# Hands-On, Hands-Off: Case Studies in Architectural Education

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## INTRODUCTION

Typically, student work in architecture courses involves hypothetical design projects. Most students, therefore, have limited personal experience with the construction and functioning of actual buildings. One result of this educational approach is that students come to consider buildings as abstractions, focusing primarily on composition and theory, while overlooking energy use and environmental considerations, qualitative spatial experiences, and the potential effects of design decisions on occupant health and comfort. Technology courses are often taught in the traditional manner of large lectures, focusing on memorization of principles and concepts and evaluation by examination. In contrast, recent curricular changes in several architecture programs have used the case study approach to provide opportunities for experiential learning – one that integrates abstract conceptualization with reflective learning, concrete experience, and active experimentation.[1] A recent endeavor, the Vital Signs Curriculum Materials Project (1992-1998), encourages the next generation of architects to design environmentally responsible and energy-efficient buildings by promoting a pedagogic approach that provides opportunities for experiential learning by developing case studies following firsthand investigations of existing buildings.

Increase knowledge base/invigorate interest: While the case study method itself is not uncommon to teaching in professional schools (e.g., law, business and medicine), its typical use in architectural education offers a less-than-whole picture. For example, in large environmental technology classes we often show examples of architectural strategies used to achieve energy efficiency in buildings. Rarely do we have the information to validate the claims of energy savings. Or we show the beauty and modulation of daylight found in buildings by Tadao Ando or Alvar Aalto, yet can provide little information about the actual lighting system performance and its relation to design intent. Do glare conditions exist in Aalto's libraries with clerestory windows? Are people thermally comfortable in Ando's concrete structures? How much energy does using a daylight-integrated lighting system save?

Various programs using the Vital Signs approach in studio, lecture, seminar, and independent study settings have asked questions such as these. Students have gone into existing buildings; interviewed and surveyed occupants; observed, measured, and gathered physical data; and developed case studies that are now shared worldwide over the Internet. The process has produced an ever-expanding, usable knowledge base shared between students and design professionals. An unexpected outcome is the very favorable response to the approach from students who have participated and gained first-hand experience in buildings.

Experiential learning theory/benefits: Psychological types or personality styles have often been criticized in teaching circles for being too stereotypical, static, and fixed in their descriptions of individuals. "[Such] ... views often get translated into a self-fulfilling prophecy, as with the common educational strategy of "tracking" students on the basis of individual differences and thereby perhaps reinforcing those differences."[2] The foundations of experiential learning originate in the works of educator John Dewey, developmental psychologist Jean Piaget, and social psychologist Kurt Lewin. Kolb writes that the structural model of the learning process allows for unique individual adaptive processes, which characterize the complexity of human individuality.

The investigative case study approach lets students learn through a choice of experiences. For example, individuals with an orientation toward concrete experience might grasp an intuitive and artistic approach to design problems and would enjoy involvement in real investigations and real problems. Those oriented toward reflective observation might approach a case study by trying to understand why something happened and objectively comparing many different possibilities. Those oriented toward abstract conceptualization would develop, based on accepted theories, a rigorous and systematic analysis—a valuable skill with quantitative data! The primary concern for those oriented toward active experimentation is to exert some influence over their environment in an iterative manner. The impact of each of these learning processes is highly variable from one individual student to another, reinforcing the case study approach as an experiential approach that would likely maximize learning and knowledge.

The awareness of the need for a revised pedagogic approach to architectural education has developed over time. Two previous efforts supporting the development of architectural teaching materials have had a hand in shaping the Vital Signs effort. The first of these was the Passive Solar Curriculum Development Project coordinated by the University of Pennsylvania during the early 1980s. The second was a series of summer retreats in the late 1980s sponsored by the Society of Building Science Educators to address the pedagogy of building science. These retreats offered a chance to discuss the needs of teaching programs in disciplines related to energy use. At one particular retreat, held at Harvard's Pack Forest in 1988, there was a discussion of both the value and rarity of good building case studies.[3]

