Chapter 3

Sustainability and Architecture Education

Interest in sustainable design has started to impact architecture education and practice. But there is a great need for systems thinking, interdisciplinary teaching and learning, and rigorous research. This is an important moment for the academy and the profession.

— Vivian Loftness, FAIA, University Professor, Carnegie Mellon University School of Architecture, 2005

Chapter 3 captions (clockwise)

Students on a building tour at the January 2004 Agents of Change workshop at the Burton Barr Central Library (Will Bruder) in Phoenix. Photo courtesy of Agents of Change

Visitors explore the house by the California Polytechnic State University-San Luis Obispo team at the 2005 Solar Decathlon. Photo by Stefano Paltera/Solar Decathlon

Students synthesized social, environmental, material, and economic issues in John Quale's ecoMOD course. Photo by ecoMOD

CHAPTER 3: SUSTAINABILITY AND ARCHITECTURE EDUCATION

THE NATURE OF ARCHITECTURE EDUCATION

As it is typically organized, architecture education presents significant challenges for incorporating the principles of ecological literacy.

The first challenge is simply time. Becoming a licensed architect requires a professional degree. While there are many variations on how to pursue this degree, the two most basic options entail five years at the undergraduate level or up to three and one-half years at the graduate level. The first option is often seen as the most convenient because of time, and many students choose the second option only because they decide late in college or after graduation to pursue architecture.

Many of the largest programs and most of the state universities offer the five-year path. Because the study of architecture is intensive and requires a large number of credits within the major, often there is very little opportunity to expand the curriculum to include more courses from other disciplines, even as electives. Ecological literacy's aim of a diverse interdisciplinary education becomes nearly impossible within the existing curriculum of architecture schools. But the lack of a broader liberal arts education is a long-standing criticism of architects, whose training typically is quite insular. Every architect and student can tell stories of rarely leaving the architecture building when they were in school.

The longer path might offer more time to pursue other subjects outside architecture, but this does not ensure that those subjects would be presented from an ecological perspective or that they apply well to the study of architecture. Many if not most students who obtain a four-year nonprofessional degree do so not knowing yet that they will go on to become architects later. The only completely effective solution would be to rethink not just architecture schools but all general education at every level along the lines of ecological literacy. In this way, any student in any subject would learn about the essential connections that subject has with others and with the natural world. Architecture would be just one thread.

Assuming the kind of radical overhaul of education that David Orr and others advocate will not occur in the near future, for the present architecture education can adapt on its own. One obstacle for doing so is the accreditation process. For licensure, states generally require architects to have graduated from a school accredited by the National Architectural Accrediting Board (NAAB), which is the sole agency authorized to do so in the United States. To obtain accreditation, architecture schools must conform to certain standards and guidelines outlined by the NAAB and, at the moment, these standards are not focused on environmental issues. The Association of Collegiate Schools of Architecture (ACSA), however, formed a Task Force on Sustainability that two years ago proposed ways to alter the NAAB's standards to reflect a commitment to sustainability. One of the recommendations was to add a preamble that introduces architecture education from the point of view of sustainability: "Architects in the 21st century will be expected to take a leadership role in stewardship of our global environment. To accomplish this goal, students of architecture should find, infused through their education, a philosophy that acknowledges the connected principles of ecology, social justice, and economics. This philosophy should be substantiated by the providing of future architects with the technical knowledge necessary for precise, expert and wise architectural action." While the NAAB did alter some of its criteria language in response to ACSA recommendations, the preamble has not been adopted.

Within current guidelines, NAAB-accredited degree programs often offer only one or two environmentally focused courses, and even the programs with more courses often treat the subject only in a lecture or seminar format, so it risks appearing incidental. Because of their length, undergraduate professional degree programs often have the most number of required environmental courses and introduce environmental issues earlier in the curriculum. On the other hand, at the graduate level, many students come from a different background that gives them a potentially more well-rounded view. A student with an undergraduate biology, material science, landscape, engineering, or similar degree brings a multidisciplinary perspective and academic maturity to the exploration of sustainable design, if the setting is supportive.

But relying on chance to create a diverse student body is no solution. And the importance of interdisciplinary thinking is rarely understood, much less formalized within a given curriculum (or practice). In *Metropolis* magazine's most recent annual survey of educators and practitioners (June 2005), responses to questions about subjects that "should undergo extensive design research" are telling. More than 80 percent of teachers and practitioners say sustainability is an important topic, but only 60 percent say "environmental impact" is, so a full one-fifth of respondents believe those subjects to be different. Other closely related fields, such as climate, biology, geography, systems theory, and economics, were emphasized by much smaller groups (30 to 40 percent for each). The meaning of sustainability becomes extremely doubtful when climate and environmental impact are deemed less urgent issues.

This narrow view of sustainable design is evident in the typical curriculum. While many schools of architecture are now seeing environmental courses as a necessary requirement, few if any treat sustainability as fundamental to the practice of design. Studio courses are the core of architecture education. When the environment is discussed only in "support" courses, students are likely to see it as inconsequential. Faculty who teach environmental courses are often not central to studio education, and vice versa. As a result, tenure may be difficult for them to achieve, and the school's commitment to environmental education becomes sporadic and weak.

Within the studio setting, the mentor system pairs a single instructor with up to 15 students, if not more. The teacher typically works with one student at a time to guide the development of a project, and the criteria used to judge success are often merely the individual taste of the instructor and/or the student. Personal expression rules in education and practice both, and this makes it difficult to embrace sustainable design's emphasis on logical principles and communal values. The integrated design process of working closely with all stakeholders and consulting experts at all stages of the project, including predesign, implies a model of collaboration that unfortunately is foreign to architects and students who are accustomed to working virtually alone, without significant influence from others.

This fact suggests that the essential conditions of ecological literacy and architecture education may contradict one another. According to Orr, the idea of "environmental education" is redundant because all education takes place in an environment, even if most subjects are not taught this way. Ecological literacy is about immersing the student in the world. By contrast, the architectural academy, which is still conducted in the Beaux Arts tradition, is traditionally about cultivating one's personal expression through an isolated studio experience. In other words, architecture education is about removing yourself from the world. So the two types of education arguably are governed by opposite values or conditions. Bringing them together requires either bridging the gap—not an insignificant task—or, even more difficult, completely altering architecture's pedagogical system and possibly its fundamental values. The result would be a design process

that is truly communal (rather than personal), collaborative (rather than individual), and based on rational principles (rather than subjective taste).

Restructuring architecture education to embrace ecological literacy will require these issues to be addressed within the core curriculum of the school if not the university at large. Among the Ecological Literacy in Architecture Education grant program submissions are many hints about how to go about this, even if none represents a comprehensive reorganization. To date, several models for new curricula have been proposed by others.

CURRICULAR INNOVATION FOR ENVIRONMENTAL SUSTAINABILITY

The curricular challenge for schools of architecture is significant: There should be a major transformation of education to enable architects to be the leaders of collaborative design processes with nesting scales of responsibility to ensure sustainable use of land, water, transportation, engineering, and building materials, assembly, and integrated systems, as well as building use and adaptive use.

Architecture schools have a long tradition of embracing environmental education in coursework, from lecture courses specifically required based on NAAB criteria to environmental laboratories to design studios focused on climate and cultural variations to design for passive solar heating or natural ventilation. These traditions exist at every university, fading in and out with the strength of the faculty.

