# Teaching for Transfer: Fostering Transmission of Knowledge Between Classroom and Studio

DONALD E. ARMSTRONG
Tuskegee University

## INTRODUCTION

> When we have lived any time, and have been accustomed to the uniformity of nature, we acquire a general habit, by which we always transfer the known to the unknown, and conceive the latter to resemble the former.
>
> - David Hume, *An Essay Concerning Human Understanding*[1]

Transmitting knowledge into the design studio from related support courses remains a perennial interest in architectural education. Over a decade ago the Boyer Report called for "A More Integrated Curriculum," noting that the architecture design studio is a potent tool for "the integration and application of learning."[2]

Educational theory refers to the transmission of knowledge as *transfer of learning*. The theory of transfer addresses "how previous learning influences current and future learning, and how past or current learning is applied or adopted to similar or novel situations."[3] Transfer occurs between a *learning* context and a *transfer* context. Within the architecture curriculum the learning context is the lecture setting and the transfer context is the studio setting. As will be shown, when transfer strategies are used architecture students gain a deeper understanding of course content and more comprehensive design ability.

## OVERVIEW OF TRANSFER THEORY

Given the call in architectural education to enhance the integration of lecture knowledge into the studio, transfer theory can be seen to hold great promise. However, the typical architecture curriculum contains barriers which block positive transfer while allowing negative transfer. As will be shown, a curricular/instructional strategy of teaching for transfer can dissolve these barriers.

Transfer theory developed over the past nine decades. Recognized for its profound importance to the general theory of education, "transfer" typically refers to *positive* transfer when learning in one situation improves performance in another. However, *negative* transfer also happens when learning negatively impacts performance. In this paper the term "transfer" will always be used in the positive sense, unless noted otherwise. [4]

Transfer is different from simple learning or the application of learning. It requires "the learning of something new in order to make the transfer." In architectural education, this indicates a need for a mutually reciprocal relationship between lecture course and studio course – learning in each context dependent upon learning in the other. Transfer occurs at varying levels depending on the degree of similarity between the learning context and the transfer context. Haskell classifies the types of transfer into several categories including one with clear relevance for architectural education, "content-to-content transfer." This refers to "making use of what we know in one subject area to the learning of another area." In architectural education this characterizes the transmission of lecture content into the studio design process.[5]

Unfortunately, the typical architecture curriculum contains four barriers to transfer between the *learning* context – the lecture course – and the *transfer* context – the related studio. These structural barriers impede the transfer of learning from classroom to studio.

The 1st barrier is the conflict between the mode of knowledge presented in the classroom versus the mode used in the studio. Lawson states that this conflict is related to the difference between the type of memory used by classroom students compared to the type used by studio students. The former, *theoretical memory* is the type of memory process by which students retain knowledge in lecture courses. This is diametrically opposed to *experiential memory*, the mode of retention needed to foster transfer into the studio.[6] This is related to the 2nd barrier, the conflict between the knowledge taxonomy used in the classroom and that used in the studio. In the lecture course the subject matter is organized into categories based on topics, a *topic*-based taxonomy. In the studio subject matter is divided into categories based on design phases, a *process*-based taxonomy.[7]

The 3rd barrier is conflicting course schedules between lecture course and studio. Driven by testing schedules, the pace of the typical lecture course is typically out of synch with that of the concurrent studio, which is driven by a schedule of projects and design phases. The 4th and final barrier is the conflict between the disciplinary perspectives held by lecture course faculty and those held by the studio faculty. Often, the perspective of a faculty member teaching a lecture course in construction technology, history, theory or practice is at odds with that of a faculty member teaching a studio course focusing on design methodology and media applications.

## STRATEGIES FOR FOSTERING TRANSFER OF KNOWLEDGE INTO THE STUDIO

Transfer can be fostered by strategically linking classroom and studio. The author has developed two integrated sets of strategies, one set for the lecture *learning* context and one for the studio *transfer* context. These strategies are based on: 1) general transfer theory, 2) examples of implicit transfer found in the literature of architectural education, and 3) the author's teaching experience. When two linked sets of transfer strategies are used, one for the classroom learning context and one for the studio transfer context, an integrative learning experience results.[8]

### Strategies for the Classroom Learning Context

1. *Use abstraction to teach for understanding*. Foster transfer by having students "learn with understanding rather than merely memorize sets of factors or follow a fixed set of procedures."[9] Use instructional methods which illuminate the principles underlying specific cases.

