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Outside Front Cover:
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REVIEWS

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Comparative Anatomy
A Beginning Course
in Architectural Design

The goals, methodology, and content of a beginning course in design are presented here as an approach to the teaching of the fundamental principles of making architecture. In the course the pedagogical how has equal standing with the what of content. Concepts from educational theory and practice are applied, including working with a hierarchy of educational goals and employing the idea of "scaffolding" to help the student learn and use the material. Taught by different people in different schools for more than 30 years, the course makes use of established building types, progressive sequencing of assignments, multiple iterations, and ongoing comparisons between projects, which allow students to develop a rigorous foundation in their training as future architects.

The beginning is the most important part of the work. —Plato, *Republic*

How to begin? The question is not just about starting; it carries symbolic weight as well—about origins and priorities and "first moves" that shape the outcome of enterprises. This article presents a one-semester studio course that begins with buildings and the parts and patterns that make them. The title "Comparative Anatomy" suggests a relation to the ways other major disciplines begin their professional studies. As the future physician begins by examining organs, functions, and systems pertaining to the body, so perhaps future architects can begin their studies by learning and working with a number of vital elements, assemblies, and relations that are integral to well-designed buildings. Of course, things move along much more quickly for the architecture student than for his or her medical counterpart. Almost immediately the design student is asked to go beyond anatomy to "diagnose" and "prescribe" as well.

Over the years and in a number of settings the course has proven an effective teaching instrument for introducing architectural design. It was developed collectively in the late 1970s and early 1980s by the author and colleague Hanno Weber, while we both were on the faculty at the School of Architecture at Washington University in St. Louis. We taught the course as a joint effort to two studios of 15–20 students, a mix of third and fourth-year students in a six-year program. Since then, the course has been used by each of the instructors separately up to the present day—by myself at the University of Texas at Arlington, and by Weber at the University of Wisconsin-Milwaukee. The course has been successfully offered by teams of instructors to a larger group of students, or as a smaller studio led by a single instructor. The course is scalable; it is also flexible, allowing considerable variation in response to faculty and curricular needs.

The course has acquired several nicknames— "Anatomy Lessons" after the great Rembrandt depiction of learning by dissection, and "The Swiss Train" because of its high degree of organization and tight schedule. The outline and outcomes of the course were first presented to a wider academic audience as "Studio Teaching Based on the Concept of Type" in 1979 at the Blue Mountain Conference, an annual invited meeting on architectural education organized by Syracuse University's School of Architecture; here it will be simply referred to as "the course." The course locates itself in the usual architectural curriculum right after the students' "basic design" experience, in which they acquire knowledge and abilities in graphic/descriptive means and formal manipulation/organization. In the "4+2" curriculum the course occurs most often in the third year' in 3–4 year post-baccalaureate programs it often finds itself in the second or third semester of a sequence.

Overview and Organization of the Course

The course aims to provide the student with the basic vocabulary, knowledge, and ability to approach designing buildings with a degree of thoughtfulness and confidence. Through a calibrated sequence of discrete design studies, the student engages a number of basic issues in a cumulative way so that "new" knowledge is introduced and then added to prior knowledge. Earlier work, developed on his or her own or by classmates, serves as point of entry to the next assignment; there is little "flailing about."

The overall organization of the course is graphically summarized in a diagram showing week-to-week assignments, site context conditions, and readings (Figure 1). The first part of the course consists of a sequence of four intensive one-week design exercises each focusing on one aspect of organizing a building: *circulation* order, *structural* order, *volumetric* order, and *enclosure* order. Three generalized *solution types* are identified within each of the above aspects; a lecture and readings discuss them with respect to precedents and current practice. The class is divided into thirds and each group takes one of the three solution types to resolve a class-wide program brief, one of a series of three during the semester, each characterized by very different space and use de-

	Focal Issue	Assigned Types	Programs *Approx 9000 sq.ft.each*	Site	Assigned Readings *Essays and Book Chapters*
	Introduction + Organization				• *Moneo,* *The Solitude of Building* • *Moneo,* *On Typology* • *Colquhoun,* *Typology + Design Method*
Week 1	Circulation Order	• Linear • Loop • Radial • Grid	**Program A** **Government Services Center** *Many similar discrete spaces*	None	• *MacCormac,* *Anatomy of Wright's Aesthetic* • *Moore et al,* *Assembling the Rooms* • *Moore et al,* *Including the Machines*

Week 2	Structural
	Order
		• **Masonry Bearing Walls**
		  Parallel Walls, PC Slab
		• **Concrete Frame**
		  Rect Bay, Conc Slab
		• **Concrete Column + Slab**
		  Square Bay, Round Col
					• *Schodek,*
					Structural Patterns
					• *Sekler,*
					Structure, Construction, Tectonics
					• *Seligmann,*
					LeCorbusier as Structural Engineer

Week 3	Volumetric
	Order
		• **Figural**
		  Singular Form
		• **Elemental**
		  Multiple Different Forms
		• **Cellular**
		  Multiple Identical Forms
					• *Rowe,*
					Mathematics of the Oldeal Villa
					• *Eisenman,*
					Real and English: Destruction of
					the Box
					• *Coquhoun,*
					Centraal Beheer

