Teaching Energy in Design:

A Matter of Attitude, Circumstance and Style

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1983

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Underlying premises of the passive design curriculum development project were "...that a fundamental shift in design philosophy was necessary in order to save a significant amount of energy..." and that to achieve that shift a "...building should be considered as mediator between man and climate, able to provide conditions of comfort primarily by its form and the configuration of its building materials". Furthermore "...whatever information [about the building as an environmental filter between man and climate] is taught in lecture or seminar courses is not transferred or reinforced in studio...."[1]

In Project Journal: Teaching Passive Design in Architecture, Prowler and Fraker sought to "...make explicit certain hidden assumptions about architectural education and the relationship of technical subjects to this educational process. We believe this relationship is at the heart of the energy in architecture question."[2] They identify three key considerations: 1. "The question of whether energy concerns are relevant to architectural form...is embedded in theoretical, methodological and educational issues which have been inherited from this larger debate of the role of technics in design." 2. Environmental control technology and abundant energy have allowed architects to maintain comfort within buildings regardless of the interactions between climate and building form. This has "reinforced the widely held belief that technics in general and environmental controls in particular are independent of form. From this premise, the simple pedagogical result is that technology has become separated from the primary educational experience...the design studio". 3. While many architectural educators acknowledge that a holistic view of architecture would include firmness, commodity and delight they "maintain that technics is the 'servant of design.'"

The Association of Collegiate Schools of Architecture's Request For Proposals, "Teaching Energy in Design", acknowledged the importance of Prowler and Fraker's concerns when it stated

"...program sponsors are interested in the more general problems that arise when any technology or design strategy is emphasized..." and called for "...case studies that offer insights into the value of the materials used as well as the more fundamental questions of teaching methods and content".[3]

In light of these wider concerns, Beginning Exercises in Energy Conscious Design: A Resource Book in Building Climatology by Allen, Moore and Mahone, of the Massachusetts Institute of Technology, was a particularly interesting package to evaluate. First, it is applicable to studios, which, because of their integrative nature, seem to hold the most promise for linking energy and design. Second, it is aimed at faculty members who are unfamiliar with energy issues. If energy is to become an integral part of design teaching, it must be integrated into the course work of instructors who are not experts in the subject matter. Third, the authors believe technics and design are related. They state that "Energy has become as integral and inescapable a factor in architectural design as load bearing structure."

EVALUATING FACULTY

Six members of the architecture faculty at the University of Oregon participated in this program. They are Donald B. Corner, Jerry V. Finrow, Thomas C. Hubka, William Kleinsasser, John S. Reynolds and Michael Utsey. The faculty have in common the fact that they all teach design studio and speciality courses. They are quite diverse in other respects. One of them has taught for four years, three for 10-12 years, and two for 15-17 years. Two have a modest knowledge of energy, three have above average, and one has extensive knowledge of energy. Their specialities include media, environmental control systems, theory, design process and materials and construction processes. Their studios, where all curriculum testing took place, are graduate and undergraduate at introductory, intermediate and advanced levels.

The remainder of this paper is based on the review of course handouts, student work, observation of studio process and interviews with the faculty. The author greatly appreciates the testing faculty's participation and acknowledges their willingness and openness in discussing the project and sharing their feelings. The interpretation of work and interviews, however, is the author's alone and he is soley accountable.

TESTING AND EVALUATION

The emphasis of this evaluation is not on how successfully the exercises in the MIT package helped students learn about energy, but how the pedagogical setting and faculty attitudes about technics, energy, teaching and learning affected their use of the package. This seems appropriate since it was written for faculty and since considerations which extend beyond the particular package are at issue. The evaluation rests entirely on the shoulders of one "informed" observer, and makes no pretense about objectivity.

After one year of exposure to the MIT package, one of the six evaluating faculty wrote a new exercise for each of the ten chapters and tested them during a 10-week studio. One faculty member wrote a new exercise combining ideas from Chapters 1, Thermal Comfort, and 2, Thermal Analysis of Building Sites, and used it in a one term studio. Another instructor combined suggested exercises from Chapters 3, Solar Geometry, 4, Simple Site Interventions, 5, Heating Load, and 8, Shading Devices, and used them as the core of a sketch problem, used once in a two term studio. One instructor read the MIT package completely but didn't try any of the exercies. One instructor skimmed the MIT package, "thought about it a couple of nights," and didn't try any of the exercises. One instructor didn't read the package and didn't try any of the exercises.

Is this record one of success or failure? Are we on or off the track of creating "...a fundamental shift in design philosophy in order to save a significant amount of energy..."? Are we altering the situation in which "...information [that] is taught in lecture or seminar courses is not transferred or reinforced in studio..."?

TECHNICS AND DESIGN

The six testing faculty were unanimous in their feeling that technics are fundamental to architectural design. However there was a certain consistency in attitude that technics should play a supporting rather than a primary role in determining basic building organization and form. "I think they [technical considerations] are followers rather than leaders as frames of reference for design...one makes a big mistake when they become leaders, because there are other frames of reference that are simply more fundamental...[for example]... responding appropriately to setting and supporting activities and purposes."