Sustainability, as discussed in Chapter 2, goes far beyond energy and materials and involves land use, water, transportation, innovative engineering, landscape, and social justice. This broad array of issues and frameworks demands collaborative design processes and broad, multidisciplinary, linked thinking.

Over time, many catalysts have strengthened the environmental movement. Inspiring thinkers and authors have probed design implications of climate, land use, materials, and assembly. These include Reyner Banham, Viktor Olgyay, Ian McHarg, William Caudill, Baruch Givoni, Ed Allen, and G. Z. Brown, as well as leading educators from the passive solar movement of the 1970s—Don Prowler, Jeff Cook, Edward Mazria, and many others. Some environmentalists from the passive solar movement have become deans and department chairs, including Doug Kelbaugh, Harrison Fraker, and Vivian Loftness (see Appendix, Champions of Ecological Literacy in Architecture Education).

Research leaders from national laboratories have also been catalysts. These physicists, architects, and engineers—such as Doug Balcomb at Los Alamos and Steven Selkowitz at Lawrence Berkeley Labs, and others—focused on the challenges of passive conditioning, material detailing, and the calculation tools critical to their success.

Foundations have been catalysts, too, committed to raising awareness and hosting important gatherings and discussions. Some of the same foundations have also helped fund a new generation of buildings that demonstrate innovations in process and architecture for sustainability. These include the Tides Foundation (supporter of this report and plan), the Heinz Family Philanthropies, the Chesapeake Bay Foundation, the David and Lucile Packard Foundation, the Pew Charitable Trusts, and the Kresge Foundation.

The U.S. Green Building Council's LEED rating system has helped raise the profile of sustainable design as a part of current architecture practice and skill sets. The rating system has made it possible for many clients, architects, and allied professionals to engage in sustainable design in a way not possible before. LEED has been a part of creating university-wide awareness of sustainable design; the rating/certification system has had a role in the growing green campus movement and in shifting the focus of some faculty in many universities.

Most important, several sustainable practitioners in multiple disciplines have inspired students of architecture, authors, scientists, and foundations that propagate their works, from Buckminster Fuller, Ian McHarg, Ken Yeang, Guy Battle, and Christopher McCarthy to Glenn Murcutt, Renzo Piano, Richard Rogers, Norman Foster, Will Bruder, William McDonough, Stefan Behnisch, and many others, including some who have won AIA Top Ten Green Project awards (see Appendix).

Vehicles for Introducing Ecological Literacy in Schools of Architecture

These pages cite examples of universities, schools, departments, and individual teachers who have contributed to the growing presence of sustainable design subject matter—and in some cases ecological literacy—in architecture education. These examples are cited randomly and are not meant as a comprehensive list. In most cases, there are far too many examples to mention, which is certainly a positive condition. Inevitably, a seminal course or program may have been omitted; no significance should be concluded.

There are also several architecture schools that have long been known for their attention to issues of energy and building systems, environment, and sustainability. Some of these are mentioned below within one or more of the vehicles of architecture education. A significant number of innovative faculty is dedicated to sustainability across the country (and throughout the world), and many strong efforts are not mentioned here. This report was intended as a broad-brush background to the AIA COTE plan for the future (see Chapter 5).

Architect and sustainable design consultant Sandra Lebowitz Earley has undertaken a more comprehensive cataloging and analysis of sustainable design education. Her book, due out fall 2006, offers a recent historical survey and timeline, a full list of programs in the United States and Canada, and a comparison of curriculum efforts. It is also important to consider education efforts going on outside the architecture schools, especially those that are likely to affect architects in practice, such as real estate, construction management, urban design, landscape architecture, industrial and interior design, and other allied programs. The catalytic gains from these programs and leading sustainability faculty around the nation cannot be overstated.

The Studio

Studio-based education, with iterative design processes involving an ever-increasing number of critics, is an essential vehicle for environmental education and practice. Studios that focus on specific materials and their assembly (wood studios, masonry studios, and tensile studios) offer great opportunity to teach environmental detailing and aesthetic exploration centered on the craft of building. Some studios are designed to challenge students to design for comparative climates and are framed to erase the line between architecture and landscape; others directly explore passive solar design and natural ventilation as form givers and detail generators. Indeed, studios framed by sustainable design issues are no longer rare in part because they are usually inspired by a single faculty member whose own interests can guide the content. (By the same token, the autonomy of that arrangement usually means that sustainability-driven studios are still very much in the minority at most institutions.) Many of the submittals to the grant program associated with this report were descriptions of "green" studios.

Perhaps the biggest challenge of ecological literacy to the studio system is the need to teach design as a participatory and collaborative process. Neighborhood revitalization is critical to sustainability but can only be effective with inclusive, participatory processes, the type taught by David Lewis leading the Urban Lab at Carnegie Mellon University and formerly Yale, by Troy West at New Jersey Institute of Technology, Stroud Watson at the University of Tennessee, and many others. At the same time, other studios need to tackle the collaborative design and engineering processes that ensure systems integration for sustainability in complex buildings from hospitals to courthouses—with all disciplines involved from the early design stages. These innovative design processes are beginning to emerge in practice and need to be embraced in architecture education. The studio time to build neighborhood participation and the faculty cost of multidisciplinary expertise needs to be acknowledged by leaders of schools of architecture (and university leadership in general), with the realization that these skills and a focus on sustainability will position graduates as leading professionals.

History and Theory

A mostly untapped opportunity exists to explore sustainability in both history and theory classes. A few history classes use sustainability as the lens. At Parsons School of Design, Jean Gardner has woven sustainable design issues into her history courses (see Chapter 4). At Carnegie Mellon, Christine Mondor and Charle Rosenblum teach a History of Sustainable Architecture course that investigates approaches to building in nature that precede, critique, or supply the ideals of the Industrial Revolution (before which the natural environment was the only basis for building). This class sets out to formulate a history of sustainable architecture. Ethics courses, which exist at only a few schools and are rarely required, often address issues of ecology and equity; these represent another way of thinking about the breadth of sustainability to which most architecture students are not exposed.

Indeed, the major debate in the environmental design community about the definition of sustainability should be played out by historians and theorists in schools of architecture in dialogue with environmentally focused faculty and practicing architects. How can we capture the critical aspects of culture, climate, and place to sustainability? How can we capture the element of time and the engagement of people, or ensure the form-generating and system innovations so critical to the environment, or engage learning from nature in the design process itself? Can any of these things be measured in a rating system? The opportunity to expand the definition of design theory beyond artistic and literary theory is a frontier for architectural historians.

Laboratories

Environmental laboratories that offer the chance to test ideas are a very effective tool for architecture education. Daylighting labs, integrated systems labs, and materials labs have the potential to significantly advance sustainable design. University learning labs that enable students and professionals to test innovative technologies across the system types—enclosure, mechanical, lighting, networking, interior systems—are equally important to moving commercial and residential building solutions beyond conventional into the truly sustainable. From the earliest days of the General Electric lighting lab to present-day daylighting labs, hands-on learning about light is unparalleled and long lasting.

Building on the success of the laboratory tools developed by G. Z. Brown at the University of Oregon, the Northwest Energy Alliance has supported the development of multiple daylighting testing laboratories. Students and professionals learn to explore design alternatives in scale models, evaluate the comparative impacts, and detail materials and assemblies, with linked simulation tools and graphic evaluation techniques. The lessons learned become intuitive for the

design professionals, central to their design process, returning to the labs to address climate and building type variations on the best way to daylight, passively solar heat, and naturally ventilate buildings.

