance (albedo) factors are preferred. For example, some cities in the United States require roof materials to have a minimum albedo rating of .65 (65 percent of the solar radiation is reflected back into the atmosphere).

• **Urban heat island effect**. The urban heat island effect is caused by roofs, roads, and parking areas that absorb solar radiation during the day and retransmit the stored heat during the afternoon and evening. By designing surfaces such as roofs with light colored and reflective material, the amount of heat energy stored in these materials is diminished and therefore the urban heat island effect is reduced. Grass or vegetated roof areas have good insulating value and may also reduce the urban heat island effect and provide cooling through evapotranspiration.

• **Optimize building glazing systems.** Orientation, light transmittance factors, and U-value are all factors architects consider in selecting glazing. Glass which is low-E (emissivity) is desirable because it is coated with a material that allows a maximum amount of sunlight to be transferred through the glass and not reflected back into the atmosphere.

Lighting

The illumination of the interior of a sustainably designed building requires a holistic approach that balances the use of artificial and natural lighting sources.

1.1 Daylighting

Properly filtered and controlled solar radiation may provide a valuable source of illumination to a building interior. This process is called "daylighting" (simply having properly designed fenestration that allows natural sunlight to replace or dramatically reduce the need for artificial lighting).

Because unwanted sunlight (particularly in summer months) can also add to the internal heat load of a building, the architect must be careful to allow only beneficial sunlight and reduce unwanted solar heat gain. There are several techniques for controlling daylighting:

- Overhangs, fins, and other architectural shading devices.

- Sawtooth (not bubble) skylight design, which allows the glass to face north for illumination -not south for solar heat gain.
- Interior window shading devices, which allow solar gain during cool months, and the blocking of solar radiation during the warmer seasons.
- Light shelves, which permit the daylight to reflect off the ceiling and penetrate farther into the interior without affecting views outside.

<u>1.2 Higher Efficiency Light Fixtures.</u>
In addition to a daylighting strategy, light fixtures that are more efficiently designed reduce energy cost and increase comfort, such as:

• Fixtures that use fluorescent or HID lamps, which provide more illumination per watt than incandescent lighting.
• Fixtures that are designed to diffuse or bounce the illumination off the ceilings or internal reflectors, which are more efficient, cause less glare (especially in an environment with computer monitors); and save operating costs.
• Fixtures that have higher efficiency (T-8) fluorescent bulbs, which produce more lumens per watt and thereby diminish the heat generated by lighting.
• Fixtures that offer dimming or multiple switching capability, which permit the architect a more energy efficient lighting design.
Dimming or multiple switching fixtures allow the architect to design lighting patterns that blend nicely with daylighting opportunities.

For example, an office with perimeter fenestration allows daylighting supplemented with overhead lighting that can be dimmed or reduced.
The interior spaces, which are too far from the perimeter for daylighting, may be controlled with switches or dimmers that allow relatively higher levels of illumination.
The result is an even illumination pattern, which saves on artificial lighting costs, by relying on daylighting at the perimeter.

• Fixtures that use higher efficiency lamps such as fluorescent, high intensity discharge (HID) sulfur lighting (exterior only).
• Fluorescent fixtures that use high efficiency electronic ballasts.

Additionally, the architect may avoid less efficient incandescent lighting where possible, install task lighting to supplement diffused ambient lighting, and install LED (light emitting diode) lighting for exit signs. LED lighting lasts longer than incandescent and is far less expensive to operate.

1.3 Lighting Sensors and Monitors

Where possible, lighting cost can be diminished by installing light monitors that sense occupancy conditions. As long as the room contains people, the lights will remain on. If people leave, the sensor will wait for a few minutes, then shut off all the lighting in the room.

Lighting sensors can be designed to operate with a preference for motion, heat (from people), or desired time of occupancy.

1.4 Lighting Models

Computer lighting models are one option that allows the architect to simulate the levels of sunlight that penetrate into a building design, depending on the building location, varying times of year, fenestration orientation, and design.

By incrementally altering fenestration (skylights, windows, or light transport systems) and the artificial lighting system, the architect may optimize the daylighting and artificial lighting systems for the building.