Even though technics is considered fundamental by all of the instructors, none elected to offer a studio whose primary focus was a set of technical concerns. Although four instructors included numerical analysis, mostly related to the

MIT exercises, none of them asked their design students to use numerical evaluation and design in a reiterative manner to achieve a particular goal or supply any numerical proof of performance at the end of the project.

The similarity of attitude and approach is strongly related to the institutional setting. Design studios last only ten weeks, term-long projects predominate, and the studio comprises 30 to 40% of the students' credit load. The Department states that the curriculum is design centered and that design is comprehensive, dealing with place, human activity support, construction and structure, environmental control and spatial ordering.

The idea that design is a comprehensive integrative activity has been translated literally into the way that studios are taught. Design instructors tend to select problems that enable students to consider the full range of curriculum categories and to establish hierarchies based on their understanding of the project. Because projects are broadly defined and the term is short and design credits are a minor part of a student's term load, projects rarely progress beyond a schematic resolution. While having real benefits in terms of helping students to think integratively, the depth of thinking in specific areas suffers.

The lack of time in studio for in-depth analysis and design-evaluation-redesign, combined with the instructors' vision of technics as playing supporting roles results in technical considerations being addressed primarily in lectures and seminars, which are, by their nature, disconnected from the central focus of the department, the design studio.

ENERGY AND DESIGN

All six instructors initially identified energy as an important world problem and understood that buildings play an important role in the consumption of energy in the United States. Given that perspective one might expect that they would put energy high on the list of things to consider. They did not necessarily do so. Two instructors ranked energy as important, two called it important but no more so than several other considerations, and two felt that while it was important it was not as important as other architectural considerations.

Although admittedly important as a national and international problem, when viewed from the perspective of designing a single building, energy tends to merge with other technical considerations and play a supporting role to other design endeavors.

Given its conceptual inclusion with other technical concerns there are still several characteristics of energy which seem to set it apart in the view of the testing faculty. Primary among those seem to be its lack of a consistent set of visual manifestations. This is due in part to the influence of climate and the way in which the interaction of climate, occupancy and building form can seem to make any given design strategy inexplicably change from appropriate to inappropriate. For example, an appropriate north facing skylight in a condensed building form with a low skin-to-volume ratio and a cooling load can become inappropriate as the designer elongates the building's shape for non-energy reasons, increasing its skin-to-volume ratio, producing a heating load and the need for a south facing skylight. Because most United States climates are temperate, their salient characteristic is change, not constancy. Therefore for skin dominated load buildings, the appropriate response is changability. For architects trained to use visual characteristics as primary clues, the nature of an energy conscious design is a particularly difficult one to assess.

Faculty have developed several strategies for making energy conscious design more readily visible. For example, one instructor always includes includes highly visible program elements like a passively ventilated hose drying tower on a fire station which allow students to apply energy principles without fear of overbalancing the entire design towards energy.

The visual manifestations that do present themselves are further complicated by the fact that they are rarely pure in their roles. The same windows that are used for solar gain are also used more commonly, and with greater confidence, for view and light.

Given the difficulty of visual assessment, energy problems and solutions are frequently described quantitatively. Most of the instructors saw quantitative characterization as severely limited in its descriptive power and have developed means linking considerations of quality to quantity. Two of the most successful were the numerical documentation of a microclimate and use of models for light analysis. The microclimate analysis adapted from chapter 2 of the MIT package involved recording the air temperature, mean radiant temperature, wind speed, and relative humidity three times a day for four days for a microclimate nearby that the students knew well. One of the most satisfying aspects of the exercise was the link formed between a numerical description of human comfort and experience of the same. The process of making measurements heightened the students awareness of the interaction of the climatic variables and made them acutely aware of variation in microclimate caused by buildings.

Models are particularly effective in that they can be used for both quantitative and qualitative analysis of light. Again, the visual experience of a space can be tied to a numerical description. Equally valuable, time can be speeded up so that usually slow changes can be appreciated. The instructor who gave these two exercises to his studio of new graduate students (who had undergraduate degrees in other fields) thought that the issue of linking quantity and quality at the introductory level was particularly important so that students developed a comprehensive and integrative view of design. Once this view of design was established students could focus on narrowly defined quantitative descriptions later on in their education without fear of neglecting the integrative nature of design.

A perplexing question for most faculty seemed to be whether energy consciousness should be used as a limitation to or generator of design. Used as a limitation, energy concerns could be used to narrow the field of acceptable solutions; however, to produce the field of acceptable solutions, some other design generating criteria had to be used. This position fits well when one considers technical considerations as supportive to more fundamental considerations. However, some faculty thought energy concerns would be more strongly in evidence if they could be used directly as design generators. It was extremely important for them to have examples in the form of case histories, typologies, or patterns, which demonstrate how energy can be generative while maintaining a balance with other architectural concerns.