The School of Architecture at Carnegie Mellon University (CMU) has taken the position that future architects should be accountable for the measurable performance of the buildings they design. This accountability demands that architecture education must provide hands-on knowledge about thermal, air quality, visual, acoustic, and spatial performance, as well as long-term building integrity in a fully integrated, occupied setting. With support from a consortium of building industries, federal agencies, the university, and a major alumni donor, CMU built the 7,000-square-foot Robert L. Preger Intelligent Workplace (IW) to demonstrate innovations in each building subsystem—from structure, enclosure, heating, ventilation and air conditioning, and lighting to interior systems and telecommunications innovations that support the changing nature of work. The IW demonstrates a wide range of innovations in materials, components, and assemblies for environmental quality and conservation, as well as their relationship to the individual worker.

These are just two examples of successful environmental learning labs. Many others exist, from the thermal testing labs at the University of California-Berkeley, materials and lighting labs at the University of Michigan, and John Yellott's solar testing lab at Arizona State University to solar test beds at Massachusetts Institute of Technology.

Research Centers

Closely related to laboratories (one often includes the other, though the missions and strategies are distinct), are centers for environmental research. A few of these are on university campuses and elsewhere (often nonprofit associations off campus) that interface with students in various capacities.

The first National Science Foundation (NSF) Industry/University Cooperative Research Center (IUCRC) was the Center for Building Performance and Diagnostics at Carnegie Mellon. Led by Volker Hartkopf, the center explores innovations in the integration of advanced building systems for individual health and productivity, organizational and technological flexibility, and environmental sustainability. CMU's master of science degree in sustainable design is now in its third year (complementing master and PhD programs in building performance and diagnostics).

At the University of California-Berkeley, the Center for Built Environment (the second NSF IUCRC) explores new building design strategies and technologies and indoor environmental quality under the direction of Edward Arens and Gail Brager. Recently the team has been analyzing whether building occupants are more productive and satisfied in green buildings than conventional ones using survey results from 20 buildings.

At the University of Minnesota, John Carmody directs the Center for Sustainable Building Research, conducting building research on sustainable design, energy efficiency, innovative building components and building design processes, as well as research on postoccupancy evaluation and human responses to buildings. Carmody and his colleagues are currently launching a master of science in architecture sustainable design track this fall.

Pliny Fisk III and Gail Vittori are codirectors of the Center for Maximum Potential Building Systems, more commonly known as MaxPot, which Fisk founded while he was on faculty at the University of Texas-Austin's School of Architecture and Planning. The center uses "life cycle design to foster ecological balance … and engages in interdisciplinary collaborations with a

common vision of healthful environments, economic prosperity, and social equity," according to its Web site. The mission was to focus on relationships between natural and built environments with an emphasis on local economic development and the sustainable community. Fisk recently joined the College of Architecture faculty at Texas A&M University as a visiting professor (in addition to University of Texas-Austin, he has also taught at Ball State University, the University of New Mexico, the University of Oklahoma, and Mississippi State University). Fisk and MaxPot led the University of Texas-Austin 2002 entry in the Solar Decathlon.

Design-Build

Design-build and community outreach projects are also critical to sustainability education. As with testing labs, hands-on learning is among the most powerful teaching tools and provides the most durable lessons—but sustainability must be central for the long-term success of the project. Every generation of students begs for the opportunity to undertake a design-build effort, yet the time commitment, the cost, and the liability make this curricular alternative difficult. The success of some of the best-known examples, such as Auburn University's Rural Studio, illustrates the importance of these efforts and their focus on equity as a key factor in sustainability. The Solar Decathlon has also prompted many schools of architecture to team with other departments and pursue multiyear design-build projects.

The Auburn University Rural Studio, founded in 1993 by D. K. Ruth and the late Samuel Mockbee, FAIA, and now led by Bruce Lindsey and Andrew Freear, was conceived as a way to improve the living conditions in rural Alabama and provide a meaningful hands-on experience in an architecture pedagogy. This "context-based learning" takes the students out of the classroom and into some of the poorest counties in the nation, where they build what they design as a way to learn for themselves the cultural, social, and technological aspects of designing and building. The studio has been highly successful and widely published, which attracted outside funding and ensured its continued survival. It also has helped attract students to the program and has had an impact on the community it serves.

Yale School of Architecture has run a First Year Building Project since 1966 when Charles W. Moore headed the school. The projects are designated for disadvantaged communities, partnering with Neighborhood Housing Services, a New Haven-based nonprofit developer. After a juried competition among the students, student-led working drawings, bidding, and then summer construction (with a team of 10 and two high school students), new or renovated homes are made available at affordable rates to first-time buyers. Studio 804, run by the University of Kansas School of Architecture and Urban Design's Dan Rockhill (and submitted to the grant program associated with this report), is a design-build studio for third-year graduate students with a goal of providing affordable housing in Lawrence, Kans., and surrounding communities. Rockhill's students have designed, built, and sold several houses receiving national recognition. With growing interest in sustainability among students and faculty, these design-build projects are increasingly incorporating environmental innovations from straw bale to green roofs to high-performance enclosures and mechanical systems.

Community Connections

Also important to environmental education are the tools for participatory design with communities and building occupants. These inform place-responsive programming and design and engage communities in cherishing and owning the results. The AIA has long realized the importance of community and participator design for professionals, establishing Regional/Urban Design Assistance Teams (R/UDATs) in 1967 as a multidisciplinary, grassroots approach to community development. More recently, Sustainable Design Assistance Teams (SDATs) bring

multidisciplinary, participatory design teams to communities to create sustainable visions for communities and their ecosystems.

Yet few schools introduce participatory and/or multidisciplinary early design decision-making in the studio setting. Do we still believe in the design genius working in isolation? Certainly, as we work around the world, often clueless to the particulars of climate, culture, or place, participatory design processes will continue to become increasingly critical to effective practice. Moreover, the participatory process may be equally central to ensuring the commitment of the larger community to sustainable goals and to engaging the citizenry in a powerful educational experience.

One leader in participatory design, Henry Sanoff of North Carolina State University, has written numerous books and developed many interactive games and tools that have helped to transform the way professionals work with communities and given clarity and method to participatory courses in several schools of architecture.

One of the oldest participatory community design studios in a school of architecture was developed by David Lewis and Ray Gindroz at Yale University. These Urban Lab studios engaged students in learning "in the streets" gathering insights and visions to inspire neighborhood interventions that might heal communities in distress. (The Urban Lab studios were brought to Carnegie Mellon University when Lewis and Gindroz established their practice, Urban Design Associates, in Pittsburgh in 1964.)

At the University of Arkansas School of Architecture, Stephen Luoni teaches an elective fifth-year studio through the Community Design Center, which is engaged in developing new design methodologies applicable to community development issues in Arkansas, with currency at the national level. According to Luoni, the program "introduces a multiple bottom line, integrating social and environmental measures into economic development. Integrative design solutions add long-term value and offer collateral benefits related to sustained economic capacity, enhanced ecologies, and improved public health—the foundations of creative development." The center works with other groups such as the Center for Business and Economic Research, the Delta Research and Design Center, and the Arkansas Forestry Commission.