Benchmarking

The U.S. Department of Energy provides "benchmark" information of total energy consumption in BTU's/ SF for various kinds of buildings in the United States. These standards, or benchmarks, can be useful in the measuring of energy efficiency standards for various types of buildings:

For example:

• Average for all office buildings (pre 1990)	104.2
• Average for all office buildings (1990–1992)	87.4
• Average for all educational buildings (pre 1900)	87.2
• Average for all educational buildings (1990–92)	57.1
• Average for all laboratory buildings (pre 1990)	319.2
• Average for all health care buildings (pre 1990)	218.5

Source: U.S. DOE, Commercial Building Energy Consumption and Expenditures.

Benchmarking is a good way to alert the design team to the base energy standards for their design. It's a good place to start and ultimately a standard to beat. And, one can see from some of the comparisons (Office and Educational Buildings), that some energy efficiency is occurring, but we still have improvements that are needed with all buildings, especially in the area of Laboratory and Health.

Commissioning

Commissioning is an organized process to ensure that all building systems perform interactively according to the intent of the architectural and engineering design, and the owner's operating needs.

Commissioning usually includes all HVAC and MEP systems, controls, ductworks and pipe insulation, renewable and alternate technologies, life safety systems, lighting controls and daylighting systems, and any thermal storage systems. Commissioning also verifies the proper operation of architectural elements such as the building envelope, vapor and infiltration control, and gaskets and sealant used to control water infiltration.

Commissioning is a process required for LEED certification, but is a recommended procedure for any building involved with sustainable design procedures.

Source: Commissioning Requirements for LEED Green Building Rating, Version 8. February 5. 1999
Pg. 71, The HOK Guidebook to Sustainable Design, Sandra Mendler & William Odell, John Wiley & Sons, Inc., New York, 2000

Innovative Technologies

Besides the aforementioned issues of solar design, improved lighting systems, improved HVAC systems, and improved building massing and envelope design, there are several "innovative technologies" that the architect can offer to their project team for consideration.

<u>1.0 Ground Water Aquifer Cooling and Heating (AETS)</u>
One alternative to full air-conditioning with chillers, which make heavy demands on electricity, is the aquifer thermal energy storage that uses the differential thermal energy in water from an underground well to cool a building during summer and heat a building in the winter.
This is an efficient a relatively low cost system, but it may require approval from the local environmental authority before installation.

<u>2.0 Geothermal Energy</u>
Where appropriate, heat contained within the earth's surface causes macro-geological events (such as underground geothermal springs or lava formations) that may be tapped to produce heat for adjacent structures.
In select locations this heat energy can be transferred and conveyed to supplement a building's heating demand.

<u>3.0 Wind turbines</u>
Small-scale wind machines used to generate electricity can be mounted on buildings or in open space nearby. These systems have the advantage of being relatively cost effective; a tested and established technology; systematically started-up; and have a relatively high output.
These systems have the disadvantage of needing a relatively high mast; requiring substantial structural support; potentially causing noise problems; and being visually intrusive.

<u>3) Photovoltaic systems</u>
The basis of the PV systems is the concept that electricity is produced from solar energy when photons or particles of light are absorbed by semi-conductors.

Most PV systems are mounted to the building (either on the roof or as shading devices above fenestration). Currently, PV systems are not cost effective. But with promised government subsidy necessary to achieve an economy of scale, PV's may be a viable method of electrical production in the United States, Japan, and Germany in the near future.

4) Fuel cells

Even though Sir William Grove invented the technology for the fuel cell in 1839, it has only recently been recognized as a potential power source for the future. The fuel cell claims to be the bridge between hydrocarbon economy and the hydrogen-based society.

Fuel cells are electrochemical devices that generate direct current (DC) electricity similar to batteries. But, unlike batteries, they require a continual input of hydrogen-rich fuel. In essence, the fuel cell is a reactor that combines hydrogen and oxygen to produce electricity, heat, and water. It is clean, quiet, and emits no pollution when fed directly with hydrogen.

At the moment, the fuel cell technology is still not cost effective for the commercial building market. But, there seems to be a general feeling that hydrogen-based energy reactors will soon be an optional energy source.

5) Biogas

Biogas is produced through a process that converts biomass, such as rapid-rotation crops and selected farm and animal waste, to a gas that can fuel a gas turbine. This conversion process occurs through anaerobic digestion—the conversion of biomass to gas by organisms (like bacterium) in an oxygen free environment.

