Case Studies as Research

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ABSTRACT

Architectural education employs a variety of case studies (of a sort) in design studios, lectures, and seminars. Unlike case study models used in the medical, law, and engineering professions, architecture students frequently encounter "case studies" that include only the most rudimentary information: typically only the identifying characteristics of a building (such as square footage, architect, construction date, costs, materials, geographic location, and selected imagery). Rarely do such case studies (or precedents) include building-in-use performance data or information regarding occupant health, well-being, or satisfaction. In essence, these case studies are like one-sided baseball cards – providing identifying information, but no sense of career accomplishments. Architectural precedents are not like other case studies.

Architectural education, hence the architectural profession, lacks the supportive infrastructure and culture of knowledge-based inquiry that is required for improved design. An active research agenda is not a way of life for most architecture faculty. An understanding of research is not inculcated into most architecture students. We propose that conducting building performance case studies as a foundation activity within architectural curricula will provide students with needed research skills and build the knowledge base that comes from the sharing of research within a profession.

Design activities that train students (as future practitioners) to methodically analyze building performance are rarely seen – whether such performance be economic, social, religious, thermal, or visual. This paper will outline the steps of an architectural education approach that challenges students to closely examine examples of built environments (case studies) using the scientific method – i.e., by developing a hypothesis and related inquiry questions; establishing a methodology using suitable equipment/instrumentation or surveys; gathering appropriate data from the physical/cultural environment; analyzing the collected data; and developing conclusions that include design lessons learned.

The paper will include a discussion of: 1) the approaches taken by the Vital Signs Curriculum Materials Project and the PROBE studies of the Chartered Institution of Building Services Engineers (CIBSE), 2) research skills involved in conducting substantive case studies and the pitfalls associated with case study research in architecture, and 3) design lessons learned through sample exemplary case studies conducted by architecture students.

Case Studies

Case studies are used extensively in education -- more so in some disciplines than in others. Typically a case study is presented to students for their enlightenment. Such case studies are developed outside of the class that is using the study, are often used by numerous institutions over an extended period of time, and generally try to address general situations of common concern across institutions. Case studies are rarely developed by students, but rather by academics as educational resources to be used by students. In most institutions, the development of cases studies is probably seen as a form of faculty scholarship (as opposed to research).

Wilson states that: "A case study is a reconstruction of a real-life situation(s) which is examined by one, or a group of trainees, using the mental skills of problem solving and decision making, of analysis, synthesis and evaluation, for the purpose of establishing those general principles which are illustrated by the particulars of the case" (1). Such a concept would seem to find a welcome home in architectural education, which purportedly deals with the analysis and synthesis of complex situations on a daily basis. The ability to "construct" as case study, rather than just view a reconstruction, would be icing on the cake.

The Australasian Faculty of Occupational Medicine (AFOM) has prepared a concise summary of the benefits that can accrue from the use of well-developed case studies of the conventional sort (2). These benefits (substantially paraphrased herein) include:

- The likelihood that learners will more clearly see links between theory and the real world;
- A need for learners to critically grapple with complex situations, concepts, and issues;
- An opportunity to discuss varying opinions regarding the case study with peers (and faculty);
- An opportunity for learners with different perspectives and interests to contribute to an understanding of the case study "story";
- A need for thinking to occur "outside the box."

Disadvantages related to the use of case studies were also summarized by the AFOM. Key disadvantages (again liberally paraphrased) include:

- The case study process is less familiar than more common teaching approaches (lecture, lab, studio), and may prove difficult for learners to embrace;
- Reasons for using a case study may be unclear to the learner (Why are we doing this? Where is this going?);
- Learners may incorrectly believe that practices or results illustrated in case studies are examples of good (or bad) practice and wrongfully incorporate them into (or exclude them from) their own practices;
- Faculty may not have the necessary skills (or background knowledge) to engage a given case study and may allow cases to be treated glibly, intuitively and/or unsystematically. For some faculty, case study teaching can be extremely threatening -- there is often serious risk-taking involved!

The Australasian Faculty of Occupational Medicine described a "good" study as having the following characteristics:

- The case study is a slice of reality that forces learners to address complex situations;
- The case study forces learners to use complex problem solving processes, of the type required in real life situations;
- The case study drives a need for further research and information acquisition;
- The case study should create tensions between conflicting points of view;
- The case study invites learners to engage the characters, issues, and dilemmas in the case;
- The case study should encourage debate.

