Pollution Prevention in Architecture

NATIONAL POLLUTION PREVENTION CENTER FOR HIGHER EDUCATION

Introductory Module

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Introduction

Buildings have diverse effects on the environment during their entire life cycles. Although the tangible impacts are visible only after construction begins, decisions made on the drawing board have long-term environmental consequences. To achieve environmental sustainability in the building sector, it is crucial to educate architecture students in environmental issues.

In spite of the urgent need, teaching materials specifically designed for sustainable architecture have been virtually nonexistent. While many energy conservation materials have been developed since the 1970s[1], resources for addressing larger environmental issues and pollution prevention techniques are greatly lacking. Although some environmental education in architecture has been done on an ad-hoc basis, it is fragmented and insufficient.

To provide a framework, appropriate pedagogical models, and supporting educational resources, we have developed this compendium specifically for teaching environmental sustainability and pollution prevention in architecture. In the development process, we have:

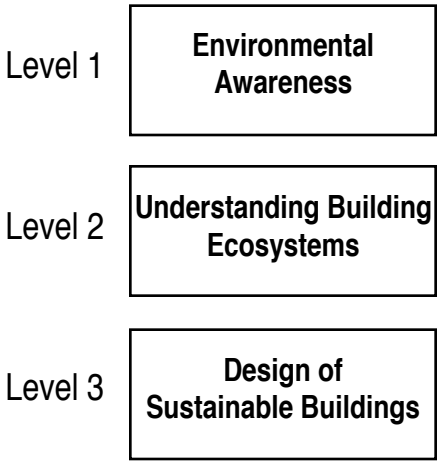
- assessed the current status of research, development, and design activities in this area
- compiled information on new materials and products that enhance environmental sustainability (lower toxicity, higher recycled material content, lower embodied energy, and higher energy efficiency).
- surveyed architectural educators in the U.S.

Our survey indicated a significant shortage of teaching materials for environmental education in architecture; our subsequent attempt to identify educational materials currently being used at architectural schools has only reaffirmed the fact that architecture educators lack adequate educational resources.

[1]Charles C. Benton and Alison G. Kwok, "The Vital Signs Project: Work in Progress," *Proceedings of the ASES Conference (SOLAR 95),* Minneapolis, 1995, Boulder, Colo.: American Solar Energy Society.

Objectives of Environmental Education

The ultimate goal of environmental education in architecture is to increase sustainability in the building sector. In achieving this goal, we discern three levels of educational objectives.



Level 1: Creating Environmental Awareness

A majority of architecture students choose the field because of their artistic aspiration, and their primary interest is in form-making. While students are generally sympathetic to the environmental cause, they may not be active environmental advocates. Thus, it is important to make them aware of the following:

1. Form-making (i.e., architecture) impacts local as well as global environments.
2. Their profession is responsible for some environmental problems.
3. They can contribute to a healthy global environment by practicing sustainable design.

The primary strategy for the early stage of education is to stimulate students' interest in environmental issues. Once that is underway, introduce the basic laws governing the nature and environment; then demonstrate the relationship between the natural laws and design. Note that it is much easier to instill an environmental consciousness at the formative stage of education than in later stages!

Level 2: Understanding Building Ecosystems

The second level of education is to create an understanding of how buildings can be "designed for the environment." For this purpose, a building should be understood as an ecosystem through which natural and manufactured resources continually flow. Within the building ecosystem, a series of subsystems regulate the flow of one or more types of resources. It is important to understand that a building affects and pollutes the environment on both the input side ("upstream") and the output side ("downstream"). Case studies of representative buildings, both successful and unsuccessful, can be

effective teaching tools. To enrich students' learning, choose case studies that illustrate:

- a range of buildings designed under different physical and social contexts
- the ways fundamental principles of design impact the environment
- original design concepts, procurement of materials, considerations given to the construction process, and various building performances during operation.

Level 3: Ability to Design Sustainable Buildings

The third level of environmental education is to give students the skills and knowledge-bases to seek and find sustainable design solutions. Introduce methods and techniques ranging from site planning, building design, and specification of materials to the recycling and reuse of architectural resources in design. Rather than teaching a set of specific skills, develop your students' abilities to explore, assess, and pursue various alternatives for sustainable design.

The Current Status of Environmental Sustainability in Architecture

Although there is a universal consensus on the importance of environmental education in architecture, the questions of what, when, and how to teach specific subjects related to environmental sustainability cannot be easily answered. One reason for this is that architecture covers a vast number of disciplines ranging from art to science — determining the level and extent of environmental education within design, technology, history, theory, practice, and environmental behavior is a formidable task. (At present, in the absence of a clear pedagogical framework, environmental education is being presented as an ethical issue rather than science.)

In the process of developing this compendium, we have assessed the current status of sustainable architecture in the

areas of research, design practice, and education. Specific areas of the assessments include:

- Current environmental technology course curricula, based on an informational survey of architectural educators
- Building materials and products with a higher degree of environmental sustainability (lower toxicity, higher recycled material content, lower embodied energy, higher energy efficiency)
- National Architecture Accreditation Board (NAAB) criteria relevant to environmental education

See Appendix A for survey responses.

Educational Survey

We surveyed architecture educators to determine the current extent of environmental education in the field. We chose the architecture schools and environmental technology department from members of the Association of Collegiate Schools of Architecture (ACSA). Our one-page questionnaire sought the status of environmental education in terms of the quantity and intensity of courses dealing with sustainability and the types of educational materials used in these courses. We asked respondents to send copies of their teaching materials, such as syllabi, bibliographies, and assignments, with their completed surveys. We also asked them what case study buildings, field trips, laboratory facilities, and conferences they used in teaching environmental sustainability.

Findings

- Of the 200 surveys sent out to faculty members of accredited architectural school in the United States and Canada, we received 14 responses. This very low response rate (7%) may indicate a lack of importance placed on sustainable design by many architectural educators.
- The responses revealed a number of courses dealing specifically with sustainable design but few that incorporate sustainable issues into the general curriculum. Of the respondents, only 3% reported current courses dealing specifically with sustainability. However, 93% said they addressed sustainability issues within the context of other courses (generally

those focusing on basic environmental control systems). After examinating the syllabi received, we determined that this meant that one or two lectures on a sustainability topic were included in a semester-long class.