This is achieved by setting learning outcomes related to design thinking. In Boge and Sullivan's "Interwoven Curriculum," support courses and studio share a common set of such outcomes: "acute observation, drawing conclusions from observed evidence, explicit demonstration of thinking, working through a hierarchy of scales and precise and accurate use of language and representation."[10] This parallels the Boyer Report's call for "new categories for the architectural accreditation standards organized around *modes of thinking*: the discovery, application, integration, and the sharing of knowledge."[11]

Subject matter and design thinking can be linked in the lecture course by organizing the content into a process-based taxonomy isomorphic with the phases of a concurrent design project. For example, in Bovill's "comprehensive studio," students in a construction technology support course learned how to represent mechanical systems as a concept diagram used to develop a design parti in the concurrent studio.[12]

2. *Provide time to learn.* Students need adequate time to process new information and to understand its relevance and logic. Each presentation of new content should be limited to what students can reasonably be expected to address in the concurrent design stage, not merely memorize.[13]

To synchronize the delivery of lecture content with the phases of a concurrent studio project, faculty should limit the amount of content and its rate of delivery. Allow for iterative applications of the content, in order for students to apply it, receive feedback and re-apply it.

The amount of content does not have to be limited to what can be actually incorporated into the final design. For example, the student, in order to evaluate a family of options and select the best one to apply in their design project, must first acquire an understanding of the full family, before rejecting some options and selecting others. Haskell refers to this as the "usefulness of useless knowledge," which may be irrelevant in one situation but useful in a future context.[14]

3. *Engage students in the deliberative practice of knowledge*. Engage students in self-monitoring, including "attempts to seek and use feedback about [their] progress."[15] Achieve this through lectures in synch with iterative studio design cycles involving feedback and revision.

4. *Present subject matter in multiple contexts*. Offer "examples that demonstrate wide application of what is being taught." Students will "abstract concepts and develop a flexible representation of knowledge."[16] Do this through case studies in which multiple similar cases are used to illustrate a single principle. In Cole's "special topic studio" the support courses' content is integrated "across related lecture courses by using common case studies. This allows disparate material to be related based on a common focus."[17] "What –if?" questions can be used to highlight underlying principles:

- "What if this part of the building was changed?"
- "What if the building was on a different kind of site?"
- "What if the function of the building changed?"

### Strategies for the Studio Transfer Context

These are tactics for getting students to use their classroom knowledge to deepen their understanding of the design process. Students perceive that the knowledge is useful, interesting and that it enriches their design work.

1. *Base studio learning on the principles acquired in the classroom*. Classroom content and studio content should share "not only simple perceptual features but also shared categories, elements of procedures, principles, and even emotional attitudes."[18]

In the author's integrative "*tech*studio" approach a process-based taxonomy is shared between the lecture and studio contexts. The taxonomical categories into which content is organized is identical in the two contexts. The shared content focuses on abstract principles, using similar language and identical building precedents in both contexts.[19]

2. *Allow transfer to unfold in time*. Transfer is a "dynamic process that requires learners to actively choose and evaluate strategies, consider resources and receive feedback…Often, transfer is stronger in days following initial attempt …transfer should be viewed as increased speed in learning a new domain – not simply initial performance."[20]

Content can be "pulled" from a support course as it's needed in the studio. In Edward Allen's "second studio," support content is "offered within the studio as the students need the information…experience has shown that students learn technical skills more efficiently and include them more readily into the building design process when the skills are acquired on an as-needed basis during ongoing design projects."[21]

Allow the studio pace to drive the lecture course pace. Create projects which allow students to process lecture content. Bovill, Allen and Armstrong all use a single semester-long studio project of limited scale as the vehicle for transfer. This allows for adequate transfer and detailed development.[22]

3. *Provide prompting for transfer*. A prompt is any device used in the transfer context which causes a student to make a connection with the learning context. Prompting fosters transfer, particularly if graduated into a series of prompt-feedback-reprompt cycles.[23] In a classroom-studio pairing this can occur through cycles of lecture-design-evaluate-redesign-reevaluate.