Biogas has several advantages: it is a relatively high energy production; it lends itself to both heat and power production; it creates almost zero carbon dioxide emissions; it virtually eliminates noxious odors and methane emissions; and it protects ground water and reduces the landfill burden.

6) Small scale hydro

Harnessing the energy from moving water is one of the oldest energy production systems in the world. In some locations, small scale hydro power is a efficient and clean source of energy and is devoid of environmental penalties associated with large scale hydro projects. It allows small scale, local energy production, with relatively low cost.

7) Ice storage cooling systems

One of the problems for energy supply companies is that the highest demand for electricity often coincides with the highest cooling demand.

The utilities would prefer to "flatten the curve" (to even out or flatten the measure of average daily energy demand). The less number of peaks (high points of energy demand), the less the utilities have to supplement their power supply with expensive, supplemental fuels.

One way to reduce this peaking problem is to supplement a building's cooling capacity with an ice storage system.
An ice storage system has three components: a tank with liquid storage balls, a heat exchanger, and a compressor for cooling.
The essence of the ice storage system is that the chilling and freezing of the ice balls occurs at night (when the cost of energy is lower due to lower demand). During the day, the cool temperatures, stored in the ice, are transmitted into the building's cooling system.

Source: *Sustainability at the Cutting Edge*, Peter F. Smith, Architectural Press, An Imprint of Elsevier Science. Linacre House, Jordan Hill, Oxford OX2 80P, 2003

SUSTAINABLE DESIGN QUESTIONS

1. Sustainable Design is primarily concerned with the following issues?

    I. economics
    II. aesthetics
    III. environment
    IV. mechanical systems

Options
A) III
B) I, II, III
C) I, III
D) all of the above

2. The *Natural Step* is an approach to the environment that follows which of the following principles?

    I. The biosphere affecting humans is a relatively stable and resilient zone which includes 5 miles into the earth's crust and 5 miles into the troposphere
    II. Improved technologies have dramatically increased the number and quantity of available natural resources.
    III. Toxic substances released into either the sea or atmosphere will only influence areas adjacent to the toxic source.
    IV. Using building materials that are recycled is an adequate sustainable design approach.

Options
A) I
B) II
C) II, IV
D) none of the above

3. The planning phase of a sustainably designed architectural project should include which of the following elements?

I. Native landscaping that is aesthetically pleasing and functional
II. Designing structures in the floodplain that can resist the forces of flood waters.
III. Consideration of sun orientation, topographic relief, and the scale of adjacent buildings.
IV. Locating projects within existing neighborhoods that are adjacent to public transportation.

Options
A) I, II
B) I, III
C) I, III, IV
D) all of the above

4. The Ahwahnee Principles include which of the following ideas?

I. Communities with only residential use should be relegated to areas outside the central business district.
II. Preserved open spaces should be either wildlife habitats or recreational areas.
III. Transportation planning should include roads, pedestrian paths, bike paths, and mass transit systems.
IV. Job creation and economic diversity is a desired goal.

Options
A) I
B) II, III, IV
C) III, IV
D) none of the above

5. Life Cycle Costing is an economic evaluation of architectural elements that includes which of the following factors?

I. First cost
II. Maintenance and operational costs
III. Repair costs
IV. Replacement cost

Options

A) I
B) II, III, IV
C) II, IV
D) all of the above

6. LEED, the name of a program that environmentally evaluates sustainable projects, is a checklist that is concerned with which of the following which of the following?

I. Indoor Air Quality
II. Storm water
III. Innovative energy systems
IV. Aesthetic Design

Options

A) I
B) I, II, III
C) II, III
D) all of the above

7. Which of the following is a consultant that might be employed in a sustainable design project?

I. Wetlands engineer
II. Energy commissioner
III. Landscape architect
IV. Energy modeling engineer

Options

A) I
B) I, II
C) II, III, IV
D) all of the above

8. Sustainable Design may require research and education that is beyond a normal architectural project. Which of the following is part of this process?

I. Energy modeling
II. Education of the client
III. Art selection
IV. Selection of energy efficient appliances

Options
A) I, IV
B) I, II
C) I, II, IV
D) all of the above

9. Sensitivity to the nuances of site conditions is key to sustainable design. Which of the following are site conditions the architect should examine in the design process?