- Homework and visual materials (slides, videos, etc.) were the most commonly used educational materials. Of the respondents, 71% used homework such as research projects and essays; 62%, visual materials; and 47%, "other" materials such as design studio projects, service-based learning activities, and student presentations. Only 43% employed laboratory exercises for teaching sustainable design. Most respondents used a combination of teaching materials.
- Specific buildings and/or field trips were used as environmental case studies by 86% of the respondents. To enhance and reinforce course materials, they led field trips to local utility companies as well as to residential and commercial buildings featuring alternative energy systems and other sustainable features.

Conclusions

In general, the responses indicate a significant shortage of teaching materials designed specifically for sustainable architecture. The number of courses focusing on it and the frequency with which it is discussed within other architecture courses reflects the low level at which sustainable design concepts have been incorporated into the regular curriculum.

Sustainable architecture is a complex subject that should be covered throughout the curriculum. The syllabi received show how sporadic this coverage really is; the educational materials that faculty cite suggest the need for new materials to provide students with a sustainable architecture knowledge base for use in their future practices.

The development of new materials can be facilitated by an exchange of current materials among educators. This will require an organizational structure and inexpensive media for the distribution of educational resources. This Compendium provides a framework for teaching sustainability in architecture schools and a means of distributing copyright-free material to educators.

The NPPC is willing to provide additional materials free of charge on our website — please see the front page for information on how to contact us!

Building Product Manufacturers Survey

The use of environmentally friendly building materials is the simplest step for achieving environmental sustainability in architecture. However, architects cannot use such materials unless they can get answers to these questions:

1. "What attributes make a building material or product environmentally sustainable?"
2. "How can the environmental sustainability of a building material or product be measured?"
3. "Where can designers find the information on sustainable building materials?"

See Appendix B for a sample survey form and database entry.

Each step of the manufacturing process — gathering and refining raw materials, installation, and ultimate reuse or disposal — is associated with a range of environmental consequences. Evaluating these consequences is difficult, if not impossible. Knowledge of the material itself is not enough: the architect must know the source of the raw material, the methods of obtaining it, and the processes used by manufacturers, which can vary greatly from one brand to the next.

To assess the current status of sustainable building materials, we surveyed 500 building product manufacturers. The two-page survey was composed of five sections:

1. Information on the company, product name, and Construction Specification Institute code (a system for specifying building materials).
2. A description of the product, including dimensions and suggested applications.
3. Sustainability features of the product and information on estimated cost compared to traditional materials.
4. Buildings in which this product was used.
5. General comments.

Responses

We were relying on manufacturers, who may not always be objective; some representatives seemed to have little awareness of the environmental impact of their products. Also, although over 500 surveys were issued, only 121 people responsed to the survey; the majority simply submitted a product catalog, which we have added to our resource library. Therefore, a quantitative evaluation of sustainable versus non-sustainable materials was not possible.

Criteria for Sustainable Building Materials and Products

We identified three groups of criteria, based on the building material life cycle, that can be used for evaluating environmental sustainability of building materials. The presence of one or more of these features can assist in determining a building material's relative sustainability.

See the Sustainable Building Materials *module for a complete discussion of building materials' life cycle phases and definitions of sustainability criteria.*

PRE-BUILDING PHASE: MANUFACTURE

- Waste Reduction
- Pollution Prevention
- Recycled Content
- Embodied Energy Reduction
- Use of Natural Materials

BUILDING PHASE: USE

- Energy Efficiency
- Water Treatment/Conservation
- Use of Non- or Less-Toxic Materials
- Renewable Energy Systems
- Longer Life

POST-BUILDING PHASE: DISPOSAL

- Biodegradability
- Recyclability
- Reusability

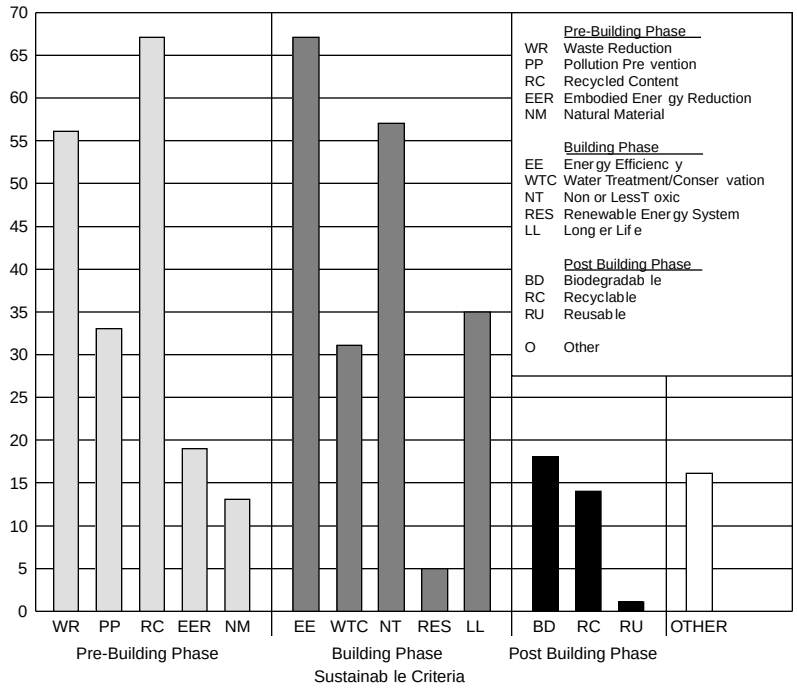


Figure 1: The frequency of various features of sustainable building materials.

Findings

The results of the survey were based on the sustainability criteria discussed above and the percentage of respondents claiming each feature for their products (see **Figure 1**).