4. *Teach students to be aware of their learning processes*. This can be fostered through "reciprocal teaching [in which] a teacher and a group of students take turns in leading the group to discuss and use strategies for comprehending and remembering content."[24] In Cole's "special topic studio," students "identify the issues [to be focused on]…the evolving design would 'pull' the necessary knowledge from the theory base…issues and processes were discussed in the context of the evolving design solutions."[25] Student presentations of their work in the studio present an opportunity for reciprocal teaching by having the student use their project to illustrate the principles being studied and how they were applied.

Students can be taught to create their own heuristics (procedures and rules of thumb) for designing. Student-teachers can share these with the class, to be tried and evaluated. This is provides students with a meaningful and useful skill: how to develop their own problem-solving processes. Thinking shifts from finding the one best solution to finding processes which generate multiple solutions.

## APPLICATION OF STRATEGIES

The author developed the transfer strategies presented in this paper through courses taught at Florida Atlantic University and Tuskegee University. These courses include design studios and lecture courses in structures, environmental technology, materials of construction and site engineering. In each course or pairing of lecture course and studio there was a clear distinction made between a learning context and a transfer context, and the necessary control over both in order to apply transfer strategies. The courses were taught reflectively with associated post-course evaluations and research presenting empirical evidence of the relative success of the strategies.[26]

Most recently, the author is applying this approach to a sequence of structures courses taught at Tuskegee University's Department of Architecture. These courses - *Structures I* (wood structures), *Structures II* (steel structures) and *Structures III* (concrete and masonry structures) – are taught in a "second studio" approach (a lecture course taught in a studio format). These courses were created and first taught by the author during the 2007-08 academic year. Students applied a process-based taxonomy of structural principles to a semester-long design project. The project's type, scope, site and design requirements were linked with the lecture content.

The student projects completed during the 2007-08 academic year indicated that the overall approach was successful. However, the results also showed challenges that needed to be addressed. Because most classroom time was devoted to lecture and relatively little to typical studio interactions - such as desk critiques and project presentations - students received limited feedback on their designs during the design process. As a result, unaddressed problems carried over from one design phase to the next. Students weren't able to fully master one set of structural concepts (and successfully apply and re-apply them) before advancing to the next phase.

Also, formal solutions tended to be fairly conventional and restricted to superficially mimicking examples shown in class as opposed to acquiring an understanding of abstract principles and applying them creatively and innovatively. Far more content was presented than the students were able to apply and some content was presented out of synch with the design stage where it was to be applied, requiring repetition of material. Some content was presented at too rapid a pace to allow for application, feedback and re-application. This made processing the information difficult for students.

The author's response to these challenges was threefold:

1. Focused research into the theory of learning transfer
2. Development of more detailed strategies for transfer
3. Substantial revision of the structures courses for the 2008-09 academic year based on these strategies

## REVISED APPROACH: 2008-09 STRUCTURES COURSES

For fall 2008 the author re-structured the *Structures I* and *III* courses in order to address the above challenges. The objective was to create a multileveled framework which weaves together lecture content and project criteria, and link both temporally within a course schedule based on a series of discrete, cumulative design phases within a single semester-long design project.

For each course, the lecture content was reorganized with a greater emphasis on *principles to be understood* rather than *facts to be memorized*. The previous course content was pared down to only what would be expected to be relevant to the student in the design process. A larger proportion of class days were held in the studio as opposed to the classroom in order to expand the transfer context. This was accompanied by an increased emphasis on the formal and tectonic aspects of structures. A shift in grade weight from exams to the project reflected this shift in emphasis.

An initial process-based taxonomy was prepared for each course and was reviewed and revised as the course unfolded. It was based on the following five content areas:

1. Elements: Typology of structural members
2. Engineering: Statics and strength of materials
3. Construction: Construction details and standards
4. Design: Selection, sizing and ordering of structural members
5. Representation: Communication of design intent through drawings and models

Within each content area, a taxonomy with five divisions was created corresponding to the five design phases used for the assigned project. The content was graded into five levels of complexity, gradually increasing in concreteness and specificity.

This master taxonomy for the course was used to create five lectures corresponding to five phases of design. Each lecture outline is based on the five content areas noted above. The key lecture content was summarized on a handout given to students concurrent with the lecture, at the start of the associated design phase. The handout included glossaries of terms and descriptions of procedures, with examples. Each handout was the primary reading assignment for the particular phase, augmented by readings from the textbook and other sources.