Week 4	Enclosure Order	• **Pierced Openings** • **Infilled Frame** • **By-passing Membrane**			• *Schittich,* *Building Skins* • *Rowe + Slutzky,* *Transparency . . . Part II* • *Schumacher,* *The Skull and the Mask*

Weeks 5-7	Siting
	Order
		• **Infill Site**
		  Parallel Party Walls
		• **Corner Site**
		  Right Angle Party Walls
		• **Open Site**
		  Free-standing
				One of
				Three
				Site Types
					• *Moore et al,*
					Fitting the House to the Land
					• *Schumacher,*
					Contextualism: Urban Ideals +
					Deformations
					• *Allen,*
					Object to Field

Weeks 8-10	Comprehensive Study I		**Program B** **Public Indoor Swimming Pool** *Single Principal Space*	One of Remaining Site Types	
Weeks 11-14	Comprehensive Study II		**Program C** **Public Branch Library** *Hybrid Mix of Spaces*	Last of Remaining Site Types	

Figure 1. Basic Diagram of Course Organization. Note: Examples of student work in subsequent figures demonstrate each segment of the course. Work done in the early 1980s is identified with a single asterisk, that done in the late 2000s with two asterisks. (All images are the author's.)

mands. The first—Program A—is made up of many discrete smaller spaces, no site is given, as the focus is on internal organization and consistency. Each week ends with a review/seminar which examines the ways the three solution types order circulation, structure, volumetrics, and enclosure. Succeeding weekly iterations of the continuing program brief relaxes the previous constraints while insisting on adherence to the current aspect's three solution types.

The second part of the course, a three-week design exercise, focuses on issue of *siting*. As in the earlier studies, three generic types are given—represented by three local sites the student can visit. The student now develops a design for the now very familiar Program A, used in the previous four exercises, on one of the sites. Then, in "round-robin" fashion,

for the two upcoming design exercises the student works on each of the remaining site types.

In the third segment of the course, also three weeks long, the student for the first time resolves a different program brief, a brief with one principal space and several secondary ones—Program B—on one of the two remaining site types he or she has not worked on. This change in program on a new, yet familiar, site—one third of classmates will have used it on the previous exercise—invites comparing the effects of both program and site on building organization and form.

In the four-week final portion of the course the student resolves the third program, a hybrid of space types—Program C—on the remaining site. Again, the cumulative influence of sites and programs on shap-

ing design can be seen clearly across the class. The iteration of the design experience in different but very interrelated and articulated situations brings confidence and a sense of control to the student's work. He or she learns to look for and test a number of typal responses during the various stages of the design process, becoming more adept at "working through" difficulties and taking advantage of opportunities.

Ideas Underlying the Course

Before addressing the course in more detail, a review of the conceptual thinking behind it is in order. A number of larger ideas have guided the development of the course, ideas ranging from the classic treatises on architecture to contemporary learning and teaching theory.

Buildings as Subject

Buildings offer their own educational text, and knowledge of them frames the understanding of thinkers on architecture, both practical and theoretical, from Vitruvius on. The earlier the student becomes involved with buildings, the earlier the literature of architecture becomes meaningful. Knowledge of existing buildings provides the factual material upon which subsequent abstraction in design rests.

Rafael Moneo puts it powerfully:

> I believe that in the crude reality of built works one can see clearly the essence of a project, the consistency of ideas. I firmly believe that architecture needs the support of matter; that the former is inseparable from the latter. Architecture arrives when our thoughts about it acquire the real condition that only materials can provide.[1]

By entering the studio enterprise working directly with buildings, and public buildings at that, the student engages the center of architecture. It satisfies almost immediately the desire that very likely motivated him or her to enter the field in the first place—to shape and make buildings. This immersion is especially useful when the student begins architecture following a

degree in another subject, where the student feels an understandable urgency to get on with it.

Knowledge Progressing From the Particular to the General

In 1956 a group of educators headed by Benjamin Bloom published *Taxonomy of Educational Objectives: The Classification of Educational Goals: Handbook I: The Cognitive Domain*. The *Taxonomy* was developed to provide a more precise framework for addressing curricular and evaluation issues in the broad field of education.[2] At its core, the *Taxonomy* outlines a set of learning classifications, a hierarchical set of levels, proceeding from concrete "knowledge" through higher and higher levels of abstraction and instrumental use. Learning at each higher level is predicated on achieving the necessary understanding and abilities developed in the lower ones.

The progressive classification levels are:[3] knowledge, comprehension, application, analysis, synthesis, and evaluation. Within each classification the *Taxonomy* identifies sub-classes. For example, in the first level of the hierarchical structure—knowledge—are listed *Knowledge of Specifics*; ...*Ways and Means of Dealing with Specifics*; and ...*Universals and Abstractions in a Field*. And within each of these sub-classes is an array of sub-sub-classes, such as *Knowledge of Conventions*; ...*Trends and Sequences*; ...*Classifications and Categories*; ...*Criteria*; ...*Methodology*.[4]

Nearer the "higher" range of the *Taxonomy*'s hierarchy is *synthesis*, "defined as the putting together of elements and parts so as to form a whole."[5] This activity takes us directly to what we require of students in the architecture design studio. One can argue that the demand for such "higher" level thinking occurs earlier in architecture—in design—than in most other fields, fields that often spend much more time laying out their vocabulary, framework, and factual material than architecture does.

