

A CAPSTONE DESIGN EXPERIENCE IN ARCHITECTURAL ENGINEERING TECHNOLOGY

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Abstract

At the University of Hartford, we have developed a “Capstone Design Experience” in an effort to improve our Architectural Engineering Technology curriculum. By increasing the awareness of the interrelationships between different areas of study, we are attempting to strike a new balance. We have integrated the following into a single yearlong design project: research, programming, planning, history and theory, design, model making, drawing, CAD, structures, environmental systems, presentations and writing. Our capstone program provides opportunities for exploration, questioning, testing, and criticism. It requires the students to use experience and knowledge gained in other courses and forces them to play an active role in their own learning. It demands personal accountability for decisions, and commitment to ideas and proposals that are scrutinized publicly. We believe that we have developed a model that other disciplines on campus could well profit from observing.

Introduction

The Carnegie report "Building Community: A New Future for Architecture Education and Practice" by Ernest Boyer and Lee Mitgang criticized architecture programs for lack of integration of the curriculum. At the University of Hartford's (U of H) Architectural Engineering Technology (AET) Program we have been challenged by this criticism and have redeveloped our capstone program in response. The uniqueness of architectural education lies in its combination of theory and technology courses in the lecture/seminar format within the design studio.

The “Capstone Design Experience” includes AET 470 Architectural Programming and AET 489 Senior Design Thesis. In these two courses, taken in sequence, students prepare and present their solutions and are periodically critiqued by their peers, faculty, local professionals and invited guests. Although reviews may be stressful, they are an opportunity to experience ‘real life’ and integrate knowledge learned in a variety of other courses. They demand personal accountability for decisions and commitment to ideas and proposals that will be subject to public scrutiny.[1] Students are also required to prepare a portfolio of the work created in these two courses.

Educational Reform

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Many aspects of the educational system are undergoing reform. The problem is that very few programs have been able to pull all the pieces together. Some are working on decentralizing control, others on active learning, still others on assessment and outcome-based accountability. However, few have taken all of the new approaches to learning and put them together in one program.

Many programs are still organized around the old “factory” model, where authority is centralized and flows from the top down. Professors, like workers along an assembly line, are seen as interchangeable parts, and students are viewed as products moving along an assembly line. As Albert Shanker of the American Federation of Teachers describes it, “we put them in a room, do something to them, ring a bell, put them in another room, do something to them, and so forth”. Most classes are dominated by professor talk, and an entire class of students is following the same rigid schedule. Accountability has virtually nothing to do with how much students learn; instead, it is tied to seat time for students and following the rules of the professor.[2]

We are building new ideas into the teaching and learning process at the U of H. We have begun to demand that instead of sitting passively and attempting to absorb information, the students are required to play an active role in their own learning. Theodore Sizer of Brown University argues quite correctly that under the factory model of schooling it is the teacher who does the real ‘work’ in the classroom. Nevertheless, no one learns to think by sitting in a passive mode while receiving information. One learns to think by understanding how to assemble information and then manipulating what one has obtained.. This transformation of roles, though, requires that professors are competent professionals who come to their task with an array of pedagogical and experienced knowledge and are capable of making independent judgements about how to manage the educational process.[3]

By putting these changes together, we have improved our “Capstone Design Experience” with a concept that focuses not on teaching, but on learning. Education is not about transferring information from the head of a professor into the head of a student. Education in our information rich society means equipping students with the ability to think. To put it another way, education is “learning how to learn”.

AET Design Curriculum

The design studio has traditionally been the hallmark of architectural education, the place for integrative learning to take place.[4] Schools throughout the country have been criticized for not living up to their goals. At the U of H we have been challenged by this criticism and in response have redeveloped our design studio curriculum.