Key taxonomical principles from the master taxonomy were recast as design criteria for the semester-long design project. At the beginning of the semester an initial project brief was assigned containing these criteria, the program, and site data. An individual sub-brief was assigned at the beginning of each of the five design phases with more specific design criteria linked with the concurrent lecture content. Each sub-brief was used as the basis for an evaluation form used by the faculty to assess the student's design at the given phase. The completed form was given to the student to provide feedback. Because two rounds of evaluation were given for each phase, the same evaluation form was used for each of the two rounds, with second-round improvements noted. Separate, weighted, grades were given for each round. Consistent terminology was used in the lectures, handouts, briefs and evaluation forms in order to maximize the rehearsal of principles across the different contexts.

The semester-long design project was undertaken across five design phases:

1. Conceptual Design Part 1: Creation of an initial design concept expressing a meaningful relationship between architectural form and structural form
2. Conceptual Design Part 2: Iterative development of the initial concept with an emphasis on the articulation of distinct yet integral systems of structure and non-structural space-defining elements
3. Conceptual Design Part 3: Refinement of the architectonic (generic, material-neutral) structural system articulated in the previous phase
4. Schematic Design: Transformation of the architectonic structural system into a material-specific system integrated with other building systems
5. Design Development: Large-scale refinement of members' shapes and connection details

Phases 1-3 were based on the development of a series of study concept models. Phases 4 and 5 were based primarily on drawing documents.

Each design phase was divided into a five-stage cycle: **L**ecture, **D**esign, **E**valuate, **R**edesign and **R**eevaluate (**LDERR** cycle). The lecture stage provided the *learning* context where students developed an understanding of the phase's principles. The remaining stages – two rounds of designing and evaluation – provided the *transfer* context where students used this understanding to drive the design process. The evaluation stages provided students with feedback in a timely way. By holding two rounds of design-evaluate, students had the opportunity to initially process the principles, receive feedback on their progress, and continue the processing, "rehearsing" the principles rather than simply applying them once.

In summary, a semester-long design project unfolded across five design phases, each subdivided into the five stages of the **LDERR** cycle. Each cycle was based on a process-based (phase-specific) taxonomy of principles which was the basis for the lecture content and design criteria for that phase.

## STUDENT WORK: FALL 2008

### *Structures I* (Wood Structures)

The assigned project was the *Talladega Forestry Center*, a wood materials testing facility. The site is located in the heart of Alabama's Talladega National Forest, a historic source of lumber and other natural resources. The goal of the project was for the student to develop a building design with all-wood structures in which structural form is meaningfully integrated with architectural form. The program includes a large column-free space requiring long-span structures (workshop), a set of same-sized smaller spaces amenable to a regularized column grid (offices and laboratories), and a service core to be used for lateral resistance. The site has a level ground surface in order to simplify the design of the foundation system.

Compared to the previous year's structures projects, the requirements reflect a greater emphasis on the impact of non-structural factors (site, program and sustainability) on structural design.

Students were given a project brief at the start of the semester. A separate sub-brief was assigned for each of the five design phases. Each brief included the design criteria to be met for that phase. Criteria were derived from the key principles covered in the associated lecture.

During the three conceptual design phases each student developed an architectonic design using study models. The initial lecture focused of the concept of force, both in the visual sense as well as the physical sense.[27] This was used to present a discussion on equilibrium of forces and the static-dynamic binary as principles with formal as well as structural ramifications. The project sub-brief called for a building form which embodied "dynamic equilibrium" – a balance of static and dynamic forces.

Figure 1 depicts an initial design concept. The student has expressed "dynamic equilibrium" with a building form which combines obliquely oriented triangular roof planes with an orthogonal linear form. The composition uses planer horizontal-spanning elements supported by linear vertical elements. Non-structural elements are indicated with light-color materials. The selection of planer/solid versus frame/transparent structures expresses the student's design intentions for varying degrees of spatial enclosure.

