# TECHSTUDIO:
# A Studio Approach to Teaching Architectural Technology

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## ABSTRACT/INTRODUCTION

Architectural students always seem to have difficulty applying technology information to their studio work. Technology courses privilege a quantitative, engineering perspective while studio courses favor a qualitative, aesthetic perspective. As a result, students perceive that a dichotomy exists between the technology classroom environment and the studio environment. This paper proposes a hybrid lecture-studio approach where the students apply the lecture material directly to a design project. Hereafter referred to as a techstudio, this model enables students to obtain a deeper and fuller understanding of technology.

This paper first summarizes the existing pedagogy' then critically discusses the proposed hybrid methodology using examples of projects from a cross-section of technology subjects. These projects demonstrate a level of technical proficiency usually lacking in studio work, and a level of design complexity usually lacking in technology exercises. By directly applying the technical knowledge received through lecture to a design project, students retain and appropriate the knowledge more effectively than in the traditional lecture-only format.

## BACKGROUND

The techstudio approach presented in this paper responds to the usual disconnect between the technology and art in today's architectural pedagogy. As Karsten Harries writes, "Caught between engineering and art, modern architecture has been unable to achieve a convincing and lasting reconciliation of pragmatic-technological and aesthetic considerations."[1] This schism exists, in part, because architectural technology is taught primarily through lecture, rather than studio, formats, creating a gap between the reception of technical knowledge and its application. This separation between knowledge-received and knowledge-applied compromises the student's learning experience.

The typical term schedule for an upper division architectural student contains several lecture courses in technical subjects, such as structures and environmental control systems, and a studio where ideally the knowledge presented in the lectures is applied to design projects. In reality, a relatively small portion of this information ever makes it into the projects. Because the event of *receiving* technical knowledge is separated in time and space from the event of *applying* that knowledge, the opportunities to reinforce learning through application, and to explore the qualitative aspects of technology, are diminished.

This gap between the technology and design curricula is also due to the different form that knowledge is organized for each. In the lecture course, the body of knowledge is organized into topical divisions. In architectural technology lecture courses, these topics are based on individual building systems. A *topic*-based taxonomy is presented of families and subfamilies of building systems. In the studio, however, knowledge about a given system is presented in increasing levels of specificity relating to the progressive phases of design. As a result, a *process*-based taxonomy is presented where the base of knowledge is organized according to the order in which it is needed in the design process.

How the knowledge is described is also different, as it must include the kinds of conceptual and vague descriptions of systems and their component parts that are required during the early phases of design. Any single element, a column for example, will have a conceptual description *(linear vertical support)*, a schematic design description *(steel column)*, and a design development description *(4" round tubular steel column)*. Therefore, not only are the classroom contexts of technology lecture courses and studio courses separate, but their epistemologies as well. This runs counter to modern educational thought, which since Dewey, has called for an integration of theory and practice. This integration is called for in the Boyer report, which states that the architecture curriculum ought to "encourage the integration, applications and discovery of knowledge within and without the architecture discipline,"[2] mirroring contemporary educational thought, which calls for pedagogy that enhances learning by using practice-based, experiential methods.

Experiential learning uses structured experiences to "*involve* people in experiences rather than to talk about the experiences vicariously."[3] Architectural studio is a form of experiential learning in that the student experiences the problems of integrating technology into a design rather than passively hearing about the technology in a classroom. The focus is on "the person and his own assimilation of the events."[4] However, according to John Dewey, "Mere activity does not constitute experience," because what is gained through experience is "meaningless unless it is consciously connected with the return wave of consequences which flow from it."[5] Therefore, when experience is "reflected back into a change made in us, the mere flux is loaded with significance. We learn something."[6]

Because learning is an iterative process, the learning environment ought to allow students to create and grow their ideas over time. In this process, the students need to be encouraged to consider the implications of their decisions and enticed to do a great deal of technological and philosophical research, writing, and analysis to assist them in developing a rationale to support their work. The students need to be asked to examine both traditional and innovative solutions and to participate in active discussions of current topics relevant to the work. Additionally the studio environment ought to be structured around "*problem based learning*" techniques as described by researchers, D. A. Schon and D. A. Kolb and others.[7]