The knowledge introduced and the skills developed in these classes include:

- Critical thinking – using knowledge base to evaluate design solutions;
- Problem definition – the ability to clearly understand and define what the problem is;
- Problem solving – the ability to research, assimilate and synthesize a given problem and develop appropriate solutions;
- Presentation - emphasis is placed on communication, both oral and written;

- Creativity – thinking beyond the ordinary and given path; to use your background and personal interpretation to put things together in new ways;
- History and Theory – through lectures and exercises to explore precedence and understand the ideas behind the precedence;
- Documentation – further develop both traditional and-technological documentation methods and explore multiple ways to express ideas graphically;
- Design – the process of coalescing and blending the above important skills.

Our newly revised curriculum provides continuity with an active-learning studio design course in all eight semesters. In the first semester, we provide an introductory design studio class, which is followed by Architectural Design I – V. In semesters 7 and 8 students take the Architectural Programming class followed by the Senior Design Thesis class, both of which are organized in the design studio format.

Table I - 2000-2001 AET CURRICULUM

Sem 1	Course	Credits/Contact Hrs
AET 110	Introduction to Architecture	4 Credits/8 Hours
AET 155	Architectural History I	4 Credits/4 Hours
EN 111	English I	3 Credits/3 Hours
ET 111	Introduction to Engineering Technology	1 Credit/1 Hour
MTH 112	Math for Technology I	3 Credits/3 Hours
Sem 2	Course	Credits/Contact Hrs
AET 113	Architectural Design I	4 Credits/8 Hours
AET 156	Architectural History II	4 Credits/4 Hours
PHY 120	Algebra based Physics I	4 Credits/4 Hours
MTH 122	Math for Technology II	3 Credits/3 Hours
Sem 3	Course	Credits/Contact Hrs
AET 232	Working Drawings I	4 Credits/8 Hours
AET 233	Architectural Design II	4 Credits/8 Hours
MTH 232	Math for Technology III	3 Credits/3 Hours
PHY 121	Algebra based Physics II	4 Credit/6 Hour
Sem 4	Course	Credits/Contact Hrs
AET 241	Mech., Elect. & Plumb. Systems	4 Credits/4 Hours
AET 242	Working Drawings II	4 Credits/8 Hours
AET 244	Architectural Design III	4 Credits/8 Hours
MTH 241	Math for Technology IV	3 Credits/3 Hours
Sem 5	Course	Credits/Contact Hrs
AET 236	Mechanics of Materials	4 Credits/6 Hours
AET 352	Architectural Design IV	4 Credits/8 Hours
HSS 1	Human/Soc. Science Elective	3 Credits/3 Hours
TECH 1	Technical Specialty	4 Credits/4 Hours
AUC 1	All-University Curriculum Elective	3 Credits/3 Hours

Sem 6	Course	Credits/Contact Hrs
AET 243	Structural Analysis	4 Credits/6 Hours
AET 367	Architectural Design V	4 Credits/8 Hours
EN 241	English II	3 Credits/3 Hours
TECH 2	Technical Specialty	4 Credits/4 Hours
AUC 2	All-University Curriculum Elective	3 Credits/3 Hours
Sem 7	Course	Credits/Contact Hrs
AET 351	Design of steel Structures	4 Credits/6 Hours
AET 470	Architectural Programming	3 Credits/3 Hours
EN 481	English III	3 Credits/3 Hours
SCI 1	Lab Science Elective	4 Credits/6 Hours
AUC 3	All-University Curriculum Elective	3 Credits/3 Hours
Sem 8	Course	Credits/Contact Hrs
AET 361	Design of Concrete Structures	4 Credits/6 Hours
AET 489	Senior Design Thesis	5 Credits/10 Hours
PROF 1	Professional Elective	3 Credits/3 Hours
PROF 2	Professional Elective	3 Credits/3 Hours
AUC 4	All-University Curriculum Elective	3 Credits/3 Hours
Total		130 Credits Hrs

The “Capstone Design Experience”

The “Capstone Design Experience” is divided into two parts: RESEARCH in Architectural Programming and DESIGN in Senior Design Thesis. These two courses require the student to produce an architectural project which is intended to demonstrate the integration of all the knowledge and skills gained in architectural engineering technology education.