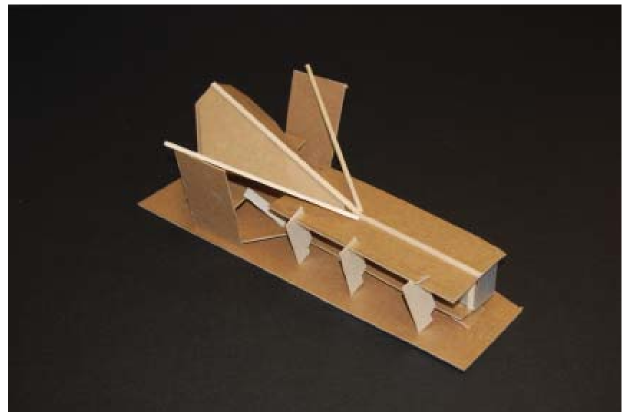

Figure 1. *Talladega Forestry Center* Conceptual Design Part 2 (Student: Brittany A. Hobbs)

In Figure 2, the conceptual design depicted in Fig. 1 has been developed further and the structural system expressed alone. The planer roof components have been transformed into frame/skin assemblies. An attempt was made to carry roof loads and floor loads downward creating continuous load paths.

Figure 3 depicts the final structural design near the end of the design development phase. The framing concept has been developed from "few and large to many and small," reducing decking spans and using lighter members.

Figure 2. *Talladega Forestry Center* Conceptual Design Part 3 (Student: Brittany A. Hobbs)

During the design development phase students explored alternative shapes for primary structural members, attempting to express their pattern of internal stresses. Connection details were designed for key structural joints (As of this writing, this phase is in progress).

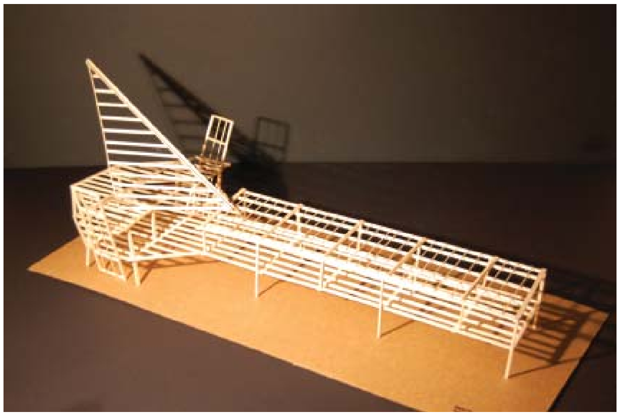

Figure 3. *Talladega Forestry Center* Design Development (Student: Brittany A. Hobbs)

***Structures III* (Concrete and Masonry Structures)**

The assigned project was the *Meditation Chapel*, an interdenominational chapel containing a large column-free group-meditation space requiring long-span structures, a set of eight same-sized smaller spaces amenable to a regularized column grid (1-person meditation cells) and a service core to be used for lateral resistance. The site is the side of a mountain overlooking an expanse of forested hills and valleys. The 45$^{o}$ ground slope provided students with a challenging alternative to the relatively flat site from the previous semester's project. Because these students had completed the wood and steel structures courses, they were allowed to use hybrid structural designs which combined concrete/masonry structures with wood, steel or tensile structures.

As in the wood structures course, the design process started with three conceptual design phases in which the student developed a material-neutral architectonic design using study models. The conceptual phases' lecture content was similar to that for wood structures. However, because of the emphasis in concrete and masonry structures on planer elements – walls, slabs and shells – the lectures included additional content about these.

Figure 4 depicts an initial concept based on the analogue "bird in flight." Skewed linear elements support triangular roof planes pitched at an oblique angle. The student's design intentions for the degree of spatial enclosure were the basis for the selection of linear versus planer elements.

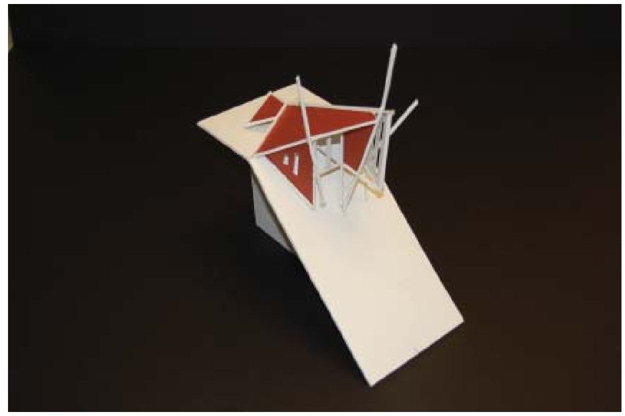

Figure 4. *Meditation Chapel* Conceptual Design Part 2 (Student: Tyrone N. Jackson)