I. Solar Orientation
II. Decorative landscaping
III. Scale and style of adjacent structures
IV. Ground water conditions

Options
A) I, II
B) I, III, IV
C) I, III
D) all of the above

10. Sustainably designed architecture requires attention to which of the following building elements?

I. Solar shading devices
II. Urban heat island effect
III. Increased parking
IV. Fenestration and glazing

Options
A) I, II, IV
B) I, IV
C) I, II
D) all of the above

ANSWERS TO SUSTAINABLE DESIGN QUESTIONS

1. (D) all of the above. The holistic approach to sustainably designed projects encourages the design team to examine the impact of environmental, economic, mechanical, and aesthetic architectural decisions.

2. (D) none of the above.

   Choice I is not correct. The zone of the earth that supports human life (five miles into the earth's crust and 5 miles into the atmosphere) is an extremely fragile ecosystem. This biosphere that has evolved over millions of years, is dramatically affected by the growth of human activity in the last one hundred and fifty years.

   Choice II is not correct either. While innovative technologies are improving energy efficiency of some building systems, the vast majority of the built environment is energy inefficient.

   Choice III is also not correct. Toxic substances have the tendency to expand and affect large areas. For example, the air above the Great Lakes contains evidence of DDT, a toxic pesticide banned in the USA decades ago. It was discovered that DDT is captured in the jet stream bringing toxic materials from far away continents, which still use toxic pesticides.

   Choice IV is not correct. While recycling is helpful, it is just the beginning of the sustainable design process. The principles of sustainable design say that we need to have more building products that can be recycled and are biodegradable to create a more sustainable ecosystem.

3. (C) I, III, IV

   Choice I is correct. Designing with native landscaping is preferred to using exotic or imported plant types. Indigenous plants tend to survive longer, use less water, and cost less.

   Choice II is not correct. Placing any structure in a floodplain, even those that resist floodwater, is not desirable. Placing buildings in a floodplain can increase flooding further down stream.

   Choice III is also correct. Buildings sensitive to the benefits of solar orientation and passive and active solar gain techniques save energy and are more visually aligned with local climatic conditions.

Choice IV is correct as well. Infill development and proximity to a variety of transportation options are design principles that benefit the inhabitants and their environment.

4. (C) III, IV

I is not correct. Communities which are only residential are not encourages. Mixed-use development (combining housing, retail, open space and commercial) is a preferred sustainable design.

II is not correct. Open space should not be designed only for recreation and wild life habitat. Additional uses such as environmental education, storm water retention, flood control, wetlands drainage, etc. should be considered in sustainable planning.

III is correct. The Ahwahnee principles encourage a wide range of interconnected transportation to encourage many options for travel.

IV is also correct. Development which permits opportunities for a diverse number of jobs is a key goal of the Ahwahnee Principles.

5. (D) all of the above

I is correct. While first cost is not the primary concern of life cycle costing, it is one of the economic factors considered.

II is also correct. The cost of maintenance is part of the evaluation.

III is correct as well. The durability of a product or system is considered in the cost of repair and part of the overall evaluation.

IV is correct because the comparison of product or system life is one of the factors evaluated in life cycle costing.

6. (B) (I, II, III)

I is correct. LEED has several options for improving IAQ (Indoor Air Quality) including filtering the air system and installing low VOC (Volatile Organic Compound) paints and caulking.

II is also correct. Methods to store, recirculate, and locally distribute rainwater are encouraged.

III is correct as well. Innovative solutions to energy conservation such as fuel cells, photovoltaic panels, and gas turbine energy production are encouraged in the LEED accreditation system.

IV is incorrect. Unfortunately, the LEED system awards no points awards for designs with strong aesthetics.

7. (D) all of the above

All of these consultants (wetlands engineer, energy commissioner, landscape architect, and energy modeling engineer) might be necessary for the holistic approach to sustainable design. The landscape architect should have experience with local, native plant design.

8. (C) I, II, IV

I is correct. Computer programs that allow energy modeling of design options allow the architect a quick method of evaluating numerous different solutions.

II is also correct. It is extremely important that the client be able to understand the value of sustainable design solutions.

III is not correct. Art selection is at the client's discretion.