The results of the survey show a concentration of products featuring the waste reduction (56), energy efficiency (67), recycled content (67), and non- or less-toxic (57) criteria. This may be due to several factors. The sources for the manufacturers surveyed were lists potentially biased toward these types of products.[2] These are also the most "conventional" areas of research and development in sustainable building materials.

Few products featured renewable energy systems (5), embodied energy reduction (19), or natural materials (13). The energy crises of the 1970s seem to have been forgotten, by the public and the government. The State of Michigan recently repealed its energy efficiency requirements for new homes, citing the additional upfront cost as a burden to potential home owners.

[2]Architects for Social Responsibility/Boston Society of Architects, *The Sourcebook for Sustainable Design: A Guide to Environmentally Responsible Building Materials and Processes,* ed. Andrew St. John, AIA; Tracy Mumma, et al., *Guide to Resource Efficient Building Elements*, 5th ed., Missoula, Mont.: Center for Resourceful Building Technology, 1995; and Victoria Schomer, *Interior Concerns Resource Guide*, Mill Valley, Calif: Interior Concerns, 1993.

The low number of products with Post-Building phase features (33 total) could be expected. This is the least considered phase of architecture, because most architects like to think that their buildings will stand forever.

Recommendations

The survey results suggest that some positive gains have been made in producing building materials that are energy-efficient, have low- or non-toxic components, utilize recycled material, and reduce waste and pollution from the manufacturing process. However, more emphasis needs to be placed on a building material's "afterlife," which should be considered at the very beginning of the design and selection process. By designing products (and buildings) for disassembly and reuse, much more efficient use can be made of our limited natural resources.

The responses also suggest the need for an industry standard and outside audit of "environmentally friendly" materials. In addition, as new products are being released daily, a more current directory of sustainable building materials and manufacturers would be desirable, perhaps in an electronic format or online.

Review of National Architecture Accreditation Board Criteria

See Appendix C for NAAB criteria and suggestions for improving or expanding the emphasis on sustainability issues.

To evaluate the minimum educational requirements for environmental issues and sustainable design in architecture, we reviewed the criteria used by the National Architectural Accreditation Board (NAAB) in certifying U.S. schools of architecture. These minimal acceptable standards for an architectural education define three levels of educational objectives: going from lowest to highest, they are "awareness," "understanding," and "ability."

We evaluated each criterion's relevance to sustainable design. Based on our interpretation of the criteria themselves and experience with the manner in which they are actually applied in architectural schools, we defined three areas: "Directly related" criteria explicitly discussed the scientific basis for understanding environmental phenomena and

environmental design issues (these criteria were primarily in the NAAB-defined groups of technical criteria and environmental criteria); "Indirectly related" criteria addressed broader design issues and the integration of technology and aesthetics; "Not related" criteria dealt with cultural, historical, and social issues.

Findings

- The language of many criteria is overly vague and can be interpreted quite differently by individual architecture schools.
- The technical and environmental criteria require awareness and understanding of certain basic environmental principles, but do not require the ability to apply this knowledge.
- There is little emphasis on the local and global environmental impact of design decisions.
- The review indicated a lack of emphasis on understanding the ecological impact of buildings and the integration of environmental issues into the overall design of architectural form and selection of materials.

Recommendations

- The criteria should be more explicit; the language should be clarified and made more proscriptive.
- Existing criteria should be expanded to specifically address the environmental consequences of architectural design decisions. In many cases, adding "environmental impact" to the elements listed in a given criteria can accomplish this goal.
- A higher level of technical and environmental knowledge should be required. Students must be capable of integrating environmental knowledge into the design process.

Because ecological design should be required and integrated part of the entire design process, not merely an area of specialization, accreditation should require environmentally sustainable design principles.

Objectives of This Compendium

This Compendium was designed to locate and develop educational resources. Furthermore, we hope this Compendium can be used in flexible segments, integrated into the regular curriculum as an instructor desires. We formulated a general framework based on our definitions of the objectives and the scope of environmental education in architecture as described on pp. 3–4.*

Flexibility

The curriculum structures of various architecture schools in the United States are vastly different in many aspects. Pedagogical models are diverse. Teaching styles of individual instructors differ depending on their background and educational philosophy. For these reasons, the educational resources need to be flexible and adaptable to various educational settings. For the purpose of increasing its adaptability, this Compendium is divided into self-contained units, called "modules."

We want this compendium to be used widely among architecture schools in the United States. To this end, we have collaborated with other universities and obtained a range of viewpoints and feedback from architectural educators and practitioners.

Compendium Structure

Each phase of the architectural ecosystem involves many topic areas related to environmental sustainability and pollution prevention techniques. Among many possible areas, we have developed modules on the following topics:

- Sustainable Design
- Sustainable Building Materials
- Recycling and Reuse of Building Materials
- Case Studies

*During the last two decades, a substantial body of knowledge has been established in energy conservation, and a variett of educational resources have been developed. While this vital aspect of sustainable design is not our primary focus, we regard it as one of the key strategies for achieving sustainability.

The module on "Sustainable Design" gives an overview of environmental sustainability and pollution prevention techniques in architecture. This "super-module" outlines issues overarching various aspects of environmental sustainability and introduces basic principles for sustainable design and pollution prevention.

"Building Materials" focuses on the environmental impact of the manufacture, use, and disposal of building materials; it also examines how the choice of a material affects the overall sustainability of a building.

"Recycling and Reuse of Building Materials" is meant to show students the upstream and downstream effects of design, construction, use, and disposal. Designed as a coursepack or supplemental reading, it provides an introduction as well as discussions, case studies, and exercises in the areas of waste prevention, construction and demolition recycling, architectural reuse, and design for materials recovery.

"Case Studies" provides an in-depth examination of the design, construction, and usage of examples of sustainable architecture.