### Shaping future design

Targeting architects for education about energy and the environment is especially important because, whether aware of it or not, architects play a central role in shaping the nation's future in these areas. With lifespans of decades or even centuries, buildings are among the most lasting objects we produce. They account for more than one-third of U.S. energy use and over sixty percent of U.S. electricity consumption. Buildings in the United States account for almost 10% of global energy use. They also serve as models for much of the new construction in the developing world. A quick sketch or clay model made by an architect in the earliest stages of design can affect building energy consumption well into the future. A thoughtless decision about building orientation may create a cooling load that burdens a building (and society) for as much as a century. Decisions about the extent and type of glazing in a commercial or institutional building will affect power use for thousands of business days.[4]

Addressing building performance topics via the case study process has the benefit of allowing students to match and compare original design intentions with actual outcomes. The value of "closing the loop" in such a fashion is that such investigations become design lessons that may well become an inherent part of the designer's palette during design decision-making – a practice that will hopefully be carried into practice. A quick sketch can affect energy consumption for years to come. For example, early, simple sketches clearly shaped the final curvilinear form of the shading devices in Renzo Piano's Menil Gallery in Houston, Texas.

Many high-profile architects and senior architecture faculty were trained during the energy-rich decades of the 1950s and 1960s and developed a design process in which both energy use and building performance receive low priority. While consulting engineers can condition almost any space that an architect hands them in the compartmentalized building design and delivery process, there is a high price to be paid in energy, equipment, and space when a building is not suited to its site and climate. In design schematics a number of goals must be considered and balanced. These traditionally include economics, aesthetics, and spatial quality; life-cycle costs, comfort, and health must also be included.

## VITAL SIGNS PROJECT

The Vital Signs Curriculum Materials Project examines the physical performance of buildings, their patterns of energy use, and their impacts upon occupant well being. Since 1992, the project has produced background material, procedures, and guidelines to support student investigations using existing buildings as case study sites. Vital Signs has also developed an Internet site that serves as a center for the electronic distribution of Vital Signs materials and student-developed case studies of existing buildings. The project has received general support from The Energy Foundation and Pacific Gas & Electric. The National Science Foundation, The Nathan Cummings Foundation, The Educational Foundation of America, and the U.S. Department of Energy have supported specific project activities. The project's primary audience is architecture students and faculty. However, dissemination of information about well-known buildings, gathered in the course of student investigations, has the potential to influence a larger audience throughout the building professions.

Efforts and activities supporting the teaching of case studies have included: Resource Packages addressing a set of physical performance topics (e.g., whole building energy use, the dynamics of solar shading devices, natural ventilation, and glazing performance) organized as modules available over the Internet; each package provides protocols for the field evaluation of existing buildings—activities that may in turn lead to written Building Case Studies describing student findings; Summer Training Sessions for faculty to receive direct, hands-on experience with field research as a teaching method; Case Study Competitions challenging students to take a detective's eye to the built environment; and Case Study Incentive Grants supporting faculty and student investigations of existing buildings in connection with studio, lecture or seminar classes; and an Equipment Toolkit Loan Program, enabling schools to use both handheld and datalogging instrumentation for a semester or a full year in the development of case studies.

## DEVELOPING A CASE STUDY

### Selecting a building and topic

Beginning a case study involves selecting a building and a topic, processes that go hand in hand. Every building has its own story to tell, each with provocative questions about building performance and how design intent was successfully (or unsuccessfully) met. Sometimes the motivation to study a building stems from curiosity about a building aspect or quality. Case study buildings generally comprise four general categories. 1) Historic buildings such as the Robie House by Frank Lloyd Wright; 2) Architecturally influential contemporary buildings such as the Denver Public Library by Michael Graves; 3) Buildings known for energy efficiency and environmental responsiveness such as the Bateson Building in Sacramento, California; and 4) projects representative of a specific building type such as a museum, a school or an office building. These categories do not represent an exclusive pool of building case study candidates. Case studies can also include unknown but interesting buildings as well (such as a building designed by a faculty advisor).

Each Resource Package presents basic physical principles, a description of how the topic affects design decision making, a discussion of applicable standards and practices, an annotated bibliography, and a set of field exercises. The list of topics covered by Resource Packages is not exclusive, creative case studies focusing on other building performance topics and methods related to energy-use, architectural space-making, and occupant well-being can easily be selected for a case study.

