

Introducing the Visual Language and Process of Design to Beginning Architectural Engineering Students

Abstract

The “Introduction to Architecture” course for freshmen architecture and architectural engineering students has been offered every fall semester since 1995. The fundamental course goals are to introduce the process of design, and to illuminate the professions of architecture and architectural engineering. The ABET 2000 criteria assessed are (f) an understanding of professional and ethical responsibility, and (g) an ability to communicate effectively. Francis Ching’s Form, Space and Order is the course text, as it very competently provides a general framework within which basic principles can be explored. Each year, the lecture presentations and assignments are re-examined and further developed in an attempt to continually improve the effectiveness of the course. In the fall of 2005, an experimental information delivery technique was utilized, in the form of a weekly case study investigation. The following paper describes this teaching methodology, and uses the student evaluation data to assess its effectiveness.

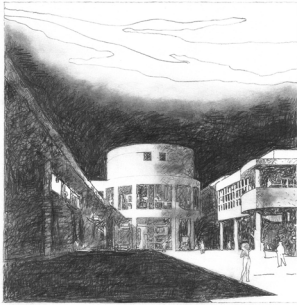
The drawing conventions, fundamental ordering systems, visual principles, and design processes that must be introduced to the beginning architectural engineering student are abstract and can be difficult to teach. As design is a process which follows no set path but conforms to the manner in which attitudes, abilities, and prejudices influence creative thought, every architect and architectural engineer approaches and solves a problem uniquely. “In particular, the view that a designer takes of his role in society, and the function and reason for his work are crucial to any real understanding of the process he employs”¹. For beginning design and engineering students, this non-linear process can be confusing and frustrating.

Francis Ching, noted architectural educator, states that “Form and space are the critical means of architecture that comprise a design vocabulary that is both elemental and timeless.”² Architecture, by its very nature, is a visual and experiential art. To learn about architecture, especially design and engineering, is therefore a visual endeavor. Beginning architectural engineering students must be introduced to the graphic conventions, the fundamental principles of form, space and order, the various visual devices, and the design process of the professional in a highly visual and graphic manner.

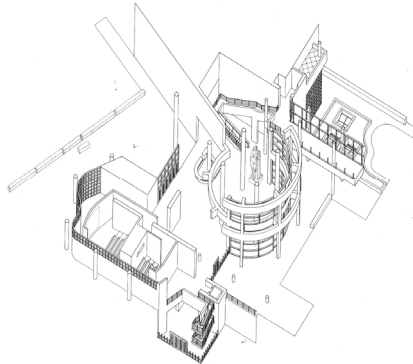
To this end, in the “Introduction to Architecture” course 160 freshmen students are presented each week with a new case study architect or engineer whose work exemplifies the fundamental design issue at hand. These case study presentations are organized into a three part series: **Architectural Graphic Communication, Fundamental Design Principles, and Design Processes**. The Architectural Graphic Communication series consists of three sessions: Drawing Types and Rendering, Orthographic Projection, and Linear Perspective. The Fundamental Design Principles series also consists of three sessions: Form, Space and Order, Visual Devices, and Formal Penetrations. The Design Process Series consists of four sessions: Architectural Design, Architectural Engineering Design, Design and Construction, and the Interview of a Professional. A description of the topic and associated case study, which utilize contemporary as well as historical designers for their subject matter, and the related student assignments are:

Architectural Graphic Communication Series

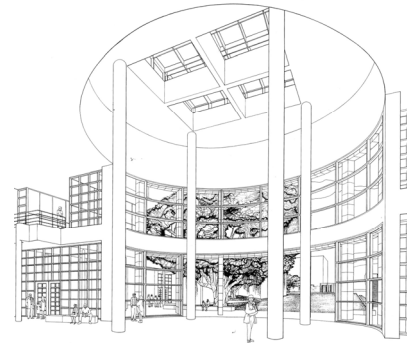
Case Study 1 – Introduction to drawing types and their purposes, illustrated by the drawings utilized by the New York architect Richard Meier in the design and communication of the Getty Center complex in Los Angeles, California.