Figure 5 depicts a different student's project in its schematic design phase. Based on the analogue "unfurling flag," the roof structure was developed as curvilinear steel 'I' beams supported by a base of kiln-fired brick masonry walls and concrete one-way slabs. The student selected these from a menu of wall and slab types presented in the schematic design taxonomy. Procedures for projecting and rendering curvilinear shapes were also covered in lecture, as were standard construction details for brick bearing walls and concrete slabs. The generic structural elements were transformed into material-specific (steel and concrete) structural members. These were sized using the rule of thumb procedures from Edward Allen's *The Architect's Studio Companion*. [28]

## PRELIMINARY ASSESSMENT OF THE REVISED APPROACH

As of this writing, the students in the fall 2008 structures courses have completed the first four phases of their designs, through and including schematic design. Design development is in progress. Although a post-course assessment will be needed for a thorough assessment, preliminary observations indicate significant overall improvement in students' work compared to the

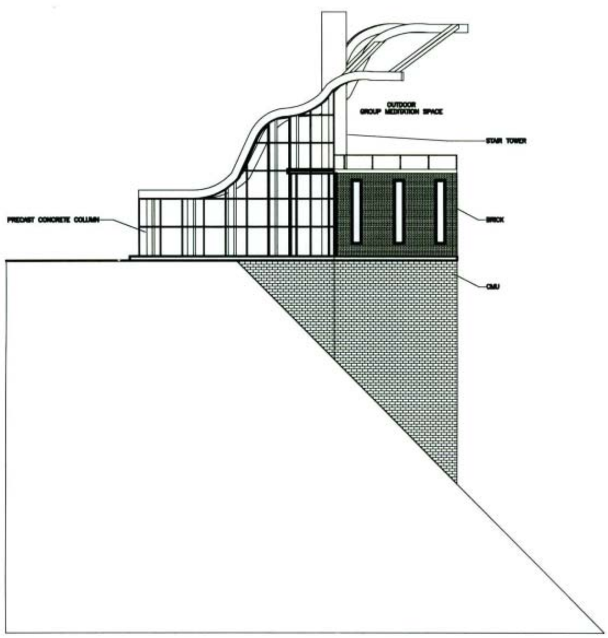


Figure 5. *Meditation Chapel* Schematic Design
(Student: Joseph D. Brown)

previous year, and improved efficacy of the transfer strategies.

Students clearly benefited from the increased lecture emphasis on the formal and tectonic aspects of structures. Another change with positive effects was the shift in emphasis from structural norms to more innovative approaches.

The most effective change is clearly the use of the LDERR cycle, resulting in a greater proportion of class time spent in studio. Generally, students used the evaluation feedback and this was visible in the revised designs. The percentage of lecture content actually showing up in the student work is much greater than in previous semesters. The heuristic evaluation sessions, where the student presenting their project assumed the role of teacher, and fellow students the role of critics, appear to reinforce learning more effectively than the traditional approach where all teaching and criticism emanates from the faculty-expert.

However, certain challenges arose during the semester which deserve attention. Because 3/5 of the project process was devoted to conceptual, material-neutral structures, some significant planned content for the later phases was dropped because it would have required more time for the students to process than allotted. A division of conceptual and post-conceptual closer to 50/50 would resolve this problem. Similarly, some of the presented content, such as load calculations and construction drawing standards, took the students longer to process than anticipated. This material needs to be spread out over a longer period with additional rehearsal/feedback mechanisms.

As a pedagogical vehicle, more systematic capture and inventory of project images at each design phase would improve the assessment process. Another improvement would be formalized post-course student surveys. These could be combined with surveys of the work of the same cohort of structures students in concurrent design studios, to observe if far-transfer is occurring. Informal observations of this type by the author indicate that many students are transferring their understanding of structures into their studios and internship experience.

## CONCLUSION

When David Hume wrote that "we always transfer the known to the unknown, and conceive the latter to resemble the former," he captured a fundamental truth of human existence. Unfortunately, as educators, our teaching sometimes prevents these simple, automatic acts of transfer to occur. Perhaps an over-emphasis on invention as opposed to iteration has lead to this.