Practicing architecture demands broad and deep knowledge. It requires a working command of many factors, from technical systems to economic management, from human behavior precedents to sophisticated visual sensibility. Educating architects—initiating future architects to this knowledge and experience—is daunting. Is there a core discipline to the discipline? How do we learn to learn?

The studio course is usually given responsibility to address these questions. Yet we too rarely really examine the pedagogical organization and structure of studio courses themselves. In studios we perhaps rely too much on mimetic learning—modeling on examples, modeling on others—than *cognitive* knowledge, which "involves the recall of specifics and universals, the recall of methods and processes, or the recall of a pattern, structure, or setting."[6]

With architecture students required to learn so much in such a short time, the ordering logic of the *Taxonomy* is compelling. Just as we develop a nesting array of organizations in our designs for buildings, so we must design the design courses. It is easy to see, especially for architects, the *Taxonomy*'s ordering logic—the continuing gradient of knowledge and abilities from the "particular" (basic terms, facts, elements, etc.) to the "general" (assembly, judgment, abstraction, etc.). The larger lessons for learning and teaching architecture follow. Designing, which requires almost continuous cycles of analysis, synthesis, and evaluation to succeed, must have a foundational base in the comprehension of underlying knowledge. Designing in an architecture studio operates at the highest of the *Taxonomy*'s learning levels. Without a rich base of applicable knowledge, one can certainly question whether design is taking place at all. Mimicry perhaps. Abstraction itself has very little meaning if one is not aware of the things being abstracted.

Scaffolding

The term "scaffolding," as it is used in the field of education, comes from work done in the psychology of learning.[7] That the metaphor applied to a major teaching and learning practice comes from building construction is worth noting in the context of architectural education. In general terms educational scaffolding is an infrastructure of learning and support that proceeds from the shared fundamentals of the discipline to independent work by the student. It is a program of incremental and cumulative instruction involving extensive instructor feedback and instructor modeling—demonstrating how one might feel, think, or act within a given situation. These resources—scaffolding—are progressively removed as the student's command and confidence grow.[8]

Traditionally, architecture design studios are settings where learning is based on the strong sympathies and admirations[9] of the instructor, who serves as a model for creating an *affective* domain[10]; this powerful modality—learning by attitude and empathy—is one of the historic strengths of the design studio as a vehicle for education. Indeed, it is just this social dimension to learning that other disciplines find so attractive. Where architecture design studios have been relatively weak is in organizing knowledge in an incremental and cumulative way and in providing ready access to it when needed, or establishing the *cognitive* domain. It is this "scaffolding," this surrounding of early design exercises with facts, standards, and examples, that the course aims to add to the normative design studio educational experience.

An earlier (1977) pedagogical project by the author explored augmenting a major studio assignment with an armature of background, information, and examples.[11] It used the *Taxonomy* as its conceptual point of departure. A 200+-page "designer's companion" accompanied a four-week assignment in the first year core architectural design course at the Harvard Graduate School of Design—the subject was a public market shelter. The "designer's companion" supplied much basic material on the design program's precedents, functional standards, structures, and materials. It was a pilot project for eventually providing each studio exercise with an easy-to-use document with readings, references, images, and data that would quickly give the student a more informed knowledge base for generating and evaluating his or her design approaches; it was funded by Harvard's President's Fund for Innovative Courses.

Scaffolding for the course discussed here refers to the program briefs, lectures, and readings that

accompany each of the first five design assignments, dealing with *circulation*, *structure*, *volumetrics*, *enclosure*, and *site*. The written brief at the beginning of each of these assignments carefully defines terms, diagrams elements and types to be used, and specifies the format of the resulting work. A lecture, presented with more than 60 images, is also part of the scaffold exercise that frames each early assignment; it reinforces the exercise's focus and shows precedents from significant past and current works. Each of the three assigned types that the student will use in a given week are illustrated with many examples, giving a wider context to the assignment and suggesting some of the visual power that traditionally accompanies the ideas in question. Readings form an additional scaffold for the first five assignments, readings by significant figures in the field. These are essays, journal articles, or book chapters—short enough to be realistically read, thought about, and perhaps used as a source of information or attitude in the student's design process.

Learning by Comparing

In architecture learning by comparing has a long and productive history—comparisons among styles, periods, cultures, types, uses, climates, and philosophies being the staple learning modality since the early eighteenth century. For instance, the plates of J.N.L. Durand's *Précis des Leçons d'Architecture*[12]at the beginning of the nineteenth century show sample building plans and building elements side by side at the same scale organized by type; in an earlier work he does the same for precedents "ancient and modern."[13] And generations of architects learned the past from Banister Fletcher's *A History of Architecture on the Comparative Method*.[14]

This course depends upon comparison in a number of ways. Most important is the concept of type, in which categories of things are defined. Then these categories can be meaningfully juxtaposed, comparisons made, and judgments arrived at. Things can be understood relative to each other. And holding some variables constant while others are free to

change clarifies the results, as it does in math and science. The course works this way by identifying three clear types within each architectural aspect, or issue, under examination. The three are not exclusive by any means but do represent a range of logical alternatives to pursue. In the first part of the course there is always a range of defined alternatives presented to the student. Operationally, dividing the class in thirds and rotating through the types produces a lively basis for comparing—and discussing— how and why some things may work better than others and under what conditions that may occur. Reviews become not "juries" but rather seminars on how different conditions and assumptions can lead to very different results. Seeing the simultaneous alternatives produced by classmates enables the student to understand, at one remove, paths not taken and where they might lead. This adds to his or her range of experience and ultimately to the capacity for informed judgment.