All-in-all, the advantages of case studies as an educational approach in architecture would seem to outweigh the potential disadvantages. The characteristics of a good case study are in line with what many might consider the characteristics of a good architectural education. The use of case studies (as understood by disciplines other than architecture) in architectural education is an intriguing idea, worthy of further exploration. This is especially true when linked to the concept of design as hypothesis (3). Any serious, knowledge-based profession should aggressively explore its underlying hypotheses through research, not simply restate them through precedent publication.

Case Studies in Architecture
Almost ten years ago, Tom Fisher (currently Dean, College of Architecture and Landscape Architecture, University of Minnesota) published an article in *Progressive Architecture* lamenting the problems faced by the architectural profession–economy, elimination of certain types of jobs by computer technologies, a decline in demand for architectural services, architects' aversion to risks involved with the complexity of construction groups, and the vulnerability of architects to the growing skepticism of the profession which is not as specialized or knowledge-based as law, medicine, or engineering (4). Fisher proposed a model of action based on lessons from the medical, legal and engineering profession where architects are involved with checking the functioning of their products—carrying out building diagnostics (what we will call building performance case studies)—to be sure that systems are working as designed, occupants are satisfied, and information brought back to practice. Case studies should be at the center of architectural education. There are a means of proving the hypothesis of design.

Most architecture schools might use the term "case studies" broadly to mean a gathering of factual building information referenced from architectural journals, the Internet, and publications. Such case studies are used as precedents for design schemes. Typically incomplete precedents -- based on the collection of limited information such as construction costs, materials used, square footage, and images taken prior to occupancy–with very little information on how a building actually worked once it was used. How comfortable are people? How much energy does the integrated lighting system use? Does the HVAC system meet the targeted requirements for ventilation?

Building engineers, sociologists, and building designers occasionally do post-occupancy studies. These studies, however, are few and far apart considering the vast numbers of buildings designed and constructed each year. We propose that regularly conducting building performance case studies as a fundamental activity within architectural curricula will answer these kinds of questions, provide students with needed research skills, and build the knowledge base that comes from the sharing of research results within a profession. The research skills involved with case study development, learned at a formative time, will lead to a more informed profession and to future building designs that are influenced by actual experiences with real buildings.

This paper outlines the steps of an architectural education approach that challenges students to closely examine examples of built environments (case studies) using the scientific method. In essence, this is a true research methodology that involves developing a hypothesis and related inquiry questions; establishing an appropriate methodology using suitable equipment/instrumentation or surveys; gathering appropriate data from the physical environment and/or from occupants of a building (the cultural environment); analyzing the collected data; and developing conclusions that include design lessons learned. Several curricular efforts and models for building performance case studies are described prior to the envisioned process.

Models for Case Studies

Vital Signs Curriculum Materials Project
The Vital Signs Project began in 1992 with the goal of encouraging the next generation of architects to build environmentally-responsible and energy-efficient buildings. This goal promoted a pedagogic approach that encouraged -- in fact demanded -- on-site experiential learning. Over seven years the Project developed and disseminated background materials, conducted four "train-the–trainer" workshops for faculty, provided faculty case study development grants, conducted two student case study competitions, and established an Internet site to distribute Vital Signs artifacts. The Vital Signs Project was created and coordinated by faculty in the University of California-Berkeley College of Environmental Design and received financial support from the Energy Foundation, Pacific Gas &

Electric, the National Science Foundation, the Nathan Cummings Foundation, the Educational Foundation of America, and the U.S. Department of Energy (5).

Vital Signs developed a variety of lasting curricular innovations, but of particular importance were four summer workshops (1995–1998) where 200 technology and design faculty were trained to use the case study approach to building analysis and understanding. Through an associated toolkit loan program, which is still active, eight $25,000 toolkits were/are provided each year to schools that are without the ready resources to acquire building measurement equipment to generate Vital Signs case studies.

The key elements of the Vital Signs approach are: 1) select building (obtaining permissions) and topic; 2) gather background information (e.g., observational visit, design intent, architect interview, review of utility bills); 3) develop a well-articulated hypothesis and set of inquiry questions about a focus issue; 4) develop appropriate measurement techniques and instrumentation; 5) collect data through on-site measurements and/or surveys; 6) analyze the data; 7) offer lessons learned about the design of the building; and 8) post the case study to the WWW to share with design professionals, faculty, and students. Each step is checked by a supervising faculty and peer-reviewed (depending upon time constraints).