### Developing a hunch

Designers, historians, scientists, or theorists typically begin their research with a question for inquiry and a guess, hypothesis, or conceptual notion that can be put to a test. For architecture students conducting case study investigations, framing the question and posing a hypothesis is a critical and basic step in constructing a well-bounded, cohesive analysis—and very often this is a difficult process. Once a candidate building and performance topics are selected, developing a clearly stated hypothesis is essential to successfully framing of the investigation. A hypothesis is a hunch or proposition about the outcome of a question of inquiry. Developing an appreciation for research methodology through use of the Vital Signs approach may well be one of the most enduring effects experienced by student participants.

The stories held by existing buildings on topics related to occupant well-being, the operations of lighting and HVAC systems, and building energy consumption, are not typically seen as design problems by architecture students. This, perhaps, is attributable to the compartmentalization of architectural practice and curricula, where each designer (engineer, acoustician, lighting, etc.) has their own vocabulary and measurement metric. However, the role of the architect is important as an integrator or overseer of all the professions. One place where the "whole" is realized is in the built artifact. By close examination of building performance and its manifestation on the building in its entirety, students will inevitably bring an understanding of their observations and measurements into their designs as they move through school into practice. Once a candidate building and performance topics are selected, developing a clearly stated hypothesis is essential to successfully framing the investigation. A hypothesis is a hunch or proposition about the outcome of your question of inquiry.

### Case Study Efforts

There are approximately 25 exemplary case studies developed by students from around the country in conjunction with the Vital Signs project that have undergone review and editing to qualify for publication on the Vital Signs website and stand as models. There are also links to more than 20 other case studies developed at schools around the United States and Canada in conjunction with the Vital Signs Project that reside on computer systems at the schools where they were produced. These studies have not gone through the peer-review process to qualify for inclusion in the Vital Signs Case Study Library, yet they provide a glimpse of the many ways university teachers and students and are putting the Vital Signs Curriculum Materials to work.

Several case study efforts, both undergraduate and graduate, are described here. These case studies received awards in the 1998 Vital Signs Case Study Competition and represent diverse examples of the implementation of the Vital Signs approach.

### Case Study at Cornell University: "It's Not Easy Being Green: The Audubon House"

Abstract: The National Audubon Society, in cooperation with the Croxton Collaborative, renovated an eight-story building in lower Manhattan with the intent of creating a working example of sustainable architecture. An undergraduate seminar at Cornell University studied the Audubon House during the spring of 1998. After an exploratory visit to the building, the student team decided to focus their investigation upon the performance of the building's lighting systems. Based upon observations during their initial visit, the students hypothesized that the lighting system did not function as intended. They questioned whether the system responded to the variety of lighting conditions experienced at the building and met the needs of occupants. To test their hypothesis the students investigated the distribution of illuminance on a typical office floor, lighting power density, penetration of daylight into offices, patterns of electrical lighting use, patterns of use for window blinds, lighting energy use and savings, and occupant perceptions of glare and general lighting conditions.