To illustrate, program and site are kept constant in the first four week-long studies. Then, for example, the student during the second week works with one of three defined structural system types to resolve the scheme developed in week one. With the additional imperative of a structural system he or she is free to modify the previous scheme as needed.

Learning by Iteration

It is a truism that the ability to do something increases with the number of times it is done. One really doesn't need Malcolm Gladwell to convince us that "practice makes perfect," or if not perfect at least a lot better.[15] Typically the architect in an office goes through numerous sketches and models, each version representing some change that might produce a superior solution. Design is an essentially evolutionary process that uses incremental variations to lead to a possibly better product. Looking carefully at the work of the masters like Le Corbusier and Wright one is struck by the huge number of studies, versions, and alternatives they have gone through on a project.

Unless used repeatedly, knowledge and skills tend not to be retained, much less expanded upon. Retention of abilities has become more and more of a concern in design education as curricula offer more choice and less structure. Variety may displace reinforcement with the result that there is too little "carry-over" from one semester to the next. The beginning series of design courses, the "core," has an obligation to offer a framework, an armature, the student can relate knowledge to; iteration helps build that framework.

Our abilities improve as we get more experience, as we encounter repeating and similar situations often enough to be able to predict with some assurance the efficacy of what we are doing. In architectural practice the time required to gain useful experience may extend for many years. But in school there is comparatively little time to learn the lessons of maintaining control of the design process. So the design studio must *compress time* in order to increase the frequency of decision points to fit into the academic time frame. In architectural practice information comes to the designer from many sources—users, clients, consultants, colleagues—information that frames the design task, both limiting and expanding possibilities. Looked at another way the studio in school has to speed up the making of important judgments in order to build a reservoir of useful experience in a shorter period. This compression of time has its costs—a lot has to be left out or only inferred. In this light we must take care that the major issues the student is intended to encounter are indeed present in a form that requires consideration and action.

As any athletics or music coach will tell us, cycling through an exercise builds familiarity and confidence, which in turn makes venturing in new directions a more comfortable and productive proposition. Why should learning to design be any different? Repetition is the key, until patterns of thinking and action become "second nature." In the first four course assignments students use a constant program and setting to explore the effects of four different major issues and several variants within each. In the

fifth assignment the same program is developed and the setting is changed—one of three quite different local sites. In the second half of the course two other programs of the same size but different spatial mixes are developed on each of the two remaining sites. Thus the student can use his or her own recently acquired knowledge and that of classmates again and again, editing and adding ideas while maintaining better control of the outcome.

The Course Week by Week

The following lays out the course in its sequence and in more detail. See the condensed diagram (Figure 1).

Introduction

The course begins with a lecture and extensive discussion about the aims and methods of the studio, with emphasis on the collective nature of the learning process. The idea of type is introduced along with the importance of drawing comparisons and inferences from the variety of work the studio will produce. The readings begin with Rafael Moneo's "The Solitude of Buildings,"[16] a passionate argument for seeing architecture in terms of the realized work. Two essays on the role and use of type in architecture follow: Moneo's "On Typology"[17] and Alan Colquhoun's "Typology and Design Method."[18]

Week 1: Circulation Order

During the first week four (an exception to the usual three) characteristic types of circulation pattern are introduced: *linear*, that limits travel between two points to one path; *loop*, that provides two alternate paths between two points; *radial*, with paths that must go through a common center; and *network*, that offers multiple pathways between points. A lecture discusses the implications and application of each type and illustrates with the circulation patterns of cities, buildings, and nature. In addition, ways of organizing functions according to their "served" and "servant" usage is introduced, with illustrative examples. An equal part of the class is assigned each of
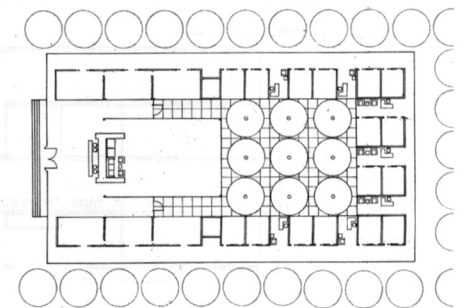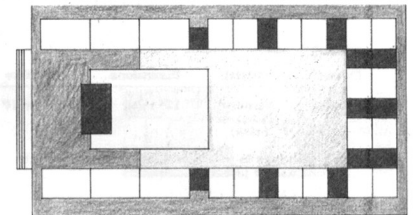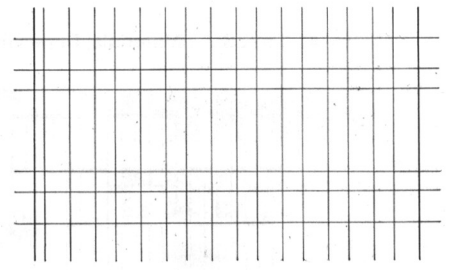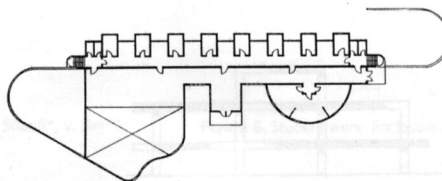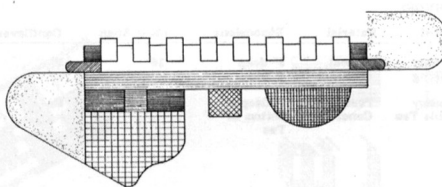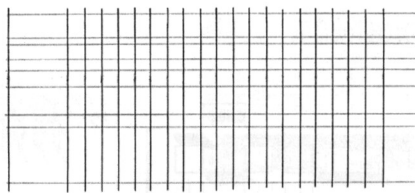
Figure 2. Student Work: Circulation Order (left: M. Sharifi*, right: K. Aoki**).