IV is correct. Locating the most energy efficient appliances, plumbing fixtures, and office equipment will improve the energy efficiency of the entire project.

9. (B) I, III, IV

I is correct. Solar orientation can affect many architectural design elements including massing, landscaping, fenestration, and building skin design.

II is not Correct. Landscape design should be functional as well as visually pleasing. Landscape design for purely visual impact is not consistent with the sustainable design approach.

III is also correct. Architectural design that understands the context (scale, color, style, texture) of adjacent structures is sympathetic to the sustainable design philosophy.

IV is correct as well. Understanding all site conditions, and their potential to assist building's energy systems is helpful. For example, ground water connected to a heat pump is a good source of supplemental energy for cooling and heating a building.

10. (A) I, II, IV

I is correct. Solar shading, whether from landscaping or architectural elements, can regulate the insulation to increase winter light and reduce warm summer sunlight.

II is also correct. Urban heat island effect is the tendency of a building roof to absorb solar radiation during the day and then emit heat radiation during the evening. Roof systems with grass or light colored roofing material reduce the urban heat island effect.

III is not correct. Sustainable design encourages approaches that reduce the area allocated to parking.

IV is correct. The type, location, and size of building fenestration are a key aspect of architectural design for sustainable projects.

PROJECT AND PRACTICE MANAGEMENT

The following sections are meant to prepare you for the expanded coverage of project and practice management topics that NCARB has added to the Construction Documents & Services division of the ARE 3.0. The table below illustrates how our current products can be used to prepare for these kinds of questions, and the following section on Delivery Methods should also be studied.

PROJECT & PRACTICE MANAGEMENT FOR CONSTRUCTION DOCUMENTS & SERVICES	
CONTENT AREAS (NCARB Description)	**BOOK AND LESSON**
PROJECT & PRACTICE MANAGEMENT	
A. Cost *Prepare estimates of probable construction cost. Consider cost implications of design decisions.*	• *Pre-Design 2*, Lesson Seven • *Site Design*, Lesson Five (Site Development Costs subsection) • *Construction Documents & Services I,* Lesson One (Cost Management subsection) • *Construction Documents & Services I,* Lesson Two (Construction Documents of Consultants/Cost Control subsection) • *Construction Documents & Services I,* Lesson Four
B. Scheduling & Coordination *Prepare and manage project schedule and coordinate all contract documents including those of consultants.*	• *Pre-Design 2,* Lesson Five • *Construction Documents & Services I,* Lesson Two .

C. Project Delivery (Including Submittals) *Establish project delivery method. Provide contract administration documentation and services.*	• *Construction Documents & Services I,* Lesson Two • *Construction Documents & Services I,* Lesson Two (Ease of Construction/Scheduling subsection) and Lesson Five (Bidding Requirements/Negotiated Contracts subsections) for "Fast-Track" delivery method. • *Construction Documents & Services 2,* all lessons.
D. Contracts and Legal Issues *Review and administer professional services and construction contracts. Consider issues pertaining to practice including risk management and professional and business ethics.*	• *Construction Documents & Services 2,* all lessons.
E. Site Planning & Design *Provide project and practice management services related to site planning and design including: cost estimating; scheduling and coordination; project delivery; and contracts and legal issues.*	• All books and lessons above. • *Pre-Design 1,* Lesson Seven • *Site Design,* Lesson Five for legal and economic factors

DELIVERY METHODS

This section was developed by Cayl S. Hollis. Cayl is an architect with 15 years of professional experience designing and managing architectural projects comprising residential, commercial, institutional and public works.

Owner Requirements

The method of delivering design and construction services is typically based upon an owner's needs and capabilities. A small organization, a small firm, or an individual that wishes to develop a project would typically require full professional design services from an architect and a traditional design-award-build delivery process. An owner who desires to participate in the design process would likely select this traditional method, ensuring that the final project meets all of the owner's criteria. The design-award-build delivery method allows for all design decisions to be made before contracting with a builder.

A large organization or firm that wishes to develop a project may have an in-house staff that has capabilities for project programming, design, engineering, facilities management, construction management or construction. Such a firm may not require the traditional design-award-build delivery method. An owner also might have certain time frame and/or cost considerations that would require other types of delivery methods. An owner who has a commitment to deliver a project for occupancy in a short time frame may not be able to take the amount of time required of the traditional design-award-build process. Such firms may require other project delivery methods, which typically consist of either the construction management or design/build methods.