The course titles, numbers, credit/contact hours, semester sequence, and descriptions are as follows:

Architectural Programming: AET 470 [3 credit hours/3 contact hours] Fall Semester Senior Year
Course Description: Client requirements, user needs, types of use, space needs, performance criteria, budget, site analysis, and prototypes will be assessed in the context of an architectural programming project. The resultant document or portfolio will become a working tool for the Senior Design Thesis.[5]

Course Integrations:

- Research and Precedent Analysis
- Architectural Design
- Architectural History
- Architectural Documentation
- Technical Writing and Communication
- Sketching
- Psychology
- Site Planning
- Estimating
- Structural Engineering
- Mechanical Engineering
- Electrical Engineering

- Plumbing Engineering
- Civil Engineering

Senior Design Thesis: AET 489 [5 credit hours/10 contact hours] Spring Semester Senior Year
Course Description: The Senior Design Thesis is the culmination of a student's career in the AET major. Students work with a selected design instructor on an approved design project of their choice, from programming through design inception to complete final presentation of their project. Projects must consider architectural, engineering and planning issues, plus budgeting, scheduling, specifications and code applicability. Final portfolio jury reviews will include both university and professional critics.[6]

Course Integrations:

- | | |
|---------------------------------------|--------------------------|
| • Research and Precedent Analysis | • Site Planning |
| • Architectural Design | • Master Planning |
| • Architectural History | • Interior Design |
| • Architectural Documentation | • Estimating |
| • Technical Writing and Communication | • Scheduling |
| • Abstract Composition | • Structural Engineering |
| • Model Making | • Mechanical Engineering |
| • Sketching | • Electrical Engineering |
| • Architectural Rendering | • Plumbing Engineering |
| • Psychology | • Civil Engineering |

“The Capstone Design Experience” also attempts to focus on the principles and realities of coordination among the various parties who design, construct and use buildings. We emphasize the roles of the various design professionals as they collaborate to make the necessary decisions, design the appropriate systems, and complete the required documents. The fundamental goal is to learn how to realize an architectural product, in today's complex building delivery industry. We need to learn how to organize ourselves so that our desires might best be understood by other parties with whom we participate with in designing and realizing projects. This includes, but is not limited to the other design consultants, our clients, local building officials, planning and zoning commissions, and the public at large. Furthermore, buildings need to adapt to keep themselves useful and appropriate to new requirements, technologies, budget pressures, and expectations. Design proposals also change during their development for many reasons, including adjustments to optimize the systems each of the design disciplines designs and decides upon. Collaborations and integration is at the heart of this approach.

Frequent Evaluations

Frequent evaluations are essential to help students see the strengths and weaknesses of their work in time to act on the insights; good coaches constantly review their players. Students who are reviewed infrequently or only at mid term are more likely to have a traumatic end of semester final review. More frequent evaluations are less likely to arouse anxiety because students become more familiar with them and see them as helpful. Once every week is an effective timeframe for informal reviews while once every month is appropriate for formal reviews.[7]

In collegial evaluations, everyone participates – senior professors, junior professors, professionals, clients, students and administrators – and everyone's opinion is heard and

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considered. Most students state that they welcome these reviews, especially if they occur as a regular part of the process.

Explicit criteria and evaluations help students see precisely where they need to improve, where they do not. Evaluators should spell out as clearly as possible what the expected standards are. All students deserve clear and stable indications about requirements. These reviews are not always pleasant, but they let students know about their progress very early in the process.