The Pratt Institute Center for Community and Environmental Development brings professional planning, architecture, and public policy skills to support community based organizations' efforts to improve neighborhoods and address social and environmental justice issues. Participatory engagement with community residents is a central theme of nearly every project. Sustainable development is the key goal that has driven this advocacy center for more than four decades.

Postoccupancy Evaluation: Learning in Existing Buildings

Postoccupancy evaluation (POE) is critical to ensuring that field performance is iteratively advanced, especially in the face of increasing complexity in buildings and rapidly emerging materials and technologies. POE is key to performance-based programming and to improving systems integration and design detailing for sustainability. Sustainability is based on the life cycles of materials and integrated systems and their adaptation to support the changing needs of occupants over time. Yet there is remarkably little comprehensive POE undertaken by professionals or students of architecture.

One major exception is the Vital Signs curriculum initiated by Charles Benton at Georgia Institute of Technology and then University of California-Berkeley, which evolved into the Agents of Change curriculum supported by Oregon for engaging students in the exploration of the

performance of occupied buildings.

The Green Campus Movement

The green campus movement has grown significantly in the last decade. The Center for Energy Research, Education, and Service (CERES) at Ball State University is an interdisciplinary academic support unit focused on issues related to energy and resource use, alternatives, and conservation. The center hosts a Green Campus Conference every other year at which an increasing number of institutions participate. Its fifth conference was last fall (September 2005). The Society for College and University Planning hosted its third annual Campus Sustainability Day in October 2005, Anthony Cortese was the keynote speaker.

The green campus movement at some universities, such as Harvard, involves some architecture and landscape architecture faculty (Ken Kao and Niall Kirkwood, respectively), but is driven largely by other schools, such as the School for Public Health. After Carnegie Mellon University, Harvard University is the second largest purchaser of renewable energy among universities in the United States. The university's Green Campus Loan Fund offers interest-free loans for onsite renewable projects, such as a recent PV installation at the Harvard Business School. Tufts University pledged in 1999 to meet or beat Kyoto Protocol levels and, in 2003, the president pledged to cut emissions further. At Berea College, ambitious plans to reduce energy consumption by 45 percent by 2015 involve building retrofits and the creation of "ecovillage" housing.

Though not all of the green campus leaders have schools of architecture, the design learning side of green campus activities is poised to expand as the movement matures past recycling efforts, stormwater issues, and energy and emissions targets to include indoor air quality targets and retrofits of existing buildings. Many of the campuses that have architecture programs are already bringing those activities directly into the classroom.

Certificates and Other Programs

There are also schools outside traditional universities, most of them lacking accreditation, but some offering a host of known experts and intensive coursework for young students or post-professional study. The Ecosa Institute is one example. The nonprofit offered its first immersion program in fall 2000. In many ways, what students get in one semester is a more holistic understanding of sustainability than they could presently get at any traditional design school. Founder Antony Brown, who worked with Paolo Soleri for years, says the vision behind the institute "is based on synthesizing the ethical and ecological values critical to the health of the environment, with the vitality and dynamism of the design arts." He contends that if designs are to be based on nature's complexities, it is absurd to educate designers in a compartmentalized, linear setting. Ecosa now offers spring and fall semester programs and several summer workshops. Brown hopes to evolve the program into a four-year design curriculum. The San Francisco Institute of Architecture is a second certificate program dedicated to green building, ecological design, and nature-based architecture.

Some schools of architecture are offering sustainable design certificate programs, such as the one at the Boston Architectural Center's (BAC) Continuing Education program. The BAC's program was developed with BuildingGreen Inc. (publishers of *Environmental Building News*) and is available online with courses managed through the BAC's courseware platform, Blackboard. The course requires Sustainable Design as a Way of Thinking, four Green Practice courses (site design, energy and air quality, interiors and materials selection, and whole building design and LEED), plus one sustainable design elective.

Such certificates strengthen professional understanding of environmental design but may not be able to ensure a full understanding of ecology, systems thinking, resource innovation, and regional frameworks that require the multiyear, multidisciplinary explorations.

Catalysts for Curricular Innovation

Over time, several federally supported efforts have catalyzed changes in architecture education with a focus on the environment. Three of them are highlighted here: Teaching Passive Design, and the Solar Decathlon, and Vital Signs and Agents of Change.

Teaching Passive Design

In 1981, the U.S. Department of Energy funded faculty at 12 schools of architecture[1] to develop innovative course modules; the volumes became Teaching Passive Design in Architecture. Led by Harrison Fraker and Don Prowler at the University of Pennsylvania, the course modules supported an important shift in architecture education to embrace passive solar design and other environmentally based theories and practices. University course modules were developed for a wide range of environmental subjects, from environmental postoccupancy evaluation (the seeds for Vital Signs), climate, and energy graphics to daylighting tools and graphic exercises and passive cooling techniques. The Association of Collegiate Schools of Architecture sent this documentation to faculty and libraries at every U.S. school of architecture.

The volumes documenting this framework were honored in 1983 with a research award from *Progressive Architecture*. Thomas Fisher, who was an editor then (he is now dean at the University of Minnesota's College of Architecture and Landscape Architecture), recalls the project as intellectually and graphically impressive: "It represented the first major attempt to integrate passive solar energy strategies into architecture education, and it stood as a model of cooperation among several schools of architecture to develop a joint curriculum. The submission had terrific graphics and a good sense of design in terms of how it talked about architecture, sending the message that *passive solar* and *good design* were compatible, something that many architects did not believe in at the time."

The Solar Decathlon: Student Demonstration Projects

The Solar Decathlon brings college and university teams from the United States, Canada, and beyond to compete to design and build houses that "demonstrate the advantages of a solar lifestyle." This massive undertaking, sponsored by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy in partnership with its National Renewable Energy Laboratory, the AIA, the National Association of Home Builders, BP, and the DIY Network, brought 14 universities to the National Mall in Washington, D.C., in 2002, and 18 in 2005.

The teams must transport their houses to Washington and then finish them to compete with their neighbors arrayed in a "solar village" on the Mall. There are 10 measures against which they are judged, including design quality, livability and comfort, as well as energy performance for space heating and cooling, hot water, lights, and appliances. The houses must be able to function completely off the electrical grid, relying on solar electric, solar thermal, and passive energies for all systems.

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[1] University of California-Los Angeles, Carnegie Mellon University, Georgia Institute of Technology, Kent State University, Massachusetts Institute of Technology, New Jersey Institute of Technology, North Carolina State University, University of Oregon, Rensselaer Polytechnic Institute, Rice University, University of Pennsylvania, and Yale University

John Quale of the University of Virginia was the faculty adviser to a team in 2002. The team won the design and livability contest with a simple plan, copper and wood cladding, rooftop photovoltaics, and an elegant, well-detailed interior. But his group had to raise about $300,000 to create this 800-square-foot gem, which made him think twice about embarking on this project a second time (instead he started ecoMOD, a studio dedicated toward affordable housing; see Chapter 4).

The solar neighborhood was dismantled after two weeks, which is a factor that bothers some educators. One of last year's teams wanted to compete but didn't like the tear-it-down-at-the-end idea and teamed with Habitat for Humanity so that the house could be rebuilt and put into use after its time on the Mall. Another will rebuild the Decathlon house as an environmental study center on campus.