Getty Center Rotunda Sketch



Getty Center Rotunda Axonometric



Getty Center Rotunda Perspective

The major communicative drawings – 2D orthographic projections such as plans, elevations, and sections, and 3D drawings such as paralines and perspectives – are part of a presentation package whose purpose is to convey design intent. The clarity and completeness of a drawing will ensure that it is understood by client and contractor alike. Additionally, it is of utmost importance to accentuate these drawings by the use of contrast (tone and texture) so that they “read”. Contrast is achieved through the process of delineating and rendering - a process that is critical in the communication of a design project.

Assignment 1

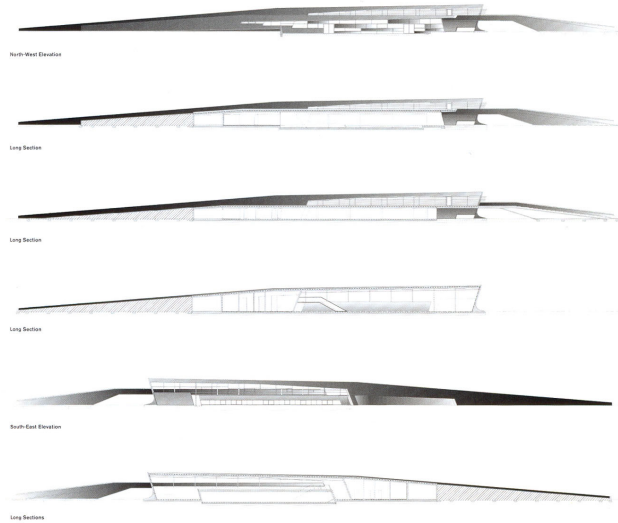
The student assignment is a two-part exercise; part one is an emulation exercise wherein students duplicate a set of example drawings, each focused upon a different technique or rendering style. For the second part, students are challenged to display their ability to visualize an object in three dimensions - paraline, based upon the two dimensional drawings (orthogonal: top and side views) that are provided.

One objective of this exercise is to introduce students to the variety of drawings that architects and architectural engineers create. Another objective is to increase the students’ skill in visualizing three dimensional objects/space from two dimensional drawings. This exercise should also encourage students to begin thinking about the materiality evident in the architecture they experience daily, in addition to helping them learn techniques of creating drawings that appropriately express the tone and texture, and the shade and shadow, of that contrast.

Case Study 2 – Introduction to the drawing convention of orthographic projection, illustrated by the work of the British architect Zaha Hadid (whose architectural style would seem to defy orthographic projection!).



Landscape Formation One, 1999



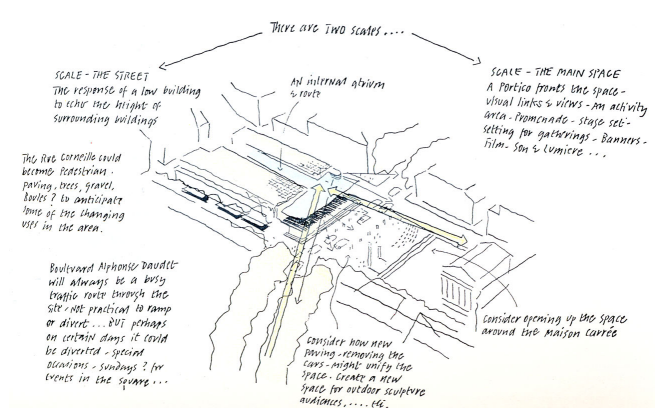
Elevations and Sections

Assignment 2

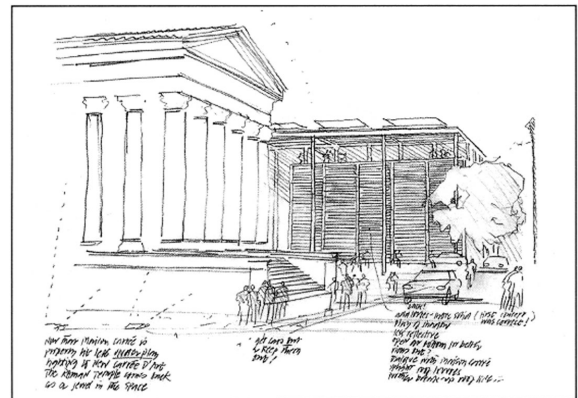
The assignment challenges each student to document their “room” in plan, and two section drawings showing the respective interior elevations. The size of the room and its relative simplicity in form allows students to demonstrate with ease their understanding of, and ability to draw, the basic orthographic representations.