Students using the Vital Signs approach were seen to make more meaningful and intuitive connections between theory and design, between initial intent (hypothesis) and final outcomes. In a paper presented to the European Association for Architectural Education, co-author Walter Grondzik wrote, "… the Vital Signs project provides an excellent vehicle for expanding student views of the built environment. In addition, it provides a structure that can enhance student communication and team planning capabilities. As establishing a methodology for a site investigation is essentially a design problem, it could also be argued that the Vital Signs project can broaden students' design thinking." These observations track quite well with the advantages to the case study approach summarized by the Australasian Faculty of Occupational Medicine. Just getting students into buildings with an investigative mind-set is typically a catalyst for learning.

A library of model case studies developed with Vital Signs funding may be found at: http://arch.ced.berkeley.edu/vitalsigns/bld/case_studies.html. The collected case studies involve student investigations of actual buildings where selected buildings and topics go hand in hand. Each building has its own story to tell, with provocative questions about building performance and how design intent was successfully (or unsuccessfully) brought to life. Sometimes student/faculty motivation to study a building stems from inherent curiosity about a specific building or a class of buildings. Case study buildings tend to fall into four general categories: 1) well-known, much-discussed historic buildings; 2) architecturally influential contemporary buildings; 3) buildings known for their reputed energy efficiency and/or environmental responsiveness; 4) buildings generally representative of a specific building type, such as a museum, school, library, residence, or office. These categories do not represent an exclusive pool of case study candidates. Local buildings with notoriety or that pique the curiosity are also often appropriate (6).

"It's Not Easy to be Green: The Audubon House" is a Vital Signs case study competition winner (the full study is on the Vital Signs website) wherein students took the opportunity to compare a well-documented (and well-publicized) design intent with the results of on-site measurements, observations, and experiences. The class selected lighting performance as an issue that could be handled within the time constraints of the semester-long course, yet one rich enough to yield interesting investigations that the class could complete in smaller teams. Lighting as a focus issue also held architectural allure. In order to gather information to support (or refute) their hypothesis, the class proposed specific avenues of investigation through testing a series of inquiry questions. Measurements using illuminance and luminance meters, data loggers on lighting circuits, surveys, and photography, resulted in the (surprising) finding that the daylight sensors were not properly tuned or adjusted; that distribution of light was fairly uneven although occupants were still comfortable with their visual environment; that privacy was a major concern. The daylight sensor finding led to a serious proposal to commission the lighting controls for the building.

Chartered Institution of Building Services Engineers (CIBSE) PROBE
Post-Occupancy Review of Buildings and their Engineering (PROBE) was a research project that ran from 1995-2002 under the Partners in Innovation scheme (jointly funded by the UK Government and The Builder Group, publishers of *Building Services Journal*). It was carried out by Energy for Sustainable Development, William Bordass Associates, Building Use Studies, and Target Energy Services (7). The PROBE process was developed by experienced survey practitioners with the intention of encouraging building services engineers and design professionals to develop better designs, with the benefit of the feedback obtained, using existing techniques and benchmarks where possible.

The philosophy behind the PROBE studies was to make post-occupancy evaluation a standard follow-up to the design and construction of all new buildings and that lessons learned from PROBE might identify how buildings can more effectively reflect those lessons. PROBE publications have been internationally acknowledge as a successful way of undertaking and reporting post-occupancy evaluations. Researchers streamlined the process over a number of years to maintain quality control on the research and findings, while working within relatively small budgets allotted for the investigations.

Similar to the Vital Signs approach (yet more rigorous), the PROBE process involves nine key steps:
1. Obtaining access and permissions to the building.
2. Pre-visit questionnaire to the building manager.
3. First site visit (pre-visit assessment, seek future permissions, review utility bills, take spot measurements using power meters, light meters, temperature probes, dataloggers, smoke pencils, and cameras).
4. Second site visit (another fresh look at the building repeating the procedure on the first visit and filling in the gaps).
5. Occupant survey with questions on environmental comfort, personal control, and background information on health, productivity, and demographics.
6. Energy assessment–which uses spreadsheets to calculate electricity consumption by end uses and is reconciled with fuel bill data.
7. Pressure testing for ventilation and envelope leakage.
8. Drafting technical report and soliciting reviews and comments.
9. Producing article for publication.