One thing the program advances effectively is interdisciplinary participation—the nature of the program is such that participation from multiple schools and departments within a university is the usual result. In most cases, at least three or more schools participate, usually with engineers or architects in the lead. Some programs have found ways to engage business students, nursing students, industrial and interior design, and journalism students as well.

Architect Edward Mazria, author of *The Passive Solar House*, was a member of the design jury for the 2002 Solar Decathlon. He told *Metropolis* he found the decathlon successful and disappointing: "Successful in that the students who participated came away with a deep understanding of how to create an architecture for today's world. Disappointing because only about half of the participants were from architecture schools. The architecture community, both schools and professionals, do not yet realize the pivotal role the profession must play in addressing pressing global issues." In 2005 there was some progress in that respect: two-thirds of the 18 teams were led by architecture schools.

The Solar Decathlon has proven to be an excellent venue for universities to undertake sustainable design-build projects with innovative goals and bring national attention to renewable energy and design to the National Mall in Washington. However, the resources for these projects are left to each university; students and faculty must spend a tremendous amount of time raising funds. For those few dozen faculty members across the 120 schools of architecture who have taken on the challenges of designing, engineering, and building with students, as well as fund-raising, external partner-building, and handling liabilities, there really should be some greater and longer-term support available. Some professors and departments avoid the competition because of the incredible demands on teacher and student time, a large portion of which is spent on fund-raising and material procurement.

2005 Solar Decathlon Participants

- California Polytechnic State University-San Luis Obispo (architecture and engineering students; faculty adviser, Rob Peña), *www.solardecathlon.calpoly.edu/*
- Canadian Solar Decathlon: Concordia University and Université de Montréal (engineering, architecture, industrial design, and communications students; faculty adviser, Andreas K. Athienitis), *www.canadiansolar.org/*
- Cornell University (architecture, engineering, business, and graphics/communications students; faculty adviser, Zellman Warhaft), *http://cusd.cornell.edu/*
- Crowder College (art, computer science, and other students; faculty adviser, Art D. Boyt), *www.crowder.edu/solar/2005/*

- Florida International University (architecture, engineering, construction management, and computer science students; faculty adviser, Yong X. Tao), *http://htd.fiu.edu/fiusolar/the_team.html*
- New York Institute of Technology (architecture, engineering, interior design, and communications students; faculty adviser, Michele Bertomen), *http://iris.nyit.edu/solardecathlon/*
- Pittsburgh Synergy: Carnegie Mellon University, University of Pittsburgh, and the Art Institute of Pittsburgh (architecture, engineering, interior design, industrial design, and communications students; faculty adviser, Stephen Lee), *www.arc.cmu.edu/sd/index.html*
- Rhode Island School of Design (architecture, textile design, and other students; faculty adviser, Jonathan R. Knowles) *www.eere.energy.gov/solar_decathlon/team_rhode_island.html*
- Universidad Politécnica de Madrid (architecture students with the Institute of Solar Energy and the Center for Integral Domotics; faculty adviser, Estefania Caamano Martin), *www.solardecathlon.upm.es/*
- Universidad de Puerto Rico (architecture, business administration, and engineering students; faculty adviser, Gerson Beauchamp), *http://solar.uprm.edu/*
- University of Colorado-Denver and Boulder (architecture and engineering students; faculty adviser, Julee Herdt), *http://solar.colorado.edu/*
- University of Maryland (engineering, architecture, business, landscape architecture, art, and journalism students; faculty adviser, Kaye Brubaker), *http://solarhouse.umd.edu/page.php?id=65*
- University of Massachusetts-Dartmouth (engineering, arts and sciences, nursing, visual and performing arts, and business students; faculty adviser, Gerald Lemay), *www.umassd.edu/solar/*
- University of Michigan (architecture, urban planning, engineering, art, natural resources and environment, business, and film/video students; faculty adviser, Jonas Hauptman), *www.umich.edu/~miso/*
- University of Missouri-Rolla and Rolla Technical Institute (faculty adviser, Jeff Birt), *http://solarhouse.umr.edu/*
- University of Texas at Austin (architecture, engineering students; faculty adviser, Michael Garrison), *www.ar.utexas.edu/utsolard/*
- Viirginia Polytechnic Institute and State University (architecture, engineering, and industrial design students; faculty adviser, Robert P. Schubert), *http://vtsolar.arch.vt.edu/*
- Washington State University (architecture, engineering, interior design, and construction management students; faculty adviser, Matthew Taylor), *www.arch.wsu.edu/solardec/index.html*

Vital Signs and Agents of Change

Professor Charles Benton of the University of California-Berkeley was the project investigator for the Vital Signs Curriculum Project (1992–1998). The effort was funded by the Energy Foundation, Pacific Gas & Electric, and the National Science Foundation and run from the Center for Environmental Design Research. The idea for the project developed many years earlier at a Society of Building Science Educators (SBSE) retreat to discuss case studies in architecture education. The Vital Signs Project reframed architecture as a science and provided a process to investigate real buildings to see their physical performance through a hands-on program that promotes the value of measurement and postoccupancy evaluation to inform design.

The project encourages architecture students to examine architectural, lighting, and mechanical systems in existing buildings with attention to energy use, occupant well-being, and architectural

space-making. The organizers developed measurement techniques designed to reveal operational patterns in contemporary buildings. The project developed and implemented several resources for faculty: resource packages on specific topics, training sessions, tool kits (worth $25,000) that were loaned to schools, case study templates, national case study juried competitions, and case study incentive grants for faculty. The project offered protocols in each of the resource packages; these describe how to make real-time observations and take short- and long-term measurements using equipment in the tool kits.

The Agents of Change (AoC) Project, headed by Associate Professor Alison Kwok of the University of Oregon (formerly principal graduate assistant for the Vital Signs project), secured two grants from the U.S. Department of Education Fund for the Improvement of Postsecondary Education (FIPSE). The first awarded in 2000, to evaluate Vital Signs and to test the AoC training model and the second (2002–2005), to disseminate the AoC training model that incorporates the Vital Signs methodology and postoccupancy evaluation in architectural curricula, prepares current and future faculty (students interested in teaching) to teach in schools and in practice. This project has been coordinated by Kwok and supported by the efforts of graduate teaching fellows and SBSE members as faculty trainers and advisers.

AoC builds on the Vital Signs project but brings in teams of faculty and teaching assistants for training workshops, where they learn to use data acquisition systems and handheld equipment; conduct a mini, field-based case study of a notable building; practice learned teaching skills through teaching peers; develop case-study exercises tailored for use at their home institution; and learn to train future teaching assistants (TAs). Faculty and teaching assistant trainees are expected to incorporate the case study methodology in their coursework, participate in project evaluations, revise and share teaching exercises, submit course syllabi, evaluate case studies, and train other TAs and faculty.

Ben Spencer, a graduate student at the University of Virginia and a participant at the Agents of Change workshop in Phoenix, characterizes the AoC experience:

> The Agents of Change conference in Phoenix was an informative and rewarding experience. It allowed me to translate the impressions I had of the Phoenix Public Library, based mostly on photographs, into an understanding of its spatial qualities and the way energy flows through the building. It helped substantiate my belief that on site, hands-on architectural analysis should be an integral part of architecture education and should complement more the abstract analysis of plan, section and diagram. . . . working with a team, rooming with people from other institutions and group discussions involving everyone at the conference allowed me to establish connections with people who have interests similar to mine. Universities can be insular places. The more we branch out and communicate with one another, the more progress we will make in transforming the environmental ethics of architecture.