Each module contains the following:

- **Overview of key publications**. These are meant to provide a background. They discuss principles, techniques, and examples for implementation. The teaching materials include lab and studio exercises, essay questions, and sample curricula submitted by educators around the country.
- **Resource lists.** These resources are designed to provide a starting point for more in-depth analysis in a given area. They were compiled from various organizations, associations, and commercial companies that offer educational aids, slides, videos, computer software and online services.
- **References.** An extensive bibliography of books, journal articles, industry publications and conference papers, organized by module and topic classification.
- **Annotated bibliography.** Provides a summary of selected bibliography entries, offering information on the topics covered by the material, the audience level, and relevance to various sustainable design issues.

Summary

It is our goal to have this compendium used widely among architecture schools in the United States. To this end, a range of viewpoints and feedback from architectural educators and practitioners have been incorporated into the development of the compendium. At present, Compendium modules cover Sustainable Design, Sustainable Building Materials, Recycling and Reuse of Architectural Resources, and Case Studies. Many important topics such as sustainable urban design, site planning, and design studio are not included in the project. We hope that this compendium will continue to expand through the collective efforts among architectural educators around the country.

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The mission of the NPPC is to promote sustainable development by educating students, faculty, and professionals about pollution prevention; create educational materials; provide tools and strategies for addressing relevant environmental problems; and establish a national network of pollution prevention educators. In addition to developing educational materials and conducting research, the NPPC also offers an internship program, professional education and training, and conferences.

Your Input is Welcome!

We are very interested in your feedback on these materials. Also contact us if you wish to order any of our materials, collaborate on or review NPPC resources, or be listed in our *Directory of Pollution Prevention in Higher Education*.

We're Online!

Most of our educational materials are available FREE OF CHARGE on our website: **www.umich.edu/~nppcpub/**
Please contact us at nppcpub@umich.edu if you have comments about our online resources or suggestions for publicizing our educational materials through the Internet. Thank you!

Appendix A:
Current Status of Environmental Education

An informational survey of educators, administered by the College of Architecture and Urban Planning at the University of Michigan, was designed with the goals of determining the current extent of environmental education and collecting existing teaching materials on environmental sustainability. This one-page survey requested information on specific courses dealing with sustainability, the types of educational materials used in these courses, laboratory facilities available, and textbooks used. Respondents were also asked about seminars, professional developments series, or conferences held by the their university that dealt with environmental sustainability.

Of the 200 surveys that were sent out to faculty members of accredited architectural schools in the United States and Canada, 14 responses were received, for a response rate of 7%. The survey revealed a lack of courses dealing specifically with sustainable design issues but found that many professors address sustainability principles within the context of other courses: Of the respondents, only 3% reported current courses dealing specifically with sustainability; however, 93% reported addressing sustainability issues within the context of other core courses. Generally, this meant one or two lectures on a given sustainability topic in a semester-long class.

The survey asked respondents to include syllabi, bibliographies, and assignments with their responses. These materials have been compiled as separate components of the Architectural Compendium for Environmental Education. In general, the responses indicated that there is a significant shortage of teaching materials for environmental education. An attempt to identify educational materials currently being used at architectural schools has only reaffirmed the fact that there is a common deficiency in educational resources among architectural educators around the country.

Of the 200 surveys sent out, 14 responses were received. The following schools and faculty members responded.

Howard University
Kathryn Tyler Prigmore

Kansas State University
David W. Clarke

Miami University of Ohio
Scott Johnston
Fuller Moore

Montana State University
Thomas R. Wood

Norwich University
Diane Elliot Gayer

Oklahoma State University
Eric Neil Angevine

University of Detroit-Mercy
Stephen J. LaGrassa

University of Hawaii
Victor Olgyay

University of Idaho
Bruce Haglund

University of Michigan
Jong-Jin Kim

University of Tennessee
Richard M. Kelso

University of Texas at Arlington
Truett James

University of Utah
Robert A. Young

University of Waterloo
Sally Lerner

Question 1: Currently offered courses related to environmental sustainability.

SCHOOL/RESPONDENT	COURSES
Howard University	Environmental Systems I & II
Kansas State University	Design Studio Project, Third Year Environmental Systems in Architecture,Second Year Sustainable Architecture, Fourth, Fifth Year and Graduate
Miami University of Ohio	ARCH 413/ARCH 414 Some material in ARCH 517/518
Montana State University	No courses dealing specifically with environmental sustainability. Topic mentioned in environmental controls courses and design studios.
Norwich University	Studio course in Environmental Design offered every other year.
Oklahoma State University	ARCH 3314: Environmental Control, Life Safety and Thermal Systems ARCH 5133: Advanced Energy Issues in Architecture
University of Detroit-Mercy	ARCH 324: Sustainability and Architecture Seminar*
University of Hawaii	ARCH 214: Mechanical Systems ARCH 213: Lighting, Illumination, and Power
University of Idaho	ARCH 463/462: Environmental Control Systems ARCH 499: Natural Lighting* ARCH 499: PSDATE
University of Michigan	ARCH 315, 425: Core Enviromental Technology Courses ARCH 555: Advanced Building Systems and Operations ARCH 575: Building Ecology* ARCH 605: Environmental Design Simulation
University of Tennessee	Required third year courses, ARCH 341 and 342, include sustainability as a component, but not the major focus.
University of Utah	ARCH 537, ARCH 635, ARCH 636: Environmental controls ARCH 670: Financial incentives for construction ARCH 558: Building rehabilitation and recycling*
University of Waterloo	Environment and Resource Studies 218 *

Respondents with current courses discussing some sustainability issues: 93%
Respondents with current courses dealing specifically with sustainability: 3%

* Courses dealing specifically with Sustainability Issues

Question 2: Educational materials used.

SCHOOL/RESPONDENT	HOME WORK	LAB EXERCISE	VISUAL MATERIALS	OTHER
Howard University	Yes			
Kansas State University	Yes	Yes	Yes	Studio projects
Miami University			Yes	Demo models
Montana State University				
Norwich University	Yes	Yes	Yes	Studio design projects, readings, oral presentations, journals
Oklahoma State University	Yes		Yes	
University of Detroit-Mercy	Yes	Yes	Yes	Term paper, paper-making exercise, AIA series on sustainable design
University of Hawaii	Yes	Yes	Yes	
University of Idaho	Yes			
University of Michigan	Yes	Yes	Yes	
University of Tennessee	Yes			
University of Texas at Arlington				
University of Utah	Yes	Yes	Yes	Term projects, integration in studio design problems, service based learning activities
University of Waterloo			Yes	Team design assignment
% of responding schools	71%	43%	62%	43%

Question 3: "Are specific buildings used as case studies in the course? Do field trips include visits to any buildings illustrating concepts of sustainability? List all types and, if possible, enclose additional information on buildings."