these circulation types to use as the basis for generating a plan that organizes the following program.

The brief—called Program A—is for a neighborhood government services center, a facility that provides a contact point to the local community for common municipal services. A number of discrete rooms of similar size for offices and meetings are called for, as is a larger public meeting space and a place for outdoor gatherings. The gross area for this program, like the other two, is 9000 square feet. By holding the area of each program constant the student better sees the implications of different spatial compositions. The student produces a plan or plans showing the disposition of given program spaces using one of the circulation types. He or she also diagrams of the underlying dimensional grid being used and the relationship between served and servant spaces (Figure 2).

Readings for the week begin with Richard MacCormac's "Anatomy of Wright's Aesthetic,"[19] which among other things demonstrates the use of dimensional grids in understanding architectural order. This is followed by two chapters from Moore, Allen, and Lyndon's *The Place of Houses*—"Assembling the Rooms" and "Including the Machines"— which discuss strategies for basic plan-making.[20]

Week 2: Structural Order

Three characteristic types of structural systems are introduced—*masonry bearing walls with precast planks and tees,* a one-way spanning system; *poured concrete frames with slab*, also one-way; and *poured round concrete columns with slab*, a two-way system. An illustrative diagram of each system, along with component dimensions and their spanning and cantilever distances are shown in a page from the program brief (Figure 3). The week's lecture shows numerous examples of each type in practice, and demonstrates the rich architectonic potentials of primary structure.

Again, the student works with one of these three alternatives. Using the now more familiar

STRUCTURAL TYPES . . . Materials, Dimensions, + Constraints

Type 1

SUPPORT				SPANNING				
Element	Material	Dimensions	Bay Size	Element	Material	Dimensions	Clear Span	Cantilever
Bearing Wall	Masonry (block or brick)	12" thick	16' or 24'	One-way Planking	Precast Concrete	8" deep 4' wide	16'	4'
				One-way Double Tee	Precast Concrete	2' deep to bottom of Tee	24'	6'

Note: Openings in wall 4' or 8' wide; minimum width of wall as pier 4'.

Type 2

SUPPORT				SPANNING				
Element	Material	Dimensions	Bay Size	Element	Material	Dimensions	Clear Span	Cantilever
Column	Reinforced Concrete	1' x 2'	16' x 24'	Beams	Reinforced Concrete	1' wide x 2' deep	24'	6'
				One-way Flat Slab	Reinforced Concrete	8" deep	16'	4'