During the past five years the project has held seven training sessions at notable buildings, trained more than 100 faculty and 140 TAs, ran 15 Tool Days with SBSE (one–day, intensive training sessions for practitioners), made more than 50 tool kit loans to faculty, and developed hundreds of case studies.

The success of the project is based on peer-to-peer learning. “We always considered that the graduate students were important ambassadors for this approach,” Kwok says. “There’s an important ‘passing-of-the-baton’ to this curricular innovation that we think will give it longevity.”

She notes that although not all the graduate students who receive this training actually teach, she hopes many will. If not teaching in academia, many of these graduate students/AoC alumni are transferring the knowledge in practice.

The FIPSE grant expired in 2005 but Kwok believes another chapter is possible. “We’re looking for ways to make closer links with the professionals and the firms,” she says. “We are seeking funding to continue our tool-lending and training programs, but foresee how AoC could also have application in firms.” She is also considering the continuing education angle, considering retreat sessions where architects and other design professionals could be trained to train their office colleagues (and earn continuing education credits).

Organizational Catalysts

Society of Building Science Educators

In 1983, University of Oregon Professor G. Z. Brown and University of California-Berkeley Professor Edward Arens hatched the idea for the Society of Building Science Educators (SBSE) in response to the need for professional exchange of ideas, materials, and resources on the integration of environmental technology and design. The first SBSE meeting was held at a daylighting conference at the University of New Mexico's School of Architecture in September 1983. After its incorporation as a nonprofit organization, the SBSE’s first curriculum development retreat was held at the Heceta Head Light Keeper’s House in Oregon in 1986.

The SBSE serves five basic purposes: represent the subject areas of architectural technology, building sciences, and design integration to its members and outside interests; offer a network for exchange of information; promote research and pedagogical excellence and scholarship; act as a support network for members; and promote the institutional needs of technical education within professional curricula in architecture. The organization operates a listserv, distributes a quarterly newsletter, runs a peer review service for promotion and tenure cases, and organizes mentoring and scholarship opportunities for students interested in teaching. Curriculum resources include digital slide library on CDs, sun angle calculators, and links to course offerings. Annual business meetings are held in conjunction with the American Solar Energy Society Solar conference, as well as the annual curriculum development retreat held during the summer. Most recently, the 2005 retreat, Greener Foundations: Environmental Technology and the Beginning Design Student, was held at the Savannah College of Art and Design with more than 40 participants in attendance. (See Appendix for a report from the 2005 SBSE Retreat.)

The Leading Edge Design Competition

The Leading Edge Student Design Competition is administered by the New Buildings Institute and sponsored by a consortium of California utility organizations and the Building America Program. The international competition has for 12 years offered students the learning experiences needed to consider the environmental impacts of design decisions, to explore the use of new materials and strategies for building, and to explore the integration of aesthetics and technology for high-performing, cutting-edge architecture.

The competition objectives are to encourage and reward excellence in architectural planning and design that integrates environmentally responsive design strategies. Competition participants are encouraged to incorporate principles of sustainability in building material choices, building design, and siting; investigate new building materials that contribute to sustainable or energy-efficient building design; explore energy efficiency as a basic premise of building design; understand the impact of siting, solar orientation, wind orientation, building massing, construction methods, and material choices on building function and energy use; develop an awareness of appropriate technology for particular building type, regional climate, and site

location; explore computer modeling methods for predicting and evaluating the impact of design decisions on building performance; and explore the full integration of sophisticated design strategies and environmental design thinking in building.

Organizations for Curricular Innovation

Association of Collegiate Schools of Architecture

The Association of Collegiate Schools of Architecture (ACSA) is a nonprofit association dedicated to advancing the quality of architecture education; 250 schools are members, representing some 4,000 architecture faculty. Activities include conferences, workshops, publications (including the *Journal of Architectural Education*), awards, and competitions, as well as general support for architecture research and collaborations with allied organizations. Several ACSA competitions have been dedicated to design for the environment, encouraging faculty and students to explore the technological, ecological, and sociological challenges of sustainability in outstanding design.

From 2000 to 2003, ACSA ran a Task Force on Sustainability, chaired by Kim Tanzer of the University of Florida, then cochaired by Jean Gardner of Parsons School of Design/The New School. ACSA's 2003 Teachers' Seminar Conference was devoted to sustainability. The meeting was chaired by Tanzer, Gardner, and John McRae, then with RTKL (now dean of the College of Architecture and Design at the University of Tennessee), and Jean Gardner of Parsons School of Design/The New School. The conference included a sustainable design evaluation of some Cranbrook buildings using the Whole Building Matrix, a teaching/learning method Gardner developed.

One of the goals was to bring sustainability language into the National Architectural Accrediting Board (NAAB) criteria. "We formulated a strategy to include sustainability among the NAAB criteria and proposed some language," Tanzer says. The task force suggestions included several edits to the existing criteria, and a new preamble:

> Architects in the 21st century will be expected to take a leadership role in stewardship of our global environment. To accomplish this goal, students of architecture should find, infused through their education, a philosophy that acknowledges the connected principles of ecology, social justice, and economies. This philosophy should be substantiated by providing the future architects with the technical knowledge necessary for precise, expert and wide architectural action.

The NAAB elected not to include this preamble but did make some of the changes suggested by the task force. "Our proposal was morphed during the process of updating the criteria, as we expected it would," Tanzer says. "Overall, we were pleased to see that sustainability is explicitly written into the most comprehensive design criteria and also has a stand-alone criterion." Those portions of the student criteria:

> 15. Sustainable Design. Understanding of the principles of sustainability in making architecture and urban design decisions that conserve natural and built resources, including culturally important buildings and sites, and in the creation of healthful buildings and communities.[2]

[2] NAAB Conditions for Accreditation, 2004, p. 14.

> 28. Comprehensive Design. Ability to produce a comprehensive architectural project based on a building program and site that includes development of programmed spaces demonstrating an understanding of structural and environmental systems, building envelope systems, life-safety provisions, wall sections and building assemblies and the principles of sustainability.[3]

While the revised NAAB criteria seem to represent a commitment to sustainability, a definition of that term is not included (the task force itself generally relied on a broad definition derived from the Brundtland report). Furthermore, the impact of specific criteria (and the wordsmithing of same) on educators and classroom coursework is far less clear.

The American Institute of Architects and the American Institute of Architecture Students

There are efforts under way at the American Institute of Architects (AIA) that engage educators and seek to make connections between educators and practitioners, as well as to focus the profession and the academy on research efforts that would be beneficial to both. Some of these efforts would be natural partners for future educational innovation for ecological literacy.

The Educator/Practitioner Network (EPN) is a knowledge community at the AIA. It is a facilitation organization for educators who are interested in practice and practitioners who are interested in education. The EPN supports the emerging Case Study Initiative as a way to promote collaboration between educators and practitioners. The EPN runs the AIA Education Honor Awards, presents programs about educator/practitioner collaborations, and publishes a newsletter (that goes to all faculty who teach practice-related topics in U.S. architecture schools). According to David Hinson, 2005 EPN chair, sustainability has not been a focus because they focus more on collaboration models rather than subject areas, though it has shown up in the Educational Honor Awards program. Several award recipients have been leaders in this area.