While important advances have been made in using a studio approach to teaching architectural technology, there remains a need for qualitative approaches that integrate technology and design throughout an entire architectural curriculum. Probably the most comprehensive work in this area is the *INSIDEOUT* approach developed by G. Z. Brown and John Reynolds at the University of Oregon in the 1980s. Focusing exclusively on mechanical-electrical systems, The *Insideout* method is presented in a textbook and studio handbook.[8] Of particular significance in these texts is the structure, which allows material to be read in different sequences, allowing it to be applied in studio as well as lecture formats. Another significant feature of the *Insideout* approach is the use of evaluative testing at periodic points in the design process, with the results fed back into the process as the basis for revisions. The design process thus becomes one of problem seeking and problem solving, although with a quantitative bias. This bias, and the M/E focus limit this approach.

Recent literature has contained several examples of qualitative, multi-technology approaches to integrating technology and studio. One method has been to create a special, technology-oriented studio in the curriculum which is paired with a lecture course, or in which lecture occurs within the studio. The proponents of this method offer teaching strategies including the importance of introducing technical knowledge into the design process as it is needed. An overview of the various families of systems from which the student will select must be presented along with criteria for evaluating and selecting a specific system-type. Technical knowledge is therefore introduced in a sequence which corresponds to the various phases of design.[9]

The strength of these approaches is that they emphasize the qualitative, poetic dimension of technology as well as its quantitative, pragmatic aspects. This may be accomplished by lectures about the use of technology for "architectural expression,"[10] or presenting analogies between the making of art and the making of technical systems.[11] However, these approaches continue to accept the traditional division between technology issues and non-technology issues in the design curriculum. In both cases, the technology-oriented studio is a special adjunct to the traditional studio curriculum. If the technology/aesthetics divide is to be truly bridged, it would seem that the objective should be to integrate technical knowledge into the entire studio curriculum, within a new aesthetic that recognizes the poetic potential of the technical.

## CURRICULUM AND COURSE STRUCTURES FOR A TECHSTUDIO

In order to enhance the presence of technology in the design curriculum, a new studio paradigm is required. The techstudio model proposed requires a new curriculum structure, a new course structure and a new teaching method, which together subvert the spatiotemporal barriers found in today's architectural curriculum between receiving knowledge and applying knowledge. A techstudio may be taught in the context of a lecture course, a studio course or a co-requisite pair consisting of a studio course and a lecture course. While each contextual format has its strengths and weaknesses, we feel that the studio-lecture pairing is the most effective.

Presented within a **lecture course**, the method has the advantage of a tight focus on technology material. The disadvantage is the typically smaller credit hours and classroom hours, which limit student involvement. The advantage of a **studio context** is because of longer class hours there is greater opportunely for student involvement and more time to devote to technology issues. There are disadvantages to the studio context: technology issues easily become subordinated to the non-technical issues which are the traditional focus of studio: and design faculty may lack the needed technical knowledge.

| HORIZONTAL TERM PROGRESSION | | | |
|---|---|---|---|
| SYSTEM 1 | SYSTEM 2 | SYSTEM 3 | SYSTEM 4 |
| PREDESIGN<br>CONCEPTUAL DES<br>SCHEMATIC DES<br>DES DEVELOPMENT | PREDESIGN<br>CONCEPTUAL DES<br>SCHEMATIC DES<br>DES DEVELOPMENT | PREDESIGN<br>CONCEPTUAL DES<br>SCHEMATIC DES<br>DES DEVELOPMENT | PREDESIGN<br>CONCEPTUAL DES<br>SCHEMATIC DES<br>DES DEVELOPMENT |

*Fig. 1. Horizontal Course Structure.*

The most effective format for teaching a techstudio appears to pair a studio with a co-requisite lecture course. The main challenge presented by this approach is to coordinate the two courses. The course plans must be precisely coordinated so that the technical information is applied in the studio immediately after being received by students in a lecture. If team-teaching is used, it appears to work best when both teachers are qualified to teach both design and the technology subject.