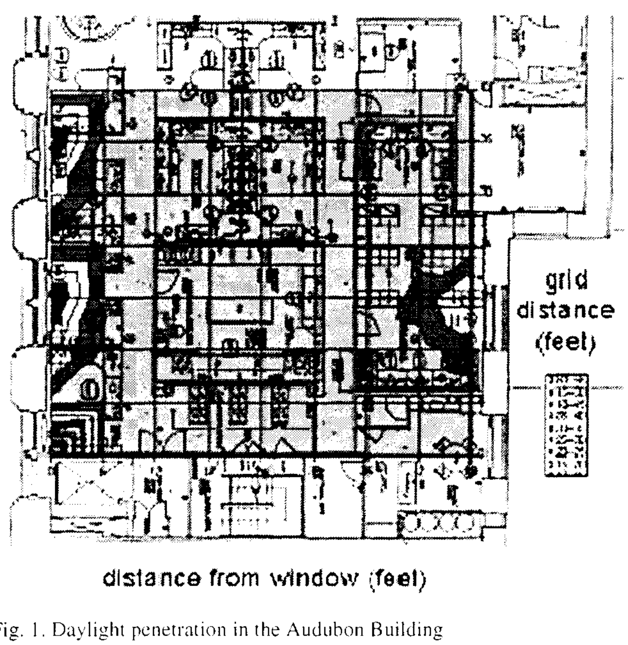


Fig. 1. Daylight penetration in the Audubon Building

The investigation found that the lighting system partially performs as intended. The students discovered that daylight does not penetrate deeply into the building. However, occupants are pleased with the sense of daylight in offices that is made possible by direct visual connection to the exterior windows from virtually all areas of the space. The students found that the lighting control system is not operating at maximum efficiency because of broken, disconnected, or uncalibrated occupancy and daylight sensors. The spatial layout and low workstation partitions, which improved visual access to exterior windows, led to a lack of privacy and noise control problems. The students found that building occupants, many of whom did not begin their employment until after the renovation of the building, did not understand the intent underlying a number design decisions, such as the choice to install low partitions.

The student team does not consider this a conclusive analysis of the building. Rather they hope their study serves as the beginning of future inquiries that further investigate issues of design, environmental impact, and occupant experience, raised by the example of the Audubon Building.[5]

### Case Study at Mississippi State University: "Dog Trot: A Vernacular Response"

Abstract: This case study is an investigation of an architectural response to regional climate conditions. The study focuses on a vernacular typology of the Southeast known as the dog trot house. The traditional dog trot house is characterized by two log houses with a central connecting passageway, a porch at either side, and a chimney at each end. Developed in response to its environment, the dog trot house is successful in providing cool, shaded space in the Southeast's hot, humid climate. This is accomplished primarily through a successful passive ventilation strategy.

This study attempts to identify, understand, and test the characteristics of the passive ventilation system using simple means available to anyone. Tests were conducted using a dog trot house located in French Camp, Mississippi as an example of this building type. Using an anemometer and a pendular wind measuring device of their own design, the students measured wind speed and direction on site during two days in March. Tests were also carried out on a scaled physical model.

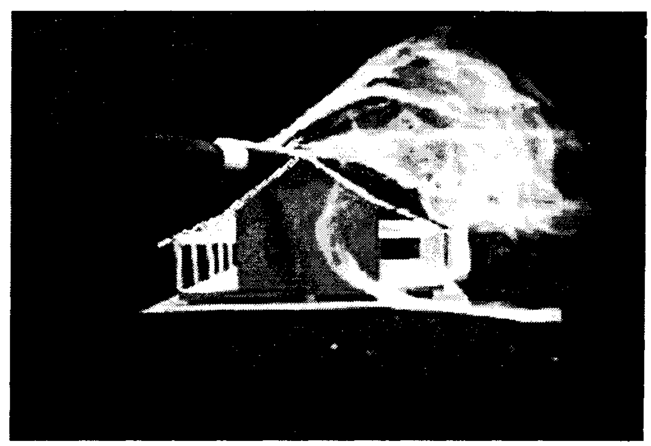

Fig. 2. Wind testing the scale model of the dog trot house at French Camp, Mississippi.

The results of the study show the geometry and orientation of the dog trot house to be extremely successful in creating passive ventilation. The north-south orientation of most dog trot houses in the southeast takes advantage of prevailing wind patterns. The tall roof and solid spaces at either side of the breezeway create differential pressure as wind passes over and through the house. The differential pressure forces air to move through the central passageway at a greater speed. Measurements show wind speeds at the central breezeway to be substantially greater than those at the exterior of the house. The authors feel the dog trot house should be considered an important prototype for designers concerned with energy efficiency.[6]

### Case Study at the University of California, Los Angeles: "The Ojai Section: Daylighting Strategies In Schools by Maynard Lyndon"

Abstract: This case study examines innovative daylighting strategies employed by architect Maynard Lyndon during the school building boom that followed World War II. The study describes Lyndon's innovative design goal of achieving balanced daylighting in school classrooms. His design solution involved three main features: a fully glazed north wall, south clerestory windows above a light shelf, and vertical louvers in the ceiling inside the classroom. These elements became known as the 'Ojai Section' after Lyndon used it for the first time in Mieners Oak School in Ojai, California.