The Case Study Initiative is a project of the AIA's Large Firm Roundtable and the EPN, and it has functioned in a task force capacity since 2001. Practitioners for large, mid-size, and small firms as well as representatives from schools of architecture have developed a framework for the case study in architecture. The goal is an online database of case studies that analyze and document projects in the context of professional practice. The case studies can originate in firms or schools but would involve input from both. A series of open meetings considered the case study as a tool for scholarship, research, and academic advancement. The AIA Web site describes the effort's aims:

> It is intended that a broad collection of case studies will begin to alter the understanding we have of practice while assisting the most recent graduate to gain insight. The case study format is intended to structure a body of knowledge that is easily accessible, including stories of practice from various perspectives, measures of success, analysis of lessons learned, and a learning plan for students and others. This information will be available to students, educators, interns, practicing architects, and the public, in an attempt to better inform all of these constituencies.

The 2004 ACSA Teachers' Seminar was dedicated to the consideration of case studies in architecture as an important tool in education and in practice. It was chaired by Marvin Malecha, FAIA, dean of the College of Design at North Carolina State University; Laura Lee, FAIA, head of the Architecture Department at Carnegie Mellon University; and Richard Green, FAIA, of Stubbins Associates (and the University of Hawaii). The conference involved discussion of

[3] NAAB Conditions for Accreditation, 2004, p. 15.

research methods, the importance of postoccupancy evaluations (with a presentation of 35 years of postoccupancy evaluations from Henry Sanoff of North Carolina State University), and a review of the case study starter kit, the materials provided to those who want to create case studies and submit them for review and possible inclusion in the AIA collection.

At present, seven case studies are available online and another batch is under review. The framework does not as yet include sustainable design criteria, though there is room for some reference to these issues at the discretion of the field team. The organization and detail of the case study format seems highly appropriate for the inclusion of sustainable design goals, methods, and outcomes. For example, postoccupancy evaluation, a tool critical to sustainable design, is only mentioned briefly. An opportunity may arise to work with this group to augment the case studies in a meaningful way.

The EPIC Project is an AIA project (organized by Continuing Education Systems and Stakeholder Relations) established to link educational institutions to commercial/industry organizations (mostly product manufacturers) and practice groups (such as local AIA components and individual firms). (Partners include ACSA, NAAB, and the American Institute of Architecture Students.) At present, there is no sustainability focus to this effort but it is an interesting database of potential partners, and those looking to partner on sustainability-driven projects could tap into this.

The American Institute of Architecture Students (AIAS) is a nonprofit, student-run organization with some 6,200 members and 132 chapters. One major event of the AIAS is its annual Forum conference, bringing 500–1,000 students together each year. Forum 2001, Going Beyond Green, was held in Pittsburgh (hosted by the Carnegie Mellon University chapter), and focused on sustainable design with keynote speakers, including Kenneth Yeang, James Wines, Pliny Fisk III, Eric Owen Moss, and Will Bruder. While the AIAS has not devoted conferences to this subject since then, there are potentially productive links to be made with this group that would further the goal to increase ecological literacy in architecture education. Indeed, students may be the most active catalysts for enriching university education to embrace the richness of ecological literacy because they have already begun to discover the wealth of multidisciplinary expertise available on campus and the urgency of the global environmental challenge.

A SURVEY OF ARCHITECTURE SCHOOLS' WEB SITES

The Web sites of the 115 accredited (and candidate) architecture schools in the United States were surveyed. The following were identified for each program: type of curriculum information available online; amount of curriculum information related to ecological literacy and sustainability; and key courses, programs, and faculty focusing on ecological literacy and sustainability. Using the collected information, each program was rated based upon the amount of ecological literacy information found in the curriculum. To rate programs, the following guidelines were employed:

None No information about ecological literacy is stated or can be inferred by the curriculum information provided

Low Information about programs or courses may imply issues of ecological literacy without stating these concepts directly

Mid Information about one to three programs or courses state issues of ecological literacy directly

High Information about three or more programs or courses state issues of ecological literacy directly

Each course and program relating to ecological literacy was then categorized according to overall themes. The focus areas of Site/Land, Studio, Daylighting, Energy Systems, Integrated Design Process, LEED, Materials, and Community Involvement were employed and curriculum information was used to match each course to the appropriate grouping.

In general, courses and programs were identified to some degree on the Web, while names of key faculty members were less commonly found online. The majority of ecological literacy curriculum information identified in this study was found to be related to Energy Systems. In addition, evidence showed that many programs offer some form of the Site/Land or Community Involvement approaches. Conversely, the more specific topics of Daylighting, Integrated Design Process, LEED, and Materials did not prove to be consistantly evident in the curriculum information collected.

There are drawbacks to this kind of survey and rating system. First, there is the lack of parity between online resources schools are able to provide. It is fair to assume that some programs may currently offer courses related to ecological literacy, yet if this information was not listed on the Web at the time this research effort took place, it was not recognized. In addition, Web research only allows us to look at information the program itself chooses to report to the public. By relying on self-identification, we are at the mercy of individuals who may not want to use labels like "ecological literacy" or even "sustainable design." Other information that is difficult to identify is whether the courses and programs listed are required for all students or electives that students with interest can choose. That is, it is nearly impossible to say if every student at a school is really being exposed to ecological literacy, even if that school offers areas of the curriculum that address these issues.

A different kind of rating system, published annually by DesignIntelligence,[4] uses design professionals rather than the Internet as a tool for gauging the skill and success of architecture school graduates. DesignIntelligence separates accredited architecture programs by degree offered and the final product is a list of the top 15 bachelor of architecture programs and the top 15 graduate programs in architecture. Arizona State University, California Polytechnic State University, Carnegie Mellon University, Frank Lloyd Wright School of Architecture, Georgia Institute of Technology, Lawrence Technological University, Massachusetts Institute of Technology, Texas A&M University, University of Arizona, University of California-Berkeley, University of Colorado, University of Illinois at Urbana-Champaign, University of Kentucky, University of Maryland, University of Oklahoma, University of Oregon, University of Texas–Austin, University of Virginia, and University of Wisconsin-Milwaukee were all identified by the Web survey to have a high amount of ecological literacy included in their curriculum information. Of these 19 "top" schools, just nine made it to the DesignIntelligence list of the best 15 in their respective categories. According to DesignIntelligence, the nation's best bachelor of architecture program is Cornell University and the number one graduate program is Harvard University. Both programs were found by the Web survey to present a medium level of ecological literacy information.

[4] *www.di.net/archschools/schools.html*

The complete results of the Ecological Literacy in Architecture Education Web Survey is included in the Appendix.

What Might an Ecological Literacy Ranking of Architecture Schools Look Like?
In 2003, the World Resources Institute (WRI) published *Beyond Grey Pinstripes,* a ranking of the social and environmental stewardship curriculum of business schools—the only such ranking that includes assessment of environmental and social impact management. According to the WRI,

> The 2003 edition of *Beyond Grey Pinstripes*, coauthored by WRI and the Aspen Institute Business and Society Program, evaluated 188 schools and found that 100 schools from 20 countries include environmental and social stewardship topics in their curricula. The survey recognizes six schools on the cutting edge and another 30 schools with moderate to significant activity. Nevertheless, the study found the depth of coverage of these topics was severely limited in the core courses—accounting, finance, and marketing—that most powerfully shape the MBA experience.