Type 3

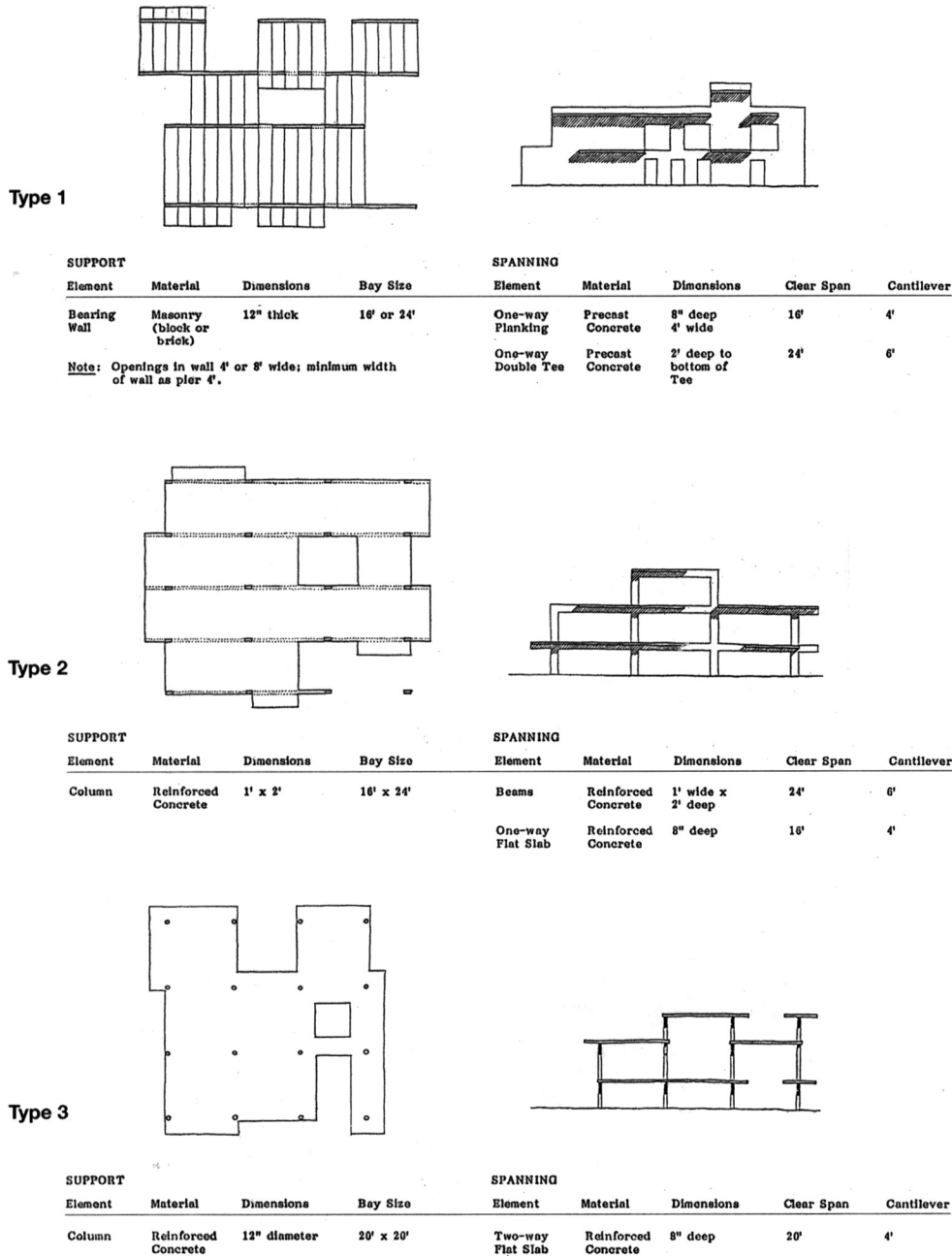| SUPPORT				SPANNING				
Element	Material	Dimensions	Bay Size	Element	Material	Dimensions	Clear Span	Cantilever
Column	Reinforced Concrete	12" diameter	20' x 20'	Two-way Flat Slab	Reinforced Concrete	8" deep	20'	4'

Figure 3. Structural types: Materials, dimensions, and constraints.

Program A he or she resolves the plan(s) from the previous week, modified or regenerated as desired, exploring the idea of "fit" between function and structure. The student produces revised plan(s), a section showing structure, and an axonometric drawing of the overall assembly of support and spanning elements being used (Figure 4).

First among the assigned readings this week is the chapter "Structural Patterns and Grids," from Daniel Schodek's text *Structures*.[21] Eduard F. Sekler's essay "Structure, Construction, Tectonics"[22] helps the student understand the relation of the means of making to the visual reading of a building, and Werner Seligmann's "Le Corbusier as Structural Engineer"[23] gives insight into the central role structure plays in the work of the twentieth-century master.

Week 3: Volumetric Order

This assignment introduces the overall three-dimensional formal properties of a design proposal, its massing, its volumetric order. The types are based on the perceptual characteristics of the volumes being used. The *figural* type reads primarily as a single simple volume, usually a rectangular prism or perhaps a pyramid, cylinder, or sphere; the Philips Exeter Academy Library by Louis Kahn and Mies van der Rohe's Farnsworth House are examples. In contrast, the *elemental* type reads as a grouping of strong, quite different, volumes, as seen in James Stirling's Leicester Engineering Building or the Winton Guest House by Frank Gehry. Different still, the *cellular* type reads as a series of many identical or similar volumes; examples include many Italian hill towns (and other vernacular communities) or Kahn's Kimbell Art Museum. The week's lecture reviews the assignment and provides examples from history and present practice to illustrate ideas and possibilities.