SCHOOL/RESPONDENT	CASE STUDIES and/or FIELD TRIPS
Howard University	"Each class visits one building during the course of a semester. The purpose of the trip is to expose students to building systems and their interrelations. This year we will be visiting the central Information Systems and Services Center for the University. The Center is currently under construction in a former Wonder Bread factory building on campus. In previous years. we have visited MCI Communications headquarters building, a dormitory under construction on campus, Union Station and Retail Shops, 1001 Pennsylvania Avenue, and the Old Post Office Building and Pavilion."
Kansas State University	Participated in AIA Video Conference "Building Connections" which included many case studies. Now use the video produced from this conference in class.
Miami University of Ohio	Dayton Power and Light's Energy Resource Center.
Montana State University	Third year studio visited the Metcalf Building in Helena, which demonstrates daylighting and energy conservation techniques.
Norwich University	Design problems have included a bus shelter, an AIDS support/healing center, revitalization of an urban waterfront, and redesign of an existing horticultural farm.
Oklahoma State University	Local residential buildings only.
University of Detroit-Mercy	Field trips to Energy Conservation Devices (Troy, Michigan) and Oakland Community College.
University of Hawaii	Specific buildings are used as case studies. Buildings change each semester but include standard examples like Bateson Building, Lockheed, and Audubon House.
University of Idaho	ARCH 499 PSDATE is developing workups on several buildings as part of the Vital Signs Project. ARCH 463 features tour of ground-source heat pump house.
University of Michigan	ARCH 535 uses multiple case studies and occasional field trips.
University of Utah	Field trips to enhance/reinforce course materials.
University of Waterloo	Visits to "Living Systems" buildings in the area. Videos of case studies used.

Responding schools using case studies and/or field trips to address sustainability: 86%

Question 4: "Does your institution possess any unique facilities that demonstrate environmental properties?"

SCHOOL/RESPONDENT	LAB FACILITIES
Kansas State University David W. Clarke	Heliodon for determining sun shadows and penetration.
Miami University Scott Johnston / Fuller Moore	Ecology Resource Center Center for Building Science Research
University of Hawaii Victor Olgyay	Currently building an E.C.S. lab, with an emphasis on lighting systems.
University of Michigan	Skydome for daylighting simulations, computer lab for energy analysis.
University of Utah Robert A. Young	Solar Table

Responding schools with lab facilities to demonstrate sustainability: 36%

Question 5: "List textbooks and readings assigned to the course(s)."

Responding schools using textbooks addressing sustainability: 79%

Question 6: "List seminars, professional development series, conferences, or special courses offered by your institution relating to sustainability and pollution prevention."

SCHOOL/RESPONDENT	SEMINARS, etc.
Kansas State University	Video series: AIA "Building Connections" Lecture Series on "Building to Save the Earth" Andreaus Duaney's"Suburban America" lecture
Miami University of Ohio	AIA Continuing Education Courses through the Dayton AIA and Dayton Power and Light. Lecture and Workshop Combinations The Design of Shading Devices for Buildings, January 1994. Daylighting in Architecture, January 1995.
Montana State University	Department assists the State Department of Natural Resources and Conservation in hosting an annual two-day energy design conference.
University of Hawaii	Hosting an EPA seminar on Pollution Prevention.
University of Waterloo	(not specified)

Responding schools offering seminars, etc. addressing sustainability: 36%

Appendix B:
Survey of Building Product Manufacturers[3]

Figure 1: Sample of the form used in the Building Product Manufacturers Survey.

Product Information Sheet

With feedback from companies like yours which produce environmentally sustainable building products, we hope to gain information needed to develop educational materials for building professionals. **Please duplicate this form if you have more than one product.** *Thank you for your cooperation!*

1. **Company Name** Enercept Inc. **Phone** (605) 882-2222
2. **Product Name** Enercept Superinsulated Stress Skin Building System **Fax** (605) 882-2753
3. **Construction Specification Institute (CSI) Classification**
   CSI Section No. _____ **CSI Section Title**_____
4. **Product Description (including dimensions and suggested applications)**

   Superinsulated Panelized Building System. Dimensions vary due to project since each project is custom designed and built. Residential, Commercial and Agricultural. Standard sizes are four feet with various lengths up to 24 feet.
5. **Key Features of Environmental Friendliness.** Please describe features of environmental friendliness that apply to your product. When available, provide quantitative data.

   Energy Efficiency: Fuel-energy savings of 40%-60% are very common over typical 2x6 constructed homes.
   ex: R-values, Shading Coefficient, System Efficiency

   Reduced Toxicity: There are no detectable toxic ingredients released from panel materials.

   Biodegradability: _____

   Durability: The engineered superior strength of the panels create structures that will withstand far more stress than typical construction.

   Fire Rating: T.S.O. Commercial Risk Service Inc. rates Enercept as slow burn, non-combustible. Flame spread of the EPS in reference to surface burning characteristics is (5). Enercept is U.L. listed.

   Estimated Cost: When compared to construction cost of conventional walls with similar performance, the price is very competitive. The predesigned panels greatly reduce the labor required to build a structure.

page 1 of 2

[3]Architects for Social Responsibility/Boston Society of Architects, *The Sourcebook for Sustainable Design: A Guide to Environmentally Responsible Building Materials and Processes,* ed. Andrew St. John, AIA; Tracy Mumma, et al., *Guide to Resource Efficient Building Elements*, 5th ed., Missoula, Mont.: Center for Resourceful Building Technology, 1995; and Victoria Schomer, *Interior Concerns Resource Guide*, Mill Valley, Calif: Interior Concerns, 1993.