In addition to *curriculum* structure, the other variable for establishing a techstudio is the *course* structure. The two options are a horizontal structure, where the course sequence is based on a series of topics, and a vertical structure, where the sequence is based on a series of design phases. The topic-based taxonomies of knowledge which are typically used in lecture courses lend themselves to a horizontal course structure where knowledge is sequentially presented across the term in topic-categories. In technology courses these categories are based on the families of building systems covered by the course. Each individual building system is dealt with in full before moving on to the next. In order to incorporate a term-long design project into the course, the design stages must be based on these topical categories. Within each stage a particular system is designed using a series of typical design phases *(programming through design development)*. Once a stage ends, the design process for the given system is complete and the next stage begins, which focuses on a new system. With this approach, the sequencing of topics is critical. Those systems that will play the greatest role in determining the global building form must be addressed first, while those that will be more local follow. The disadvantage with the horizontal format is that it is more difficult to integrate the individual systems together during the design process.

This disadvantage may be overcome by using a vertical course structure. This structure requires *process*-based taxonomies where the sequencing of knowledge is based on design phases. Compared to the horizontal method, the vertical method is more difficult to organize and implement, but it integrates technical knowledge into the design process more thoroughly. The course divisions are based on design phases rather than building systems. Within each phase, those aspects relevant to the particular phase of all assigned building systems' are dealt with simultaneously. This requires formatting the text readings and lecture material into process-based taxonomies. The overall body of information relative to a given system is organized in such as a way as to be able to present it as needed within individual design phases, commingled with information about other systems. Material is presented in increasing levels of specificity, relating to a design progressing from conceptual to development phases. The complex relationships between different building systems may be thoroughly explored.

The vertical course structure, combined with a hybrid curricular structure which pairs a studio with a lecture course, is the most effective context in which to teach a techstudio. Setting up a vertical techstudio begins with identifying the specific building systems to be addressed within the techstudio. A family of systems is thus established. Within each family, the subfamilies, and sub-subfamilies are identified, forming a taxonomical tree. Each order of families is more specific and delineated than its predecessor. During the design process, each order may be seen as a menu of options from which the student must select one option before moving on to the next order. Each menu also comes with specific criteria for evaluation and selection, which may be applied in light of the given building program. The knowledge presented in these first three orders is used during the predesign phase where basic decisions are made about the selection of building systems. Once a sub-subsystem is selected, it generates successively higher orders of knowledge about itself. These correspond to the conceptual, schematic and development phases of design.

| VERTICAL TERM PROGRESSION | | | |
|---|---|---|---|
| PREDESIGN | CONCEPTUAL DES | SCHEMATIC DES | DES DEVELOPMENT |
| SYSTEM 1<br>SYSTEM 2<br>SYSTEM 3<br>SYSTEM 4 | SYSTEM 1<br>SYSTEM 2<br>SYSTEM 3<br>SYSTEM 4 | SYSTEM 1<br>SYSTEM 2<br>SYSTEM 3<br>SYSTEM 4 | SYSTEM 1<br>SYSTEM 2<br>SYSTEM 3<br>SYSTEM 4 |

*Fig. 2. Vertical Course Structure.*

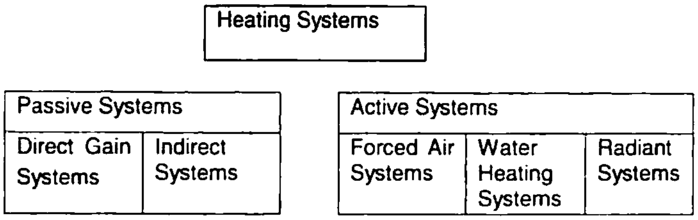


*Fig. 3. Heating Systems' Taxonomy.*

For example, concerning the selection of a heating system, the "tree" might look like this:

This approach requires the student to have at least a general understanding of each of the alternative systems before choosing one to develop. Obviously, no single project will give each student the opportunity to learn about every subsystem in detail. In fact, the specific subsystems that are studied in detail will vary from student to student allowing for a diversity of approaches within the studio and the opportunity for student sharing of insights. In the studio, the design process for each system moves through the following steps:

1. **Predesign:** Review, evaluate and select subsystems and sub-subsystems
2. **Conceptual Design:** Create a topological design that integrates the selected sub-subsystems
3. **Schematic Design:** Roughly size and lay out the sub-subsystems, individually and then integrally
4. **Design Development:** Calculate the final sizes of equipment and design the final layout of the sub-subsystems, individually and then integrally

A vertical techstudio requires new forms of teaching strategies based on process-based knowledge taxonomies. At the beginning of the lecture course the teacher must carefully explain to the students how the vertical approach works and its benefits. In each class students should receive handouts that summarize the class's lecture points and show where the material is covered in the textbook, which will be used as a reference rather than as a reader. Only the applicable information should be presented in lecture, in the order and form in which it is needed in the studio. *Distinguish* between knowledge relating to physical descriptions of individual systems, and knowledge relating to the criteria to be used in designing the systems. *Demonstrate* how the latter relates to the design process as selection criteria, sizing criteria and layout criteria. Include lectures on the expressive use of technology in relation to ethical issues such as place making and sustainability. Refer to exemplary works of architecture, such as Wright's Larkin Building, or Kahn's museums, that use technology integratively and expressively.