The criteria for grading final projects includes:

- Concept: inventive; appropriate; comprehensive; philosophic; aesthetic; social; economic; technological basis.
- Context: responds to site conditions, to city/region, to place and time, to available technology.
- Organization: comprehensive program; recognizes demands; workable; spacial fit of program elements; circulation; amenity.
- Architectural Expression: translation of concept; integrity of architectural ideas in the whole and parts; proportions; scale; visual delight
- Material Quality: appropriate materials; character; application of materials; texture and color; comfort.
- Integration: consideration of structural, mechanical, electrical, plumbing, and servicing implications in the architectural design solutions.
- Presentation: clear, readable, and appropriate presentation materials delivered both in written and oral form.
- Completeness: fulfills all requirements as stated in student's program and handouts; describes the project fully and clearly.

To insure that the desired levels of integration occur, students are evaluated by a multitude of different faculty and visiting critics. Design faculty evaluate the overall design, engineering faculty evaluate the structural and mechanical systems, site professionals evaluate the site design, client representatives evaluate the program execution, construction professionals evaluate the budget and constructability, and input is also collected from the student's peers.

The Portfolio

As programs move beyond traditional assessment strategies and standardized achievement measures, alternative assessment models such as portfolios are becoming commonplace. Portfolios are considered a more authentic means of testing the process as well as the final product of student work. Advocates believe they are more aligned with real-world situations and enable students to effectively show what they have actually learned.

A student portfolio is a collection of an individual's design work and a personal statement of their creative interests and abilities. The portfolio presents an image of the individual, their skills, how they organize themselves, and their priorities. The portfolio showcases the student's accomplishments in a visual form of text and illustrations, and it is usually enclosed in some kind of binder or case for protection and easy handling.

We like to see examples of a student's work from every step of the design process, including doodles, sketches, models, renderings, calculations, narrative, etc. The final project may not be the most important part of the portfolio because it does not show the process. A portfolio is in many ways a kind of window that opens up not just the work of the student but their manner of thinking.[8]

One of the most interesting aspects of our profession of architecture is that it is tangible. Drawings, models, and simulations are not only tools but artistic creations as well. A thoughtfully planned and skillfully executed portfolio is the best evidence of an individual's competence, skill, and talent. In evaluating past, present and future performance in academic or professional design activity, the portfolio remains the single most informative device.[9]

A good portfolio also requires good writing skills as well as good design ability. The student must demonstrate an ability to articulate in written form what their goals are. They must be able to write clear proposals and analyses of projects, as well as illustrate them. While images carry a lot of weight, written communication is an essential business skill that must supplement the student's design ability.

The Studio

The implications of proceeding with portfolios and other alternative forms of assessment include the need to provide appropriate space for working on, storing, and exhibiting student work. The space must accommodate a wide range of activities and products, including, but not limited to, computer drops with access to the internet, audio/visual studio presentations, live presentations, individual project work, large open work tables, a gallery area to display and present work, and a staging area. The studio is a dynamic space that is part work area, part museum, part theater, part warehouse, and part classroom.

These updated classrooms make ideal environments for an updated form of education. Active learning, unlike the old model of lecture-then-homework, breaks class time into smaller, more varied chunks. Students are also encouraged to help one another, which makes for a more efficient learning process.[10]

Conclusions

Architecture curriculum is by nature connected. According to Boyer and Mitgang, our most distinctive feature is the design studio, which is a model for the integration and application of learning.[11] Other disciplines on campus could well profit from observing this approach to teaching and learning. The U of H's AET curriculum is based on the blending of academic based theoretical studies with industry based problem-solving activities. We do our best to tie learning to life by doing work that connects the studios to the community. The "Capstone Design Experience" prepares students for a career of lifelong learning and professional success. Many believe that learning in a compartmental fashion has never been fully successful; our AET curriculum is by its nature integrated and connected. We have found that the most important element in good teaching is involving students to enable them to think and learn on their own.

However, more importantly, our graduates are finding a flattering reflection of their active-learning educational experience in the integration-rich workplace.

We try to remember the old chinese proverb, “I hear and I forget, I see and I remember, I do and I understand”, as the faculty strives to create an active learning environment for our AET students.

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