The goal of this exercise is to introduce the formal drawing convention of orthographic projection to students, while using a space they are intimately familiar with as the subject matter. From this experience, students should begin to be able to visualize how a three dimensional experience can be translated into conventional 2D documents. Students should also employ the techniques they experimented with the previous week – to add textures and/or shadows/tones to give the drawings contrast and increase ‘readability’.

Case Study 3 – Introduction to the use of linear perspective, illustrated by the design process of the British architects Sir Norman Foster in his work for the Musee Caree in Nimes, France.



Musee Caree Site Analysis Study



Musee Caree Journal Entry

Students constantly encounter a variety of buildings and utilize the spaces within them, without ever giving much thought to the various architectural characteristics of those buildings and spaces. The way in which a building is ordered has a profound effect on the way it is used. In addition, the manner in which form and space are designed impacts how humans interact with and respond to a building.

Assignment 4

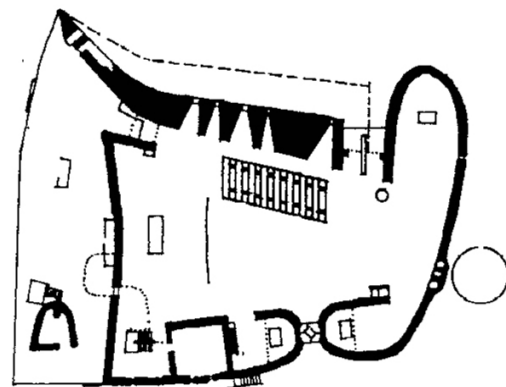
For this assignment, students select one building/space on campus, and then analyze it with regard to the qualities of form, space and order. First, they must analyze it logically and by recording factual information (draw the plan and sketch the important space(s) in perspective). They then must think of the architectural vocabulary terms and organizational concepts discussed in class (based on Francis Ching's Form, Space and Order³), and use these terms with a few diagrams to illustrate the concepts of form, space and order exhibited in the building or space they have selected. They must identify what formal transformations have occurred, document one open space and one closed space, and decide which of the five ordering systems – linear, grid, centralized, radial, or cluster have been employed.

The primary goal of this exercise is to force students to look at the architecture they experience everyday with a critical eye. They must become familiar with these architectural terms and basic concepts, in order to understand the essence of how form, space and order can be composed.

Case Study 5 – Introduction to the fundamental visual devices of design: axis, symmetry/asymmetry, hierarchy, repetition and datum, illustrated by the seminal works of the mid 20th century by the late French architect Le Corbusier.



Notre dame du Haut, Ronchamp – Hierarchy, Datum



Ronchamp Plan – Axis, Asymmetry

In addition to the essential concepts of Form, Space and Order, architects and architectural engineers have the ability to utilize a series of other fundamental design principles in the creation of architecture. These design principles are visual devices that allow the diverse forms and spaces of a building to co-exist perceptually and conceptually within an ordered and unified whole.

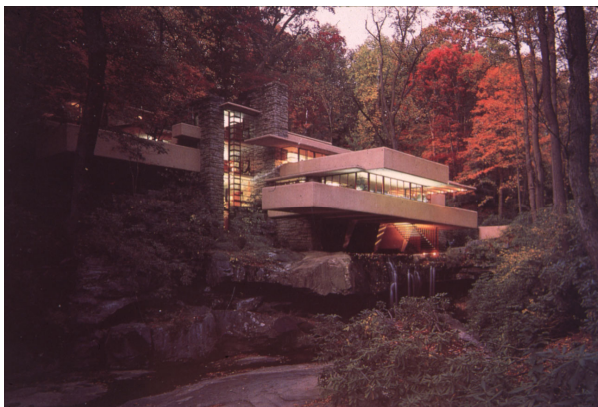
Assignment 5

This week, students use their powers of observation to identify buildings or spaces on campus that display the following basic design principles: Axis, Symmetry/Asymmetry, Hierarchy,

Repetition, and Datum. Students must think of the architectural vocabulary terms and fundamental design concepts discussed in class (based on Francis Ching's Form, Space and Order⁴), and use these terms to describe the design principles exhibited in the buildings or spaces they select to analyze. They must document their observations carefully with the addition of high quality drawings and diagrams to illustrate their understanding of the design principles.