The design project, or projects *(a single, term-long project seems to be the best vehicle)* must be carefully designed to keep the students' focus on the assigned building systems. This begins by selecting a building program with a logical relationship to the assigned systems, such as a theater to explore architectural acoustics. The size and complexity of the program ought to be limited so as to allow the greater technological development that is desired. The project site ought to be an actual site that the class may visit, in order for relevant site phenomena, such as sunlight, wind, and precipitation to be experienced. The site must contain features that allow for the exploration of the assigned building systems, such as a sloping topography which could be used to study ground water drainage.

The studio schedule must allow for flexibility in lecture scheduling and vice versa. If the studio progress lags or speeds up, the lecture pace must react accordingly in order to maintain the lecture-studio relationship. There is a tendency to allow the studio work to drive the timing, however, the studio timing must not be allowed to excessively compromise the technology material. Experience will teach the instructors how to maintain the proper balance. Quantitative procedures such as for calculating heat gains and losses are best broken down into individual parts with separate deadlines, to allow the students to

| ORDER: PHASE | SYSTEM | LECTURE | STUDIO |
|---|---|---|---|
| SYSTEM: PREDESIGN | Heating Systems | Overview of Heating Subsystems | Compare Subsystems & Selection |
| SUBSYSTEM: DESIGN | Passive Heating Systems | Overview of Passive Heating Subsystems | Compare Subsystems & Selection |
| SUBSYSTEM: CONCEPTUAL DESIGN | Direct Gain System | Overview of Generic Components | Topological Design *(not to scale)* |
| SUBSYSTEM: SCHEMATIC DESIGN | Selected Direct Gain System | Rules of Thumb for Sizing & Rough Design | Rough Sizing & Layout Scale |
| SUBSYSTEM: DESIGN DEVELOPMENT | Selected Direct Gain System | Detailed Design Procedures | Calculate Exact Sizing & Detailed Layout |

*Fig. 4. Design Process.*

receive feedback from the instructor during the computation process. The students must be taught that quantitative-cognitive and qualitative-intuitive procedures produce different states of being and are often best performed in different times and places during the design experience.

## CASE STUDIES

The following projects were done by students in various techstudio formats. Most of these were term-long projects by third year students. While the projects focus on a range of building systems, the greatest emphasis is on environmental controls.

### Carver Center for Environmental Design

This term-long project was assigned within a vertical studio-lecture course co-requisite pair. The third year students were concurrently taking an environmental controls course, which covered heating, cooling, ventilation, water supply and wastewater disposal. The same faculty member taught both the lecture course and studio. The program was for a medium sized environmental research facility with laboratories, classrooms and offices. Energy conserving features, including sunshades, ventilation towers and insulating curtain walls were part of the program requirements. The students were required to site their building on a location of their choice within a several hundred acre area of an Alabama state park. This area, which has a pine-oak forest ecosystem with a varied topography, was chosen so that the students would have to consider the effect of existing vegetation and topography on building orientation, sun shading and ground water drainage.

The lecture course began with a section called *Fundamentals*, which provided students with a foundation of scientific, philosophical and historic information concerning the course topics. This was followed by a site analysis where students visited the site, and working in teams, created a series of analysis boards showing tabular data and site images. During the schematic design phase the students chose the subfamilies of mechanical systems for their building and determined the rough sizes for the equipment. During the development phase students calculated the exact sizing of the mechanical elements.