Design-Award-Build Delivery Method

The design-award-build delivery method typically begins when an owner hires an architect to develop a project program and its subsequent design and construction documents. Bidding of the project to several contractors occurs after all construction documents and specifications have been completed. This allows for the establishment of the lowest reasonable cost for the project. The owner then awards a single prime construction contract to a general contractor to build the project based upon the completed design documents. The architect acts as the owner's agent, representing the owner's interests throughout the design and documentation phases. The architect's services typically include construction administration services. The architect then acts as an impartial interpreter of the construction documents during construction.

The benefits of the design-award-build delivery process include owner participation in the design of the project and well-established construction costs based upon relatively complete documents. The architect acts in the owner's best interests during design, and the architect acts as an impartial interpreter of the contract documents during construction. This process allows for clear separation of design and construction responsibilities, and allows for simplicity in project scheduling since each phase of the design and construction process is separate.

The design-award-build delivery process, however, requires an extended time period for design and documentation before final costs can be determined and construction can begin. This is a problem if an owner wishes to expedite a project. Also, pricing and constructability experience of the contractor who is to build the project is not available during the design and documentation phases of the project.

Construction Management Delivery Method

The construction management delivery method allows an owner to address constructability and cost issues during design. An owner can also address time issues by utilizing fast-track construction, in which multiple construction contracts are let for different parts of a project as soon as each part of the work is defined enough for a contractor to reasonably commit to a price. In this delivery method, the owner hires or utilizes his or her own construction manager to work with an architect to facilitate the process of design, bidding, and letting of the construction contracts. The construction manager can act as either an advisor to the owner, or as a construction contractor. The construction manager typically has substantial expertise in construction technology, constructability issues, construction scheduling, and construction costs.

A construction manager who acts as an advisor administers the design contracts and works as the owner's representative with the design team. He or she also manages the various construction contracts, but does not have any financial responsibility for the construction of the project. A construction manager may, however, handle some of the typical non-construction activities at the site, such as arranging temporary site facilities, site and construction testing engineering, building and site layout, and construction site cleaning. Some architecture firms offer construction management services, acting in an advisory role to the owner.

A construction manager who acts as a contractor assumes a vendor relationship with the owner. This person or firm will take on the financial responsibility for the construction of the project, typically utilizing a fixed-price, cost-plus, or guaranteed maximum price cost structure. The construction manager is brought onto the project before design work is complete so that he or she can help resolve constructability and cost issues.

A fixed-price structure allows the manager to establish a guaranteed cost of construction, including his or her own services, before the design is fully documented. The owner is not liable for bid-cost overruns. However, the owner does not obtain any of the savings that might occur from a positive bid climate. A cost-plus structure allows the construction manager to charge the owner the actual construction costs of the project plus a negotiated fee that is agreed to before construction begins. The actual costs are typically determined by the lowest bids received from the manager's subcontractors, plus the cost of any construction work performed by the construction manager's own forces. The guaranteed maximum price structure is a highest-probable-cost limitation for the construction of the project guaranteed by the construction manager. This price is established before design documents are completed, and anticipates the full scope of work and detailing needed to complete the project. Any cost savings from a positive bid climate go to the owner rather than the contractor. However, the contractor becomes responsible for any bid-costs over the guaranteed maximum price.

The advantage of using the construction management delivery method is the ability of the owner to determine the costs of a project before construction documents are complete. The ability to let portions of the work for bid before other portions of the design are complete allows for construction work to commence before all other project drawings are completed. This is a great advantage for an owner who has a short time frame to complete a project due to occupancy requirements or when an owner has to work with high interest rates, which can add substantially to the financing costs of a project. Another benefit of this method is the ability of the construction manager to resolve technological or constructability issues before construction begins, which helps reduce costs due to construction change orders.

The construction management delivery method, however, adds a cost for the construction manager that an owner would not have in the more common design-award-build process. The addition of a construction manager adds complexity to the design and construction team. This can be a benefit if the relationships are managed effectively, but can become problematic if these relationships are not adequately defined and handled. The use of the fast-track construction method also adds to the complexity of the project, requiring the management of multiple bidding periods and multiple prime construction contracts.