The case study examines lighting quality, occupant comfort, and user response in schools incorporating the Ojai Section. It includes illuminance data collected in the field, interviews and surveys of users, computer models, and physical model tests. Field measurements show that the Ojai Section performs very well in providing an appropriate level of illumination for classroom instruction, making electric lights almost superfluous during daylight hours. The design presents some problems in that it has not allowed for easy incorporation of computers and television monitors in the classrooms. It also offers limited display area because of the expanse of glass at the north and south perimeters of the classrooms.

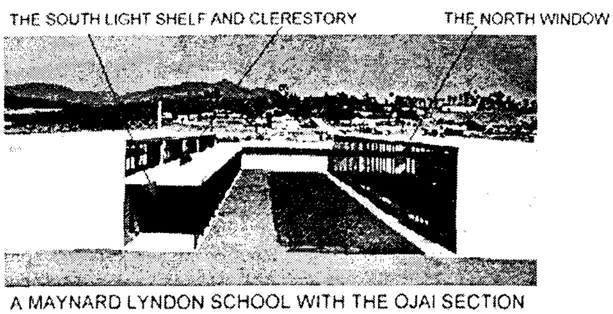


Fig. 3. Ojai Section showing daylight strategies.

School administrators report that the north facing glass and south clerestories require cleaning and maintenance. Administrators and staff appreciate the daylight in the classrooms, but were not aware that the schools had been specifically designed with this goal in mind. The lack of understanding of the design has presented some problems, particularly in the area of landscaping. At one school, trees planted many years ago have grown to a size where they almost completely block light from entering through the south facing clerestories.

The student author concludes that the Ojai Section provides well-distributed, balanced illumination in classrooms. It presents some problems in adapting classrooms to meet contemporary technological requirements, but these problems are not insurmountable. The quality of light is excellent and the Ojai Section deserves renewed attention from architects and educators interested in daylighting in schools.[7]

## CONCLUSIONS

Concepts and principles of building performance, e.g. lighting, acoustics, energy use, comfort, may be learned through student involvement in the case study process. Such experiences may be quite varied—involving the questioning of design intentions, first-hand investigations in actual buildings, and the matching of design intent with performance. Faculty and student experiences indicate that this Vital Signs approach synthesizes design and analysis, and provides a vehicle for internalizing these efforts as personal experiences in a much more effecting learning style. Although such an approach requires additional planning and structural changes to the curriculum, particularly in large lecture courses, it is also considerably more enjoyable, introduces a team investigation experience using research techniques, and expands our design knowledge base by sharing the case studies worldwide.

## ACKNOWLEDGEMENTS

The Vital Signs Project, although administered by the University of California, Berkeley is the collaborative effort of members of the Society of Building Science Educators from across the country. The valuable support of these individuals in writing the resource packages, conducting workshops at summer training sessions and inspiring student investigations through their courses has changed and hopefully will continue to shape the direction of architectural education.

## NOTES

[1] These terms refer to a particularly useful learning style theory developed by David Kolb of MIT's Sloan School of Management. Kolb's learning styles are further discussed in Organizational Psychology, An Experiential Approach, (Englewood Cliffs, NJ: Prentice-Hall, 1971).

[2] Kolb, David A. Experiential Learning: Experience as the Source of Learning and Development, (Englewood Cliffs, NJ: Prentice-Hall, 1984).

[3,4] Vital Signs Brief:<http://www-archfp.ced.berkeley.edu/vitalsigns/brief/index.html>

[5] This case study took place in an undergraduate seminar course: <http://www-archfp.ced.berkeley.edu/vitalsigns/bld/Casestudies/cornell_audubon_ab.html>

[6] Undergraduates in a lecture course developed this case study. <http://www-archfp.ced.berkeley.edu/vitalsigns/bld/Casestudies/msstate_dogtrot_ab.html>

[7] A graduate student developed this case study in an independent study course: <http://www-archfp.ced.berkeley.edu/vitalsigns/bld/Casestudies/ucla_ojai_ab.html>

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