This techstudio was successful in producing projects that achieve a balance between the technical and poetic aspects of architecture. In particular, some projects showed a rigorous integration of functional, spatial and structural order. A weakness in the process was the under-use of the site analysis data during the design process. Also, the size and complexity of the project was greater than the students had previously experienced. Combined with technological issues that were

*Fig. 5. Carver Center for Environmental Design (Project: Todd James).*

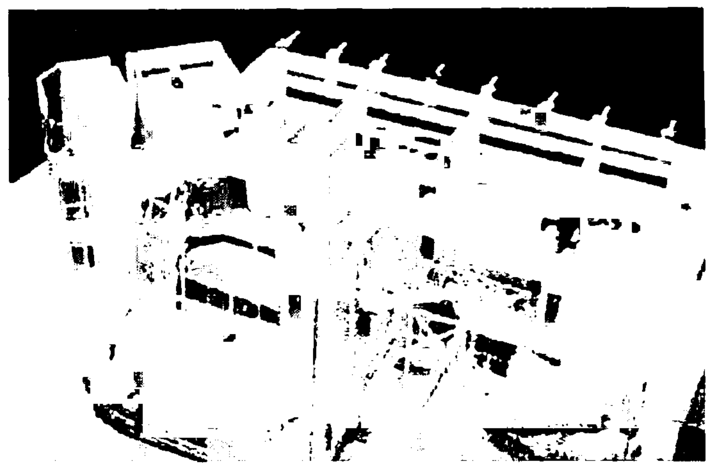

*Fig. 6. Carver Center for Environmental Design (Project: Todd James).*

new, this proved to be overwhelming at times. These problems could be corrected by the use of procedures to bridge the gap between analysis and its application, and by assigning a project somewhat smaller and simpler in order to allow for more rigorous exploration of technology issues.

### EcoCafe

The EcoCafe project was assigned as a six week project to students taking a co requisite pair of a third year studio and an environmental control systems lecture course, both taught by the same teacher. The lecture course covered heating, cooling, ventilation, water supply and waste water disposal. A horizontal course structure was used. The project site was the top of a spillway, separating a lake from a stream in an Alabama State Park. This site was chosen in order to explore the aesthetic and useful properties of water. The project program called for the design of a 4800 SF cafe that would combine dining with learning about nature. The operation of the building, including the production of power, disposal of waste and the supply of water was to be completely independent of outside utilities.

*Fig. 7. EcoCafe (Project: Eric Lane).*

Several passive design strategies were to be applied including sun shading, cross ventilation, convective cooling, day lighting and direct gain solar heating. As a techstudio experiment, the research objective was to explore the role of making presentational objects within a techstudio.

The design process began with the development of a concept model and presentation board utilizing hybrid drawings. The student was to create a building orientation and form that addressed passive heating/cooling/ventilation systems in formally innovative ways. This concept was the basis for the schematic and development phases of design.

The most successful aspect of this project was the making of presentation objects as a focus of technological inquiry. Experimenting with new two-dimensional and model-making media lead to rigorously passionate engagement of the technical issues by some students. However, many of the projects tended to focus more on non-technological, purely formal, issues. Dealing with the topographically complex site also took attention away from environmental controls. The choice of site was intended to relate to water supply and waste disposal issues, yet these were not really explored in the projects except in a perfunctory way.

These weaknesses could have been avoided by using a vertical course structure and incorporating more quantitative analysis into the design development phase, with a means for feeding back results into process. Also, a clearer focus on which control systems were to be emphasized would have helped the students' to focus better.

## CONCLUSION

These case studies demonstrate that, despite its limitations and challenges, the techstudio is a viable model for integrating technology into the studio. From our experience we feel that the students would better grasp technical issues of building systems if the following suggestions were implemented at the appropriate level.