Production Process

•Overall Environmental Considerations Oriented strandboard, which is a recycleable crop product, is used in Enercept panels. Recycled EPS is used whenever possible. The overall effect is far less energy required to produce the panels than any other building materials.

•Pollution Prevention Measures All materials are used to their maximum and EPS is recycled, for further use.

•Waste Reduction Measures The nature of the product with standard sizing allows for very efficient and complete use of materials, virtually eliminating building site waste.

•Embodied Energy Since there is no air flow through Enercept panels, windy days have less effect on the heating and cooling costs of the home.

•Recycled Content O.S.B. is manufactured from crop logs/lumber which is quickly renewable. Research is being done and processes are being developed to use a high content of recycled EPS in the core.

Ex: Made from 90% recycled tire rubber

6. A representative building in which the product is used.

Building Name American Delta Life Insurance Co.

Location Watertown SD

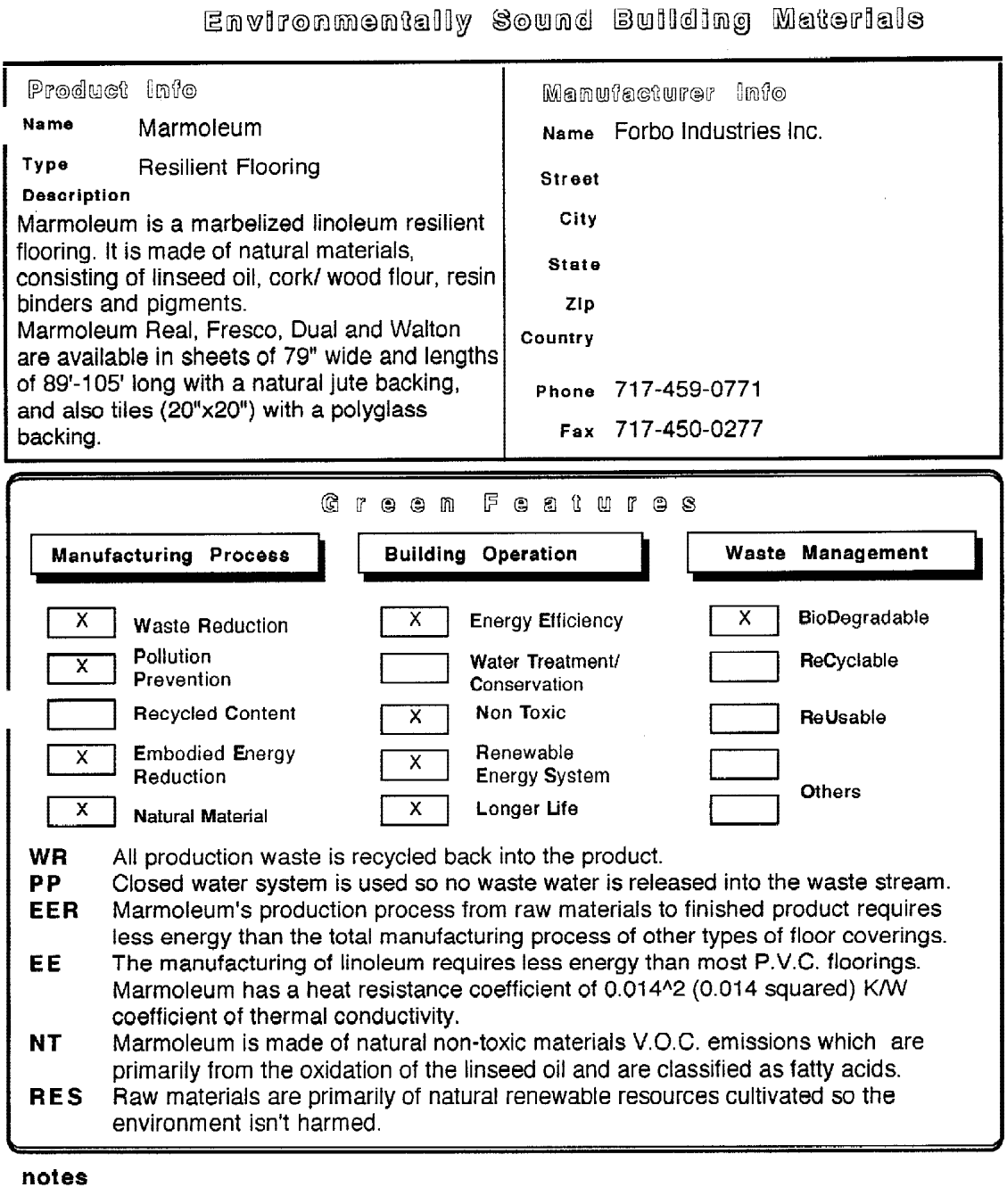
Architect Spencer, Ruff and Associates

7. Comments. Please provide any comments you would like to make in the space below and back. In particular, add other information on environmental friendliness of your product which cannot be described in above categories.

Since Enercept panels are custom built for each project all doors and window openings are cut in and framed at the factory. This means practically no waste on the construction site due to the panels being cut on site, eliminating refuse hauled to the local landfill. Enercept also supplies basement wall and roof panels, so as to totally encapsulate the home in insulation. The use of thermally broken posts as structional elements insure the most energy efficient, strong enclosure available.

Return this form to **Dr. J.J. Kim, College of Architecture and Urban Planning, University of Michigan, Ann Arbor**

Figure 2: Sample page from the Sustainable Building Products Database.



Environmentally Sound Building Materials

Product Info

Name Marmoleum

Type Resilient Flooring

Description

Marmoleum is a marbelized linoleum resilient flooring. It is made of natural materials, consisting of linseed oil, cork/ wood flour, resin binders and pigments.
Marmoleum Real, Fresco, Dual and Walton are available in sheets of 79" wide and lengths of 89'-105' long with a natural jute backing, and also tiles (20"x20") with a polyglass backing.