The student takes one of these three volumetric types and, again using Program A, shapes a building accordingly. Now both the circulation and the structure are free to change and adapt. The principal product is an axonometric drawing of the project along with new plans and sections (Figure 5). Three
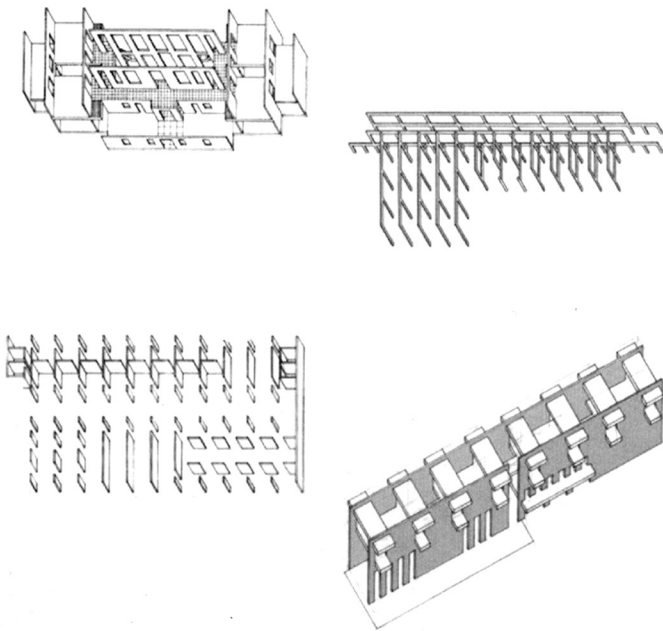
Figure 4. Student work: Structural order (clockwise from upper left: S. Castle*, M. Sharifi*, V. Sim**, W. Tunnell**).
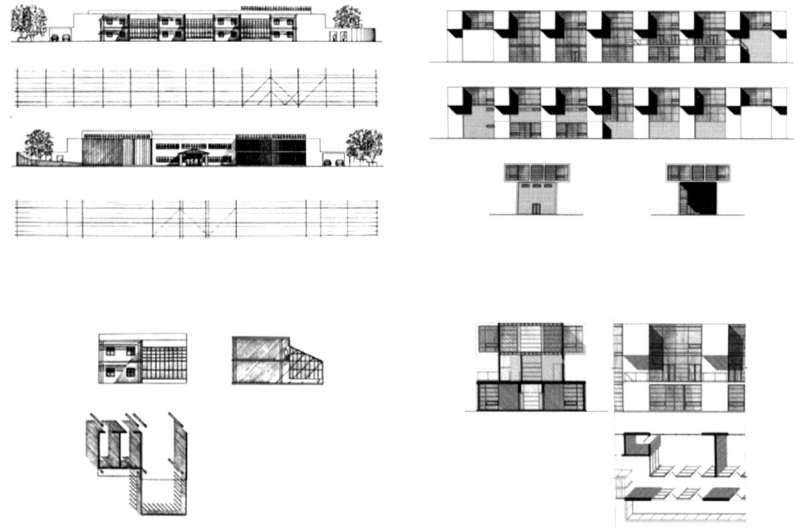

Figure 6. Student work: Enclosure order (left: I. Kythreotis*, right: W. Tunnell**).
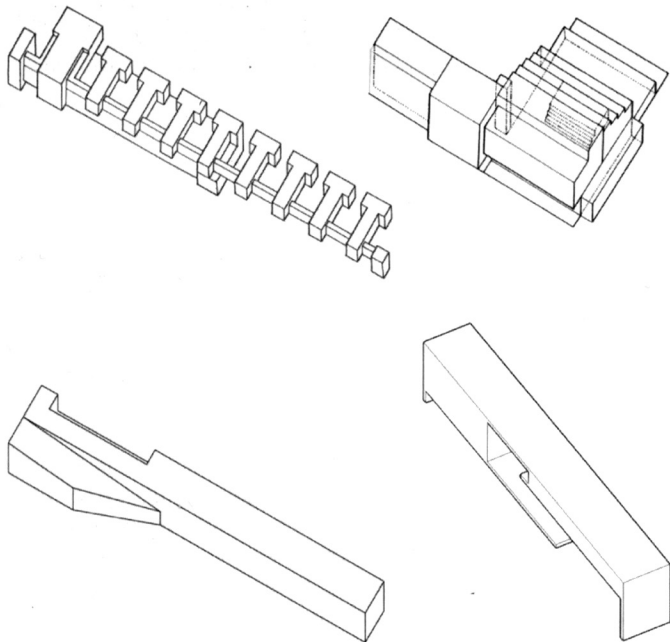

Figure 5. Student work: Volumetric order (clockwise from upper left: C. Wolf*, L. Ludwig*,, Q. Yang**, J. Chang**).
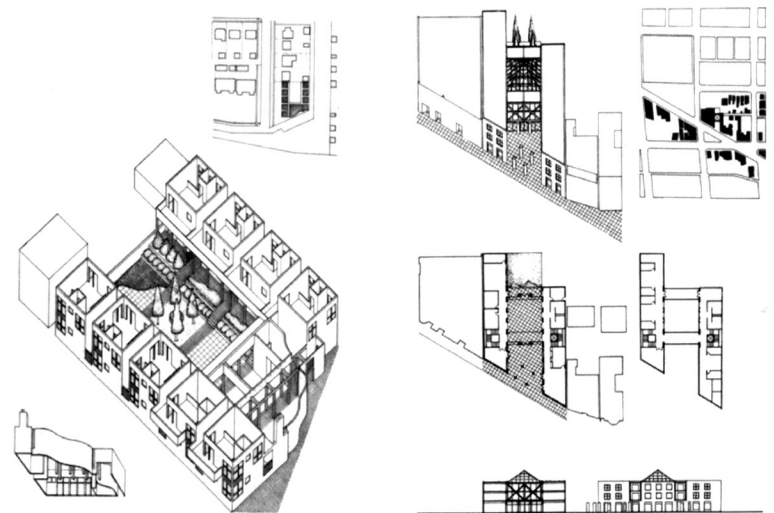

Figure 7. Student work: Siting order (left: D. Buckley*, right: E. Alsch*).