Again, the goal is to force students to look at the architecture they experience everyday with a critical eye. They must become familiar with the concept of these visual devices, in order to understand how architecture can be designed to provide a backdrop, encourage movement, or focus attention, simply due to the careful manner in which the elements are arranged.

Case Study 6 – Introduction to the nuances of formal penetrations in design, illustrated by the masterpieces of the late American architect Frank Lloyd Wright.



Fallingwater, Bear Run, PA



Fallingwater Living Room - Opening between Planes

Planar elements have an important role in defining the visual limits of a spatial field. Planes are utilized to enclose space, to define spaces from one another, or separate interior spaces from exterior spaces. The degree of enclosure provided by these planes can create a feeling of security and privacy for the inhabitants within, allow movement between spaces, or even promote or prevent visual connections to adjacent spaces.

Assignment 6

The student's assignment is focused upon formal penetrations within space defining planar elements. At the scale of a room (not an entire building), the nature of the openings within a room's enclosure is a major factor in determining the quality of its space. Students are asked to identify three separate conditions: An Opening within a Plane, An Opening at a Corner, and An Opening between Planes (based on Francis Ching's Form, Space and Order⁵). Once these conditions are found, students must draw the situation, and describe the quality and quantity of light that is permitted by this opening, and the effect this amount of light has on the space within. They must also describe the views that this opening captures or promotes from the space within.

The ability to carefully manage light and views in a space is critical to how that space is utilized, perceived, and in fact, enjoyed. This exercise aims to sensitize students to this task, and encourage them to critically examine these conditions in the architecture they experience everyday.

Design Process Series

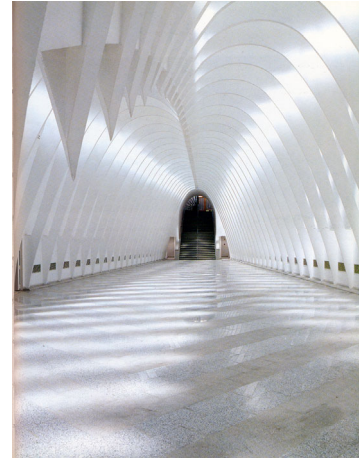
Case Study 7 – Introduction to the architectural design process, specifically of a project with a program consisting of a space of transition and a space of gathering, illustrated in one work of each of the following AIA Gold Medal designers: Frank Gehry of Los Angeles, Tadao Ando of Japan, and Santiago Calatrava of Zurich.



Frank Gehry's Pairser Platz



Tadao Ando's Church of the Light



Santiago Calatrava's Alcoy Hall

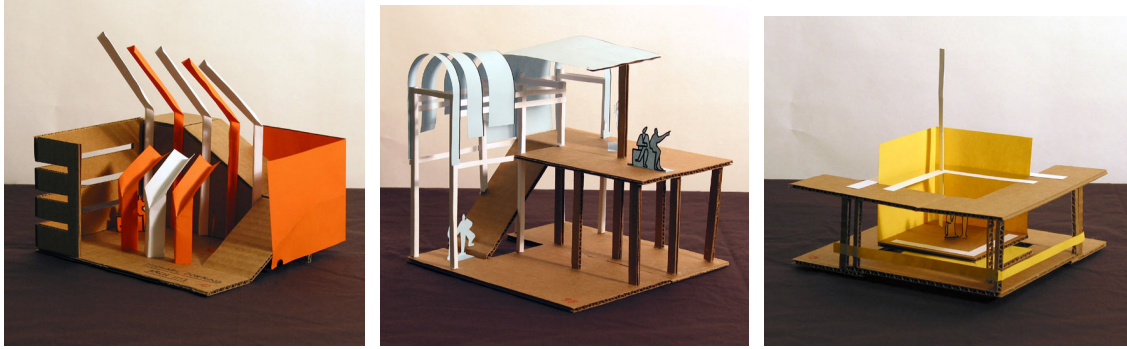
The practice of Architecture is a complex integration of aesthetic and technical systems that typically requires a team of experts in related fields working together to solve a design problem. The primary role of the architect is to work with a client to establish a design direction – a concept – that is a direct result of the project goals, the needs of the user group, and the vision of the architects and architectural engineers. Architectural engineers play an integral role in the creation of architecture, as they are responsible for the design and analysis of the required technical systems.