Design/Build Delivery Method

The design/build delivery method allows an owner to utilize a single entity that is responsible for both the design and construction of a project. This is the single greatest distinction between this method and both the design-award-build and the construction management methods. A design/build firm can be a single company that has its own architectural and construction staffs, or a company that has its own construction staff that hires an architect to perform design services. A development firm can hire an architect for design services and a contractor for construction services. A design/build firm can also be a joint venture between an architect, construction, and/or a developer.

An owner who wishes to proceed with the design/build process typically issues a request for proposals to selected design/build firms that state the design and performance requirements for the project. The design/build entities submit proposals to the owner that provide a design for the project and the costs for the design development and construction of the project. The selected design/build firm then develops the design, provides construction documents, and builds the project based upon the proposal requirements.

An owner who wishes to have more control over the design of the building can have an architect develop the schematic concept for the project. This can then become part of the request for proposals, which makes the selected design/build firm responsible for the development of the design, the construction documents, and the building of the project.

The advantages to the design/build delivery method include a single source of responsibility for both design and construction of the project, allowing the owner to select from a number of submitted designs. A reliable cost for the project is determined early in the process, and conflicts between the designers and the builders are minimized. This process also facilitates fast-track construction, since the portions of the design work that can be built early can be released for construction before the balance of the design and documentation work is complete.

This delivery method, however, minimizes the ability of the owner to participate in the design of the project. The design/build firm acts solely as a vendor so that the owner does not have an independent agent working for his or her interests. This requires the owner to be adept at managing the design/build contract through construction, or to hire an independent firm to act on his or her behalf. Any design changes would likely require a change order that the owner would have to pay. Since the submitted designs are likely based upon incomplete drawings, disputes may arise regarding the actual scope of work provided in the proposal. Also, a selection that is based solely on the lowest bid may have significant quality issues that would be difficult to address.

Structuring the Architectural Design Team

The architect can act as the sole provider of design services if his or her firm has experienced and qualified in-house staff that can provide the necessary engineering and other specialty services that are required on a project. However, most architects typically form alliances with other firms to provide these services.

In a typical alliance, the architect has the prime contract with the owner and then subcontracts services to other professional firms that act as the architect's consultants for a project. Consultants can include structural, mechanical, electrical, plumbing, civil, or acoustical engineers; landscape design firms; kitchen design consultants; information technology/communications firms; and soil and construction testing services firms.

Architects may also create joint ventures with other firms, creating a single project-based entity with other architecture, engineering, or construction firms that have specific areas of expertise or geographical experience. An architect would typically form a joint-venture with a construction firm as part of a design/build delivery method, and would then act as a vendor rather than as an owner's agent. Acting as a vendor would then require the architect to act on behalf of the joint-venture and its best interests rather than for the owner.

An architect may also act as one of several independent design and engineering firms hired by an owner. In this situation, an owner would typically have some level of project and construction management capabilities to handle and coordinate the different contracts.

DELIVERY METHODS QUESTIONS

1. Which delivery method involves an owner hiring someone with constructability and cost expertise to work with the architect during the design phase?

   A. Design/build
   B. Design-award-build
   C. Joint venture
   D. Construction management

2. Which of the following is not an advantage of the typical design/build delivery method?

   A. Facilitates fast-track construction
   B. Provides a reliable project cost early in the process
   C. The owner participates fully in the design process
   D. The design/build firm provides a single source of responsibility for design and construction

3. An architect acts as an owner's agent in which of the following situations?

   I. As a member of a joint venture with a construction company
   II. The design-award-build delivery method
   III. The construction management delivery method
   IV. The design/build delivery method

   A. I and III
   C. II and III
   B. II and IV
   D. I and IV

ANSWER KEY FOR DELIVERY METHODS QUESTIONS

1-D The construction management delivery method involves an owner who hires a construction manager to work with the architect to resolve constructabililty and cost issues during the design phase.

2-C The design/build entity is typically responsible for the design and construction of a project, based upon requirements established by the owner and issued in the request for proposal.

3-C An architect acts as an agent for the owner in the design-award-build and the construction management delivery methods (II and III are the correct answers). An architect acts as a vendor responsible for the cost and construction of a project in a joint venture with a contractor and in the design/build delivery method (I and IV are incorrect).