Regardless of how energy was taught in studio, there was fair agreement on what students should know about energy conscious design. First, they should understand that designing for climate is an integral part of energy conscious design and that climate is a contextual issue. Buildings should respond to the place that they are in, and climate plays an important role in defining the character of a place. Site, building organization and orientation in terms of the availability of sun, wind and light is the yardstick that instructors use to evaluate whether students have incorporated energy consciousness into their design thinking.

The second level of knowledge that instructors value is at a much smaller scale, involving appropriate choices of materials, insulation levels, mechanical systems, etc. Because studio projects remain schematic, these issues are rarely dealt with in any depth, and therefore their power to inform design is frequently left undiscovered.

Occasionally in seminar or lecture classes, students develop in more detail work begun in studio. Although separated from studio and therefore reinforcing the idea that energy is something you deal with outside of design, the experience can be quite powerful. As one instructor put it "they often come in with a building that's sort of half designed and they leave with a building that's two thirds designed... [in making] those steps beyond preliminary design they find that daylighting devices and those kinds of things actually make the building better -- enhance it, so I guess the thing I would like them to leave most with is the idea that it's an exciting batch of stuff that actually can tie in other things as well and it isn't just numbers."

For instructors who do not have much experience in analyzing the performance of buildings, it is very difficult for them, especially as the buildings become more complex, to judge how well a student's design will perform. Numerical analysis is seen as complicated, and very consuming of precious studio time. Yet analysis may be the key. As one instructor who didn't use the MIT exercises remarked when told that the building designs in his studio might use two to four times as much energy as an energy conserving building would, "Obviously, we wouldn't want that to happen. That is so sloppy that I can't tolerate that [as] a way of operating. It's just that it's very hard for me to know whether they are or not [using more energy than necessary]."

The most prevalent concern among the faculty was that energy considerations be appropriately balanced with other architectural concerns. Faculty felt that if a building looked like an "energy building" it was an indication that other important architectural issues were being neglected.

THE MIT PACKAGE

All instructors were offered technical assistance in revising exercises and preparing lectures for class at the beginning of the project. Of the six participants, the three who used the MIT document described their energy knowledge as above average to high and two of them taught specialties related to energy. Of the three who didn't use the package, two described their knowledge about energy as low and none of them taught specialities related to energy. It seems that while the MIT document is intended for instructors just beginning to teach about energy, and is, in my opinion, extremely well suited for that, it was more successful with experienced people than with inexperienced people. The faculty who didn't use the document describe their studios as having structured sets of objectives and methods. It was clear that the MIT exercises did not fit their methods, and the work required to rewrite them, even with assistance, was not perceived as worth the effort. When asked to speculate on what would have made more useful exercises, they each requested some sort of typology of energy conscious design. This would include a set of patterns that have a simple principle, a clear example of how it is applied, and an explanation of how to apply it in your own work.

All three instructors who used some of the exercises, changed and embellished them. The alterations usually had to do with making them more particular to the studio project and more consistant with the students' time constraints at a particular point in the design process. MIT's idea of condensing "...information on passive energy in buildings into a few nuggets of raw material from which you can manufacture an exercise, a course, or a curriculum to fit your situation" was quite effective. I'm convinced that without the MIT document, most of faculty who tried exercises in their studios would not have done so.

CONCLUSIONS

The experience of testing the MIT curriculum package has led to three general conclusions about teaching energy in design that may have some applicability beyond the University of Oregon.

The testing faculty's attitude about the role of energy in design is largely determined by their attitude about the role of technics in design. In general that attitude is one in which technical considerations play a supporting role to other more fundamental considerations in the project. They view energy as a technical concern and technical concerns as secondary in the design process. Any set of cirriculum material which does not attempt to change this attitude will be unsuccessful in creating the "...fundamental shift in design philosophy... necessary in order to save a significant amount of energy..." Without this shift, designers will be unable to consistently produce a building "...able to provide conditions of comfort primarily by its form and the configuration of its building materials."

In an institution which considers itself to have a design centered curriculum, has limited resources to commit to studio teaching when student credits in studio account for less than half of a total term load, and places a very high value on the comprehensive nature of its studio offerings, it is difficult to proceed beyond a schematic level of solution for any single issue. This results in the separation of detailed technical analysis from the studio setting. Technical analysis is taught in non-studio classes, frequently isolated from the studio problem and separated from the reiterative studio process of design-evaluate-redesign. This separation reinforces the notion that form and technics are separate and that technical considerations are the 'servant of design'.

In addition to attitude and circumstance, the instructors teaching style largely determine the degree to which energy is considered in studio. Many instructors, even if they are at ease with it, feel that too much quantitative analysis is an inappropriate use of studio time and are looking for a set of clear visual manifestations of energy conscious design that can be easily integrated with other architectural considerations.

FOOTNOTES

1. Prowler, D. and H. Fraker, Project Journal: Teaching Passive Design in Architecture. Association of Collegiate Schools of Architecture, Washington, DC, 1981, p. 23.

2. Ibid., p. 5.

3. ACSA, "Teaching Energy in Design, An Opportunity for Evaluation of Learning and Teaching Methods and Resources". Request for Proposals from architecture faculty, winter 1982, p. 2.