Assignment 7

Students are asked to imagine that they have just been hired as the lead designer for a new “space” on the university campus. The space will be visible from the president’s office, and will be a reminder to him of the creativity and innovation of students and the learning process. The new space most likely will become a meeting and gathering point for students as they go about their daily life on campus.

The functional program is quite simple: The space must be an open air pavilion comprised of a space of transition leading to a small space of gathering. The students begin by brainstorming what they want the space to feel like, and then by trying to imagine moving through and experiencing the space. This is an abstract conceptual study aimed at investigating a possible formal and spatial expression for this new architectural space.

The objective of this exercise is to allow students to begin thinking about design issues such as image, scale, and function, while considering a typical design problem. In addition, with this exercise students will begin to hone their skills in craftsmanship and three-dimensional conceptualization.



Student proposals for an open air pavilion, comprised of a space of transition and a space of gathering.

Case Study 8 – Introduction to the practice of architectural engineering design, illustrated by the work and design process of the Swiss architect/architectural engineer Santiago Calatrava.



Vertical Bracing System



Shearwall System



Moment Frame System, all towers by Santiago Calatrava

Assignment 8

Students are given an architectural engineering design problem, and must work in teams of four to propose a structural concept for a new tower. The tower must utilize one of three means to achieve structural soundness – vertical bracing, shearwalls, or moment frames. It must also support a cantilevered load near the upper region of the tower, while allowing pedestrians to pass through the base of the tower.



Students problem solve in teams.



Testing the towers for strength and durability.

In less than an hour and a half, the teammates must propose an innovative structural concept to present to the architect. They must do so in model form, at ½”=1’-0” scale, using a limited palette of materials that includes drinking straws, cardstock paper and hot glue. All proposals are evaluated for aesthetics, strength and durability. Proposals are then publicly tested to failure, while analyzed and discussed with the help of two professional architectural engineers.

Case Study 9 – Introduction to design, engineering, and construction realities, illustrated by the work of Japanese architect Tadao Ando at the Modern Museum of Art in Fort Worth, Texas.



Modern Museum of Art, Fort Worth, Texas

Gallery Pavilions



Innovative Architectural Concrete Construction

Students review the documentary “Making the Modern” illustrating the design and construction process for a very large, very public building – the Modern Art Museum of Fort Worth. Its architect, internationally acclaimed Tadao Ando, crafted a design solution for this museum while working in his office on the other side of the globe. Special lighting consultants in Europe and Washington DC designed unique solutions for the museum’s need for light without heat or UV accumulation. Building craftsmen were specifically trained to achieve the level of finish for the architectural concrete that Ando demanded.

Assignment 9

While there are many aspects of the design and construction of this project that are illustrated in the documentary, the student assignment is to think about the entire process, and then identify and discuss one aspect that they found the most interesting or impressive. They could elect to discuss the international nature of the project, the special design features (the gallery pavilions, the gallery lighting system, the unique structural solution, etc), the special construction methods, or any other aspect that they feel is interesting or important.

The goal of this exercise is to allow students to glimpse an overview of the entire process of the creation of architecture – a view few students fully comprehend as they begin their studies in architecture. During the design and construction process of this building, several processes and challenges are illustrated, involving not only the architect but also the structural engineers, the consultants, the clients, and the contractors. The idea that architecture is a collaborative effort, relying on the expertise of many individuals, is at the heart of this assignment.

Case Study 10 – Interview a local architect or architectural engineer, to investigate the real life applications of the graphic conventions, ordering principles, and design processes.



Students interview professionals: Heather Hoeffecker, PE and Mark Seibold, AIA.