Manufacturer Info

Name Forbo Industries Inc.

Street

City

State

Zip

Country

Phone 717-459-0771

Fax 717-450-0277

Green Features

Manufacturing Process		Building Operation		Waste Management	
X	Waste Reduction	X	Energy Efficiency	X	BioDegradable
X	Pollution Prevention		Water Treatment/ Conservation		ReCyclable
	Recycled Content	X	Non Toxic		ReUsable
X	Embodied Energy Reduction	X	Renewable Energy System		Others
X	Natural Material	X	Longer Life		

WR All production waste is recycled back into the product.

PP Closed water system is used so no waste water is released into the waste stream.

EER Marmoleum's production process from raw materials to finished product requires less energy than the total manufacturing process of other types of floor coverings.

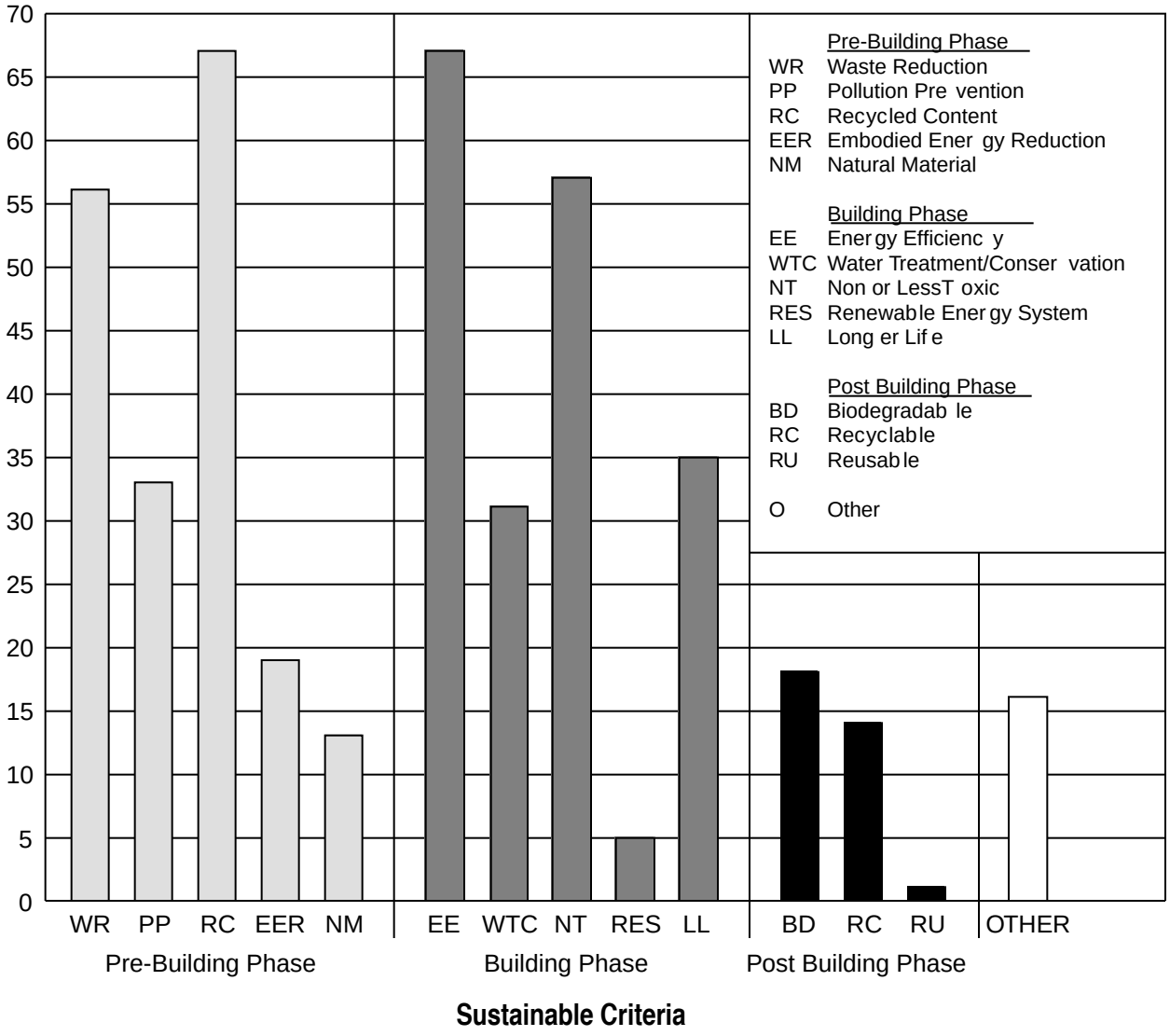
EE The manufacturing of linoleum requires less energy than most P.V.C. floorings. Marmoleum has a heat resistance coefficient of 0.014^2 (0.014 squared) K/W coefficient of thermal conductivity.

NT Marmoleum is made of natural non-toxic materials V.O.C. emissions which are primarily from the oxidation of the linseed oil and are classified as fatty acids.

RES Raw materials are primarily of natural renewable resources cultivated so the environment isn't harmed.

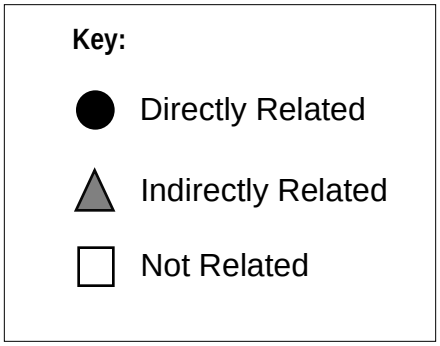
notes

Figure 3: The frequency of various sustainability features of building materials. The total number of materials included in this survey is 121; a material may have more than one feature.