Inspired by this ranking, several AIA COTE advisory group members—including Joyce Lee, Vivian Loftness, Daniel Williams, and Mark Rylander—discussed how a similar ranking system of architecture schools might be structured. A draft proposal has evolved from those discussions.

For each school of architecture (offering bachelor of architecture and masters of architecture degrees), the study would assess

- number of required courses dedicated to issues of ecological literacy and/or environmental sustainability (as central theme of course or greater than 50 percent of lectures or assignments)
- number of elective courses dedicated to issues of ecological literacy and/or environmental sustainability (as central theme of course or greater than 50 percent of lectures or assignments)
- number of required or elective courses that actively involve other disciplines in courses (designate whether it is true team teaching or guest lecture)
- number of studios dedicated to issues of ecological literacy and/or environmental sustainability (as central theme of course or greater than 50 percent of assignments)
- availability/number of graduate degrees/courses in environmental planning, design, science (MS and PhD)
- number of faculty members who
  - are involved with AIA COTE, U.S. Green Building Council, Society of Building Science Educators, Sustainable Buildings Industry Council, or other sustainable design-oriented organizations
  - are LEED accredited
  - have designed LEED-certified buildings or otherwise acknowledged leading sustainable design examples
- number (or percentage) of environmental sustainable operations and facility management practices in department/school/university
- presence of environmental building/learning center on campus
- index of green campus/green city characteristics: walking campus, mass-transit city, number of LEED buildings

- involvement of teaching/learning center in exploration of ecological learning models on campus and level of adoption of new pedagogies in the department/school/campus
- number of green design/sustainable conferences on campus in last five years
- number of lectures by ecology/sustainability experts or on sustainable design subjects (as a percentage of the department's total lectures)

This kind of ranking system could be an invaluable tool for prospective students, young educators, and others interested in this field, as well as an important benchmarking reference for institutions and departments themselves. While there are some limitations and some challenges regarding how certain indicators are calculated and (self) reported, those could be mitigated in various ways, depending on the groups behind the ranging, with an eye toward creating an objective and fair ranking system.

TRENDS TOWARD ECOLOGICAL LITERACY IN OTHER DISCIPLINES

Programs in higher education institutions reflect current trends in society toward specialization. In doing so, they frequently miss the profound interdependencies and interconnectivities between humans and the natural environment. Many examples exist, however, of a changing approach toward curricula that move from the conventional interdisciplinary teaching in which students take a group of standard courses from different disciplines and somehow tie them together. Many educators recognize the need for a more integrated approach that encompasses and bridges numerous disciplines, changing not just how people talk but, rather, how they live. In the words of David Orr, "Real ecological literacy is radicalizing in that it forces us to reckon with the roots of our ailments, not just with the symptoms…it leads to a revitalization and broadening of the concept of citizenship to include membership in a planet wide community of humans and living things."[5]

Transcending the boundaries of traditional areas of study is a key ingredient of ecological literacy. Frequently, environmental and sustainable studies spring from an attitude that the problems are solvable if only one were equipped with the right tools and methods. Constraints on ecological literacy, such as academic divisions and compartmentalization, are well established. Further, in professional programs, there are real limitations to introducing new approaches to understanding within a full load of core requirements. Overcoming these barriers will require a radical reshaping of institutions. There are already many encouraging signs of change. Many colleges and universities are developing areas of study that represent a significant shift toward integrating ecological literacy at the undergraduate and graduate levels. Those mentioned here are just a few such examples.

At Lesley University, the Master in Ecological Teaching and Learning provides educators with skills in ecology, advocacy, leadership, and research which they can apply to their respective learning communities. It stresses a bioregional perspective through field experience in a remote, wild setting followed by an urban, human-made one in recognition of one of the core tenets of ecological literacy: deemphasizing indoor, abstract learning in favor of a direct interaction with the environment. The program also examines ecological diversity as a basis for understanding diversity as a value of democracy in human communities.

[5] Orr, David. 1992. *Ecological Literacy*. Albany: State University of New York-Albany, p. 88.

The Environmental Studies Program at Redlands University encourages students to examine environmental issues within a systems perspective. It places as much emphasis on societal reform as it does on scientific rigor. The program acknowledges the bioregion as its lab and classroom, beginning with its physical campus which is set in a pristine western wilderness. Courses give students hands-on experiences with a variety of natural and built systems. The program emphasizes a problem-driven approach to promote thinking about the natural world and to find constructive ways of interacting with it. It appears to be less focused on a specific career direction than a way of thinking and working that could help lead toward major shifts in societies, to re-envision and reinvent a sustainable future.

The Gund Institute for Ecological Economics at the University of Vermont is proposing a graduate-level certificate program in ecological economics. The idea behind the certificate stems from an acknowledgement that ecological economics is inherently a transdisciplinary subject that can start to bridge the gulf that exists between the relevant disciplines. It is offered as an augmentation to existing degree programs. The certificate requires students to take two new core courses, Ecological Economics and Ecological Economic Modeling and Analysis, in collaboration with a degree program in natural resources, civil and environmental engineering, botany, biology, or community development and applied economics.

Presidio World College offers an MBA program in sustainable management that is defined as "the creative stewardship of resources to earn a profit while serving the common good." The program stresses intensive interpersonal instruction and interaction accompanied by online lecture presentations and discussions for remote participation. While the program encompasses studies of sustainability, culture, values, and ethics within a curriculum that includes accounting, finance, marketing, and economics, it does not stress a deeper understanding and competence in ecology and natural systems. The focus is on preparing professionals to position organizations—private, public, nonprofit—as leaders in the practice of sustainable management.

Rensselaer's program in ecological economics proposes a systems approach to studying human ecology as part of the global environmental system. It strives to bridge the traditional economist's concerns of efficiency and equity with environmental and social sustainability. The program embraces a transdisciplinary attitude that moves past classical economics into a "methodological pluralism" that brings together the fields of economic, social, and natural sciences, reflecting new perspectives on complex problems.

In the design professions, there is a wide range of sustainable curricula, from electives that are added into traditional course offerings to a deeper overhaul of how the concepts are taught. At Rocky Mountain College of Art + Design, the curriculum for fine art, interior design, graphic design, illustration, and liberal arts includes two "green" electives, Green Design 1 and 2, which expose students to environmental issues, sustainability, professional design standards for ecological projects, services, materials, production, and specifications of sustainable products. The focus is a pragmatic one, with less emphasis on the essential interrelatedness of humans, their work and the environment.

At the University of Washington, landscape architecture students study the fundamentals of natural processes, ecology, and regional landscape planning within a greater framework of the necessity to become citizens who comprehend interrelatedness, stewardship, and who have the practical competence required to act on the basis of knowledge and feeling—concepts inspired by Orr. By stressing community interaction outside the academic walls, the program encourages students to engage those around them in this endeavor:

> Through research and coursework, the development of ecological literacy is explored in terms of both how design processes may engage citizens in advancing their ecological literacy, and how a designed place may inspire citizens with new insights about, connections with, and stewardship for their environment.

These and other examples of learning are beginning to move from a conventional educational attitude based on a tradition of humans striving to dominate nature. Instead, they suggest a humility toward nature. Further, they represent steps toward Orr's ideas of teaching as a "true conversation" that "acknowledges the existence and interest of the other...in a dance in which the artistry is mutual."[6]

[6] Orr, David.1992. *Ecological Literacy*. Albany: State University of New York-Albany. p. 90.