In a seminar setting, small groups of freshmen students have the opportunity to meet a practicing architect or architectural engineer and learn about the professions from someone who is “in the trenches”. The students’ challenge is to simply listen and ask questions... for example, their questions might be what kind of projects the architect or architectural engineer does, what are the ‘highs’ and ‘lows’ of being an architect or architectural engineer, how an architect and an architectural engineer work together, how the educational process prepares students to become architects or architectural engineers, what is it like working in an office, how much time does an architect or architectural engineer spend on a construction site... or any other questions they might have on their mind.

Assignment 10

For their assignment, students must document this experience, in particular recording the name of the professional they met with, the name of the firm he or she works with, and any other interesting facts the architect or architectural engineer chose to share with them. They must conclude their report with any comments they have on what they learned, and how it has affected their thinking about becoming a professional.

Assessment

At the conclusion of the semester, 140 freshmen students evaluated the course on a specially tailored evaluation form. Five questions were developed to target the assessment toward the fundamental course goals: to introduce the process of design, and to illuminate the professions of architecture and architectural engineering. Also assessed are ABET 2000 criteria (f) - an understanding of professional and ethical responsibility, and (g) - an ability to communicate effectively. The table below illustrates the results of the course evaluations:

Question						Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I further developed my understanding of the role of the architect/architectural engineer in society.						82	54	4	0	0
2. I increased my awareness of the fundamental design issues pertinent to the creation of architecture.						68	64	7	0	0
3. My abilities in basic graphic communication improved.						64	48	26	1	1
4. This course challenged me to become more aware of the architecture I experience.						92	41	6	0	0
5. Overall, this course was valuable to my development as an architect or architectural engineer.						85	39	13	1	1

Question 1 targeted the effectiveness of the case study teaching method; 97% agreed that they better understood the role of the architect/architectural engineer in society. The results of questions 2 and 4 indicate that 95% of the students feel they better understand the fundamental design issues and are more aware of the architecture they experience. Question 3 hints at the student's continuing insecurities about their own ability to communicate through drawings – although 80% did acknowledge that their drawing skills had improved. Of the students planning to continue their studies in this field, 97% felt that the course was valuable to their development as an architect or architectural engineer. Written comments on the evaluation forms provide further insight of student reactions to the course:

“I found the homework assignments to be challenging and informative. The assignments forced me to think outside the box; to look at things and truly grasp/understand what I saw.”

“I liked talking about a famous architect each week, so I learned that architects have their own ways of architecture.”

“The homework was very intense and involved, but I actually learned a lot because of this fact. Not normal for a survey course, but that is a good thing.”

“The series on basic design principles was very valuable – every building I look at, I look for these things now!”

“This class was beneficial and the highlight of my week.”

The only negative comments received on the student evaluations concerned the equality of the grading process, since four teaching assistants and the instructor divide the homework each week and grade them. One student wrote that the grading should be *“less riggerous (sic)”*. In post-semester assessment discussions with the teaching assistants, each of whom had taken the course without the case study presentations, all agreed that the course was more interesting in this format. In fact, they felt it was more informative than when just the material – such as orthographic projection, architectural engineering design, etc - was presented. They also commented that the freshmen seemed more interested in their major, and knew much more about contemporary architecture than they did as freshmen students.



Beginning architecture and architectural engineering students are typically visual learners, drawn to this profession because of a desire to design and bring order to a visual field of information. Most begin this career path, however, with very little knowledge of current architecture and architectural engineering practice. Though teaching via a case study method has been utilized for many years in the medical and legal fields, its application as an educational process for the architectural field demonstrates increasing merit. In the highly visual “Introduction to Architecture” course, students are stimulated to understand how actual architects and engineers have grappled with the various graphic conventions, fundamental ordering systems, visual principles, and design processes as they relate to the contemporary practice of architecture and architectural engineering. The final result is a greater understanding and appreciation of the profession – for *freshmen students* just beginning to find their way into this unique career path.

¹ Lawson, Bryan. How Designers Think, The Design Process Demystified, The University Press, Cambridge, 1990, pg 121.

² Ching, Francis. Architecture Form, Space and Order, John Wiley & Sons, Inc, New York, NY, 1996, pg vii.

³ Ibid, Chapter 4.

⁴ Ibid, Chapter 7.

⁵ Ibid, Chapter 3.