More likely, in our current information age, a tendency to teach "broad and shallow" has undermined the traditional goal of professional education to impart a knowledge base which is broad and *deep*. Too often we limit our learning objectives to an easily *memorized* set of facts rather than an *understood* set of principles. Or, in the studio, we limit our objective to a culturally autonomous architectonic *end* rather than a culturally-grounded and constructible *means* to a real building. The latter requires a deep understanding of architectural history, theory, building technology and practice. It requires a studio environment in which this understanding – in its entirety - is an indispensable prerequisite for designing.

In Architectural education, where a goal of life-long learning is gaining a growing acceptance, can we, as educators – as responsible citizens – afford to continue to produce students who are mere depositories of knowledge which is disconnected from the act of design? Rather, we have an ethical responsibility to mentor student-designers who can readily apply a comprehensive knowledge of architecture to the design problems at hand. Teaching for transfer will better prepare these students for the future.

## ENDNOTES

1. Robert E. Haskell, *Transfer of Learning* (Academic Press, San Diego, 2001) p. xiii.

2. Ernest J. Boyer and Lee D. Mitgang, *Building Community* (Princeton: The Carnegie Foundation for the Advancement of Teaching, 1996) p. 85.

3. Haskell, p. 23.

4. Ibid., pp. 77-79.

5. Ibid. pp. 29-32.

6. Bryan Lawson, *What Designers Know* (Architectural Press, Oxford, 2004) pp. 100-104.

7. Don Armstrong and James Streuber, "*TECH*STUDIO: A Studio Approach to Teaching Architectural Technology" (In: *Architecture, Culture, and the Challenges of Globalization*, Proceedings of the ACSA 2002 International Conference) pp. 181-184.

8. In order to allow for the broadest application possible of these strategies, no assumption is made as to the curricular model used. The only distinction made is between a learning context and a transfer context. Both contexts might be provided by the same faculty member, or each by a different member. Although in architecture education the learning context will typically be a classroom with a focus on lecture-related activities, and the transfer context will typically be a studio with a focus on design-related activities, lecturing obviously can occur in a studio and designing in a classroom. The theory of learning transfer involves a re-settling of traditional learning boundaries.

9. John D. Bransford, Ann L. Brown and Rodney R. Cocking, editors, *How People Learn: Brain, Mind, Experience and School* (Website: www.nap.edu/html/howpeoplel) Chapter 3, p. 3. This article contains general strategies for transfer which are the basis for the specific strategies outlined in this paper.

10. Patricia Boge and Jim Sullivan, "Curricular Weaving" (In: *Archipelagos: Outposts of the Americas/Enclaves amidst Technology*, Proceedings of the ACSA 2004 Annual Conference) p. 497.

11. Boyer and Mitgang, p. 63.

12. Carl Bovill, et al, "Intention, Form, and Execution: A Comprehensive Studio Curriculum" (In: Journal of Architectural Education, November, 1997) p. 86.

13. Bransford, Brown and Cocking, p. 5.

14. Haskell, pp. 102-105.

15. Bransford, Brown and Cocking, p. 5.

16. Ibid., p. 8.

17. Darlene A. Brady, "The Education of an Architect: Continuity and Change" (In: *Journal of Architectural Education*, September 1996) p. 38.

18. Mary J. Gick and Keith J. Holyoak, "The Cognitive Basis of Knowledge Transfer" (In: Stephen M. Cormier and Joseph D. Hagman, editors, *Transfer of Learning*, Academic Press, Inc., San Diego, 1987) p. 15.

19. Armstrong and Streuber, pp. 181-184.

20. Bransford, Brown and Cocking, p. 12.

21. Edward Allen, "Second Studio: A Model for Technical Teaching" (In: *Journal of Architectural Education*, November, 1997) p. 92.

22. Bovill, p. 85, Allen, p. 92, and Armstrong and Streuber, pp. 183.

23. Bransford, Brown and Cocking, p. 13.

24. Ibid., p. 14.

25. Raymond J. Cole, "Teaching Experiments Integrating Theory and Design" (In: *Journal of Architectural Education*, winter, 1988) P. 12.

26. Armstrong and Streuber, pp. 180-187.

27. Rudolf Arnheim, *Art and Visual Perception* (University of California Press, Berkeley, 1974) pp. 16-17.

28. Edward Allen and Joseph Iano, *The Architect's Studio Companion* (John Wiley & Sons, Inc., New York, 2006).