The PROBE studies (many are available as PDF files located on the Usable Buildings Trust website: http://www.usablebuildings.co.uk/) have a consistent report outline. Each article, though modified over the years, includes a description of the building and the investigative results in sections such as: construction details, services arrangement, heating and hot water, control issues, lighting, occupant response graphics, CO_2 emissions, electricity consumption, pressure tests, and a final section on design lessons learned.

Building Case Studies as Research
A major difference, in philosophy and implementation, between case studies in law, business, and medicine and those proposed herein for architecture is student involvement in the researching of case studies. Rather than simply presenting pre-packaged case studies to students, we believe that students can also develop case studies. The use of case studies as objects can be very educational, but does not constitute research. Development of case studies as events is educational – and also instills a sense of research process in the learner.

In conducting building performance case studies, students are exposed to several experiences that are key to a successful research mentality. These include (and nicely echo the thoughts on case study usage summarized by the AFOM):

Hypothesis development: This is often the most difficult part of the building performance case study process – to the extent that some facilitators use synonyms such as hunch, question, or idea. Many students have trouble engaging the idea of a testable statement (the cynic may suggest this is because the un-testable statement, hyperbole, is a daily aspect of numerous design studio settings). Experiences with on-site performance investigations show that extra effort must be placed on the development of clear, meaningful, and useful hypotheses. The effort appears to be worthwhile, as grasping the concept of hypothesis opens the door to the scientific method and research. It could also be argued that this concept is the key to distinguishing between building as mental construct and building as physical construct.

Critical thinking and reasoning: Critical thinking skills are required to develop a valid hypothesis from among the hundreds of ideas that assail students as they wander about a building under investigation. Development of a viable methodology to address the hypothesis is a tour-de-force in critical thinking. In many cases, on-the-fly adjustments to methodologies are necessary to adapt to unanticipated conditions on site. Even more challenging, snap decisions are often appropriate as a means of following a line of inquiry suggested by real-time findings.

Using state-of-the-art equipment: Although equipment is not an inalienable component of research, today's students have been described as the "video generation." Feedback from Vital Signs and Agents of Change investigations shows that equipment and instrumentation is a powerful hook that can be used to capture student imaginations. Use of equipment is also educational; it typically becomes quite clear to investigators that equipment is no more useful than the creativity (and understanding) of the equipment user.

Communications: Communications skills are integral to case study development and presentation. Team investigations require team members to be on the same page and expose individual student thoughts to peer review. Presentation of case studies requires the development of information packaging skills. Students are often amazed at what they can accomplish when required to present two days of work in an hour's time.

Design Lessons Learned: Information from building performance case studies has provided feedback to the design community (architects, engineers, consultants, and design professionals) about how many aspects of design have performed in actual use. Experiences such as these in architectural education could help to bring routine feedback to bear on the programming, design, construction, operation, and occupancy of buildings. Anecdotally, the authors have witnessed accounts of information transfer to practice and in design studios. A recent graduate described the concern by the principal of an architectural firm about humidity levels in a newly constructed winery and wanted some way to monitor the conditions. The student described her experience using temperature and humidity data loggers that would provide a time-series chart over a designated period of time. The principal was amazed at the utility of this information and provided the client with assurances that wine storage conditions were optimized by the design. Many students are referencing case studies (enlightened precedents) on the web as a means of expanding their own experiences to design elements as diverse as shading devices and cisterns for their studio projects.

This kind of feedback loop will change the culture of architectural education (and eventually the architectural profession) and help to expose design to a broader marketplace of ideas , to permit open discussion between professionals about the successes and failures of designs, to increase familiarity with energy and occupant satisfaction benchmarks, and to streamline techniques for collecting and presenting information (7).

Summary

Research skills learned by investigating actual buildings give students a new way to consider architectural design as a knowledge-based process. The design process involves design intent (hypothesis), design criteria (benchmarks of acceptability), and design implementation (the methods by which intent becomes reality). Knowledge-based design can (we believe it should) involve case study research, more advanced scholarship using various modes of inquiry and methodology, and rigorous analysis to make comparisons and judgments of building performance. The learning cycle is complete when acquired knowledge completes the feedback loop from researcher-learners (whether student or professional) and is reflected in the efforts of designer-learners. Buildings are much too important to society to be allowed to go through life as untested hypotheses.

Targeting case studies in the realm of 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. Buildings are anti-entropic; 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 and resource 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 (8). Design as hypothesis should be subjected to the fullest extent of the scientific method through case studies as research.

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