Appendix C:
Review of National Architecture Accreditation Board Criteria

The teaching of architecture as a profession is governed by national standards defined by the profession. As a means of evaluating the current state of environmental awareness and education in architecture, we reviewed the criteria used by the National Architectural Accreditation Board (NAAB) in certifying schools of architecture in the United States. Our review indicated a lack of emphasis on understanding the ecological impact of buildings and the integration of environmental issues into the overall design of architectural form and selection of materials. The criteria for the various areas of accreditation are presented in the accompanying chart and evaluated for relevance to sustainable design issues. Problems with the limitations of current criteria in addressing sustainability are also discussed. Suggestions for expanding and/or rewriting criteria are given where appropriate.



NAAB Accreditation Review: Social Criteria

Social Criteria	Key	Problems/Suggestions
Be aware of basic principles governing the information of diverse cultures and human behavior.	□	
Be aware of the values, needs, and ethics that guide human behavior.	▲	
Be aware of historical methods of inquiry.	□	
Be aware of the diversity of architectural history and traditions throughout the world.	▲	Promote an awareness of vernacular architecture developed as a response to varying climatic conditions and indigenous materials.
Be aware of the implications of economic systems and policies on the development of the built environment.	▲	Expand the definition of "economic systems and policies" to include environmental costs and the importance of sustainable development in reducing these costs.
Be aware of levels of government and the areas of the law each has generated that affect architecture.	▲	The emphasis tends to be on building codes and tax or real estate laws. Expand this area of study to include the laws and policies that govern the environmental impact of building and development.
Understand the impact of various cultural values and societal settings on the social responsibilities and the role of the architect.	□	

NAAB Accreditation Review: Technical Criteria

Technical Criteria	Key	Problems/Suggestions
Understand the principles embodied in natural laws affecting the science of building.	●	
Understand the basic theories of structures and structural behavior of typical systems.	▲	Include an understanding of the environmental impact of various structural systems.
Be able to organize and design simple structural systems to withstand gravity and lateral forces.	□	
Be aware of relevant codes and regulatory standards and their application to physical and environmental systems.	▲	Include a consideration of codes governing both interior and exterior environmental conditions and the ecological impact of buildings.
Understand the basic theories of lighting, acoustics, environmental control, building systems and energy management.	●	Within this theoretical study of building systems, develop an ability to analyze them in regards to environmental impact. Change to: Understand the basic theories, conservation techniques, and ecological impact of lighting, acoustics, environmental control, building systems, and energy management.
Understand the basic elements, organization, and design of mechanical and electrical, plumbing, communication, security, and vertical transportation systems.	●	Include in this understanding a study of life cycle environmental impact. Change to: Understand the basic elements, organization, design, and life cycle of mechanical and electrical, plumbing, communication, security, and vertical transportation systems.
Be aware of the principles, conventions, standards, applications, and restrictions associated with the manufacture of existing and emerging construction materials and assemblies.	●	Expand this area of study to include the environmental implications of various types of materials and assemblies, and the potential substitution of environmentally friendly building materials and assemblies. Change to: Be aware of the principles, conventions, standards, applications, restrictions, and environmental impacts associated with the manufacture of existing and emerging construction materials and assemblies.
Understand safety requirements and selection processes for equipment and materials in site and building design.	●	
Understand the problems related to the use of hazardous and toxic materials in new and existing buildings.	●	

NAAB Accreditation Review: Environmental Criteria

	Key	Problems/Suggestions
Be aware of the principles governing the natural world.	●	Emphasis is on the physical laws governing the structural and thermodynamic properties of individual buildings. The local and global impact of design decisions are neglected. Expand awareness to include the "ecological" effects of architecture on the global ecosystem.
Be aware of the theories and methods that clarify the relationships between human behavior and the physical environment.	●	
Be aware of the principles and theories that deal with environmental context, and the architect's responsibility with respect to global and environmental issues.	●	
Understand how a specific site influences, and is influenced by, its physical characteristics and its ecological context.	●	
Understand the ecological impact of buildings and their occupants.	●	

NAAB Accreditation Review: Design Criteria

	Key	Problems/Suggestions
Be able to examine architectural issues rationally, logically, and coherently.	▲	
Be able to gather and analyze information about human needs, behavior, and aspirations to inform the design process and do basic research as it relates to all aspects of design.	●	Change to: Be able to gather and analyze information about ecological conditions, human needs, behavior, and aspirations to inform the design process and do basic research as it relates to all aspects of design.
Be able to use architectural history and theory in the critical observation and discussion of architecture and bring an understanding of history to bear on the design of buildings and communities.	□	
Be able to integrate natural and improved site constraints into the development of the program and the design of the project.	●	Change to: Be able to integrate natural and imposed site constraints and the potential for ecological impact into the development of the program and the design of the project.
Be able to articulate and clarify basic project goals and objectives and to plan appropriate design activities using techniques of programming, analysis, and synthesis applicable to a variety of project types.	▲	
Be able to design both site and building to accommodate those with varying physical needs.	▲	Change to: Be able to design both site and building to accommodate those with varying physical and environmental needs.

NAAB Accreditation Review: Design Criteria (continued)

	Key	Problems/Suggestions
Be able to apply the principles that underlie design and selection of life safety systems in the general design of buildings and their subsystems.	▲	
Be able to assess, select, and integrate structural and environmental systems into a building.	●	
Be able to select building materials and assemblies as an integral part of the design and to satisfy requirements of building programs.	●	
Be able to develop interior and exterior building spaces, elements, and components, using basic principles of architectural form making.	▲	
Be able to use the interactions between technical, aesthetic, and ethic values in the formation of architectural judgements.	▲	

NAAB Accreditation Review: Aesthetic Criteria

	Key	Problems/Suggestions
Understand basic principles and systems of order underlying 2D and 3D design.	□	
Understand history, theories, and principles on which making of architecture and urban form are based.	▲	Expand this study to include an historical perspective on the environmental impact of building and interior environmental quality.
Understand significant design methodologies and their application to architectural design.	□	
Understand purposes for building and how they are realized and given meaning through architectural form.	□	
Understand how different forms are successful or not in satisfying a proposal's programmatic, technical, accessibility and contextual objectives.	●	Expand this area of study to include environmental impact and sustainability criteria.