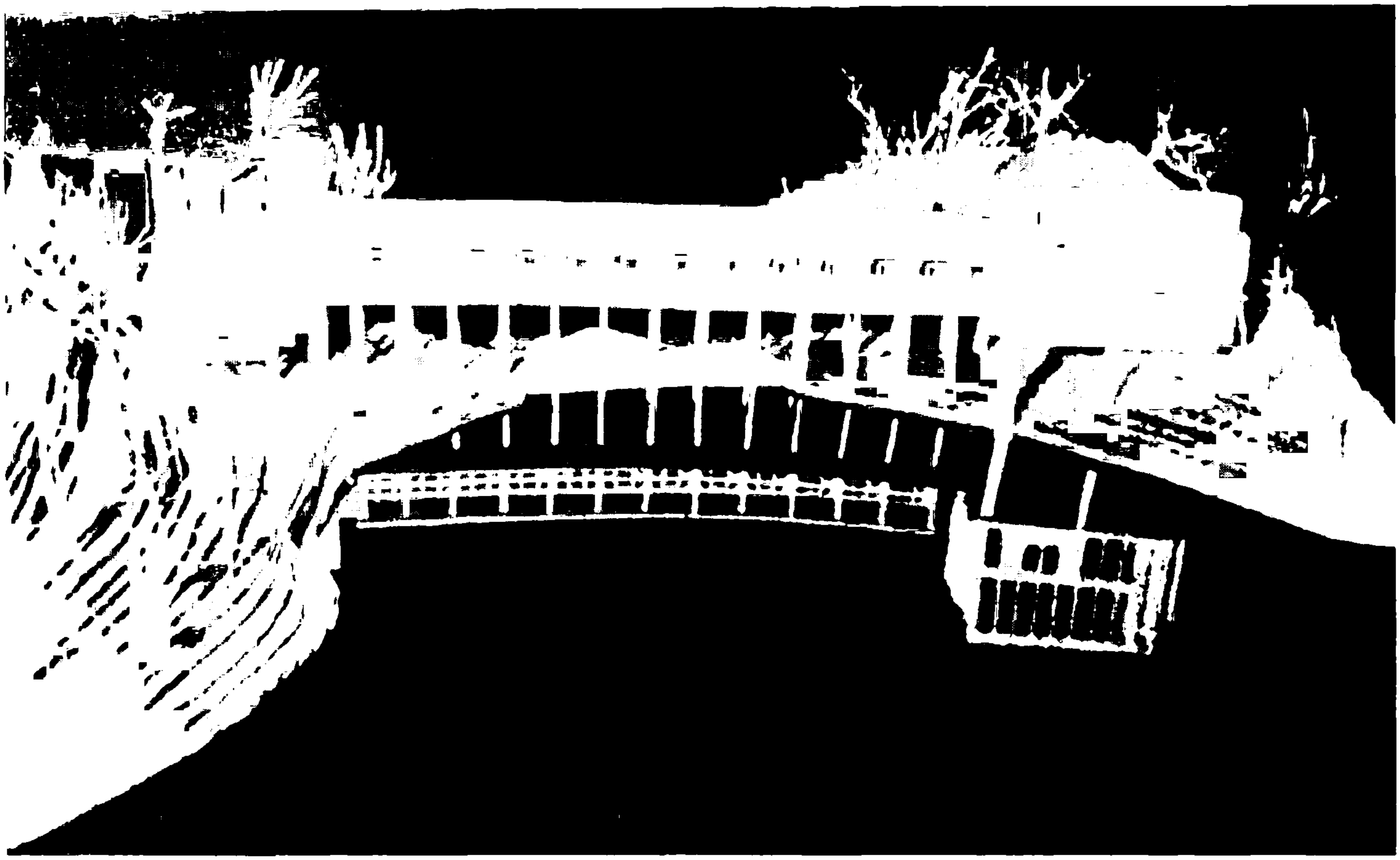

*Fig. 8. EcoCafe (Project: Lededric Taylor).*

- First, the introduction of technology into the studio probably needs to begin in the first term of a student's architectural education and continue through to the end of the last term. The traditional practice of limiting lower division studios to compositional and architectonic projects sends a message to students that materiality, structures and control systems are secondary issues. Also, when technology studios only occur once or sporadically within a students' academic experience, the students tend to regress to design habits that neglect technology.

- Second, there is a need for textbooks about technology subjects that are oriented towards studio use. These would be structured around process-based taxonomies of knowledge. In addition to presenting the engineering perspective of technology, they would include the humanities perspective found in history, the arts and philosophy.

- Third, assign more projects that integrate all the building systems to prepare the student for actual practice, where projects addresses each dimension of technology: materials, structures and environmental controls. The trend for practitioners to focus on purely aesthetic issues and to outsource all engineering design is undoubtedly rooted in attitudes learned in architectural education.

It appears that best work in architectural practice integrates technology in into a whole that is ecologically sensitive, rooted in place and is socially responsible. It is the responsibility of schools of architecture to teach the unity of the theory and practice of architectural technology.

## NOTES

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[10] Allen, p. 94.

[11] Bovill, et al, p. 84.