readings make up the week's assignment: excerpts from Colin Rowe's *Mathematics of the Ideal Villa*[24] relate to the *figural* type; Peter Eisenman's essay "Real and English: The Destruction of the Box, I"[25] provides insight into the *elemental* type; and "Centraal Beheer" by Alan Colquhoun offers an excellent discussion of the *Cellular* type.[26]

Week 4: Enclosure Order

Enclosure is the focal issue in the fourth week, raising the important functional concerns of controlling the flow of energy, light, air, and moisture. And, of course, the face of the building—the façade—is an architectural communication on the nature and character of the building itself. Once more three types are postulated: opaque enclosing walls, often bearing, with *pierced openings*; the *infilled frame*, where the enclosing surfaces are bounded by the structural elements; and the *bypassing surface*, where the enclosure lies outside the structural system and is independent of it.

The weekly lecture reiterates the factors shaping enclosure and sponsors discussion with examples from various periods and environmental situations. As usual, using Program A once again, the student works with one of the three given enclosure types. In doing so, the constraints on the previous issues—circulation, structure, and volumetrics—can be reshaped to meet the new design intensions.

For this exercise, in addition to plans and sections, the student produces enclosure studies at several scales—overall elevations, and a partial elevation at a larger scale with its corresponding horizontal and vertical sections (Figure 6). This three-view composite helps the student think of enclosure as a spatial entity and not just a flat surface. As an additional condition, the student uses an ordering grid of one-half meter (about 20 inches); those used to English measures begin to feel comfortable with the metric system.

The readings on enclosure range widely. The essay "Shell, Skin, Materials" by Christian Schittich[27] presents an overview from early buildings to the present.
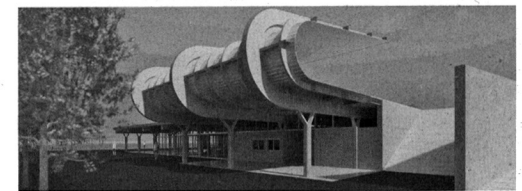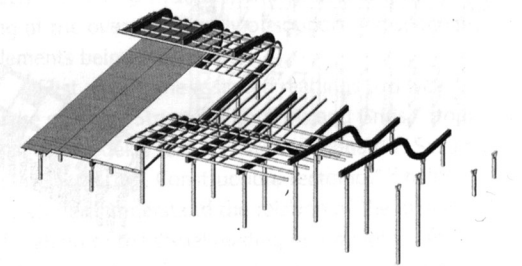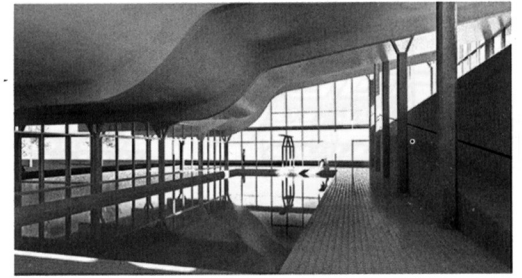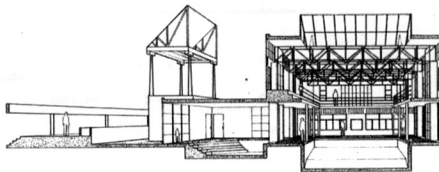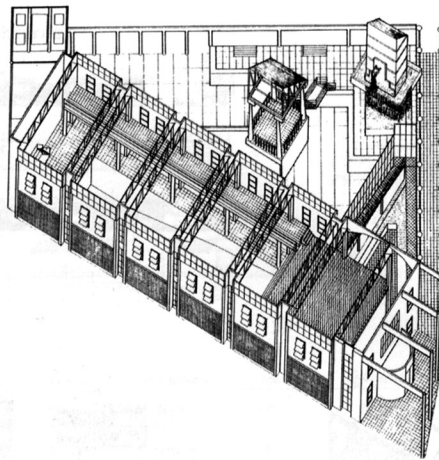

Figure 8. Student work: Comprehensive I: Indoor swimming pool (left: M. Sharifi*, right: B. Lecomte**).

Rowe and Slutzky's "Transparency: Literal and Phenomenal...Part II"[28] addresses how we read façades in terms of pattern and space, and Thomas Schumacher's "The Skull and the Mask"[29] discusses the changing role of the façade in modern architecture.

Weeks 5–7: Siting Order

The last exercise using the now very familiar Program A adds the issue of *site* to those of circulation, structure, volume, and enclosure. The previous exercises have been done without a physical context as rather idealized studies. Now three types of site are identified and a local parcel is associated with each: a compact *infill site*, one bounded by parallel party walls of adjacent buildings and facing a street; a compact *corner site*, with frontage on two streets and next to party walls at right angles to each other; and lastly, an *open site* large enough to accommodate the program as a free-standing building in the round.

Following the standing pattern one-third of the class will design on each of the three site types. With real local sites the student can experience the exact urban setting, analyze it, and use the contextual conditions to help shape his or her approach to designing a final iteration of the government services center program. By now the program and many important architectural issues have become very familiar, with knowledge of implications and options a part of the student's experience. And the time allowed expands from one week to three, along with a corresponding increase in expectations for design resolution, quality, and representational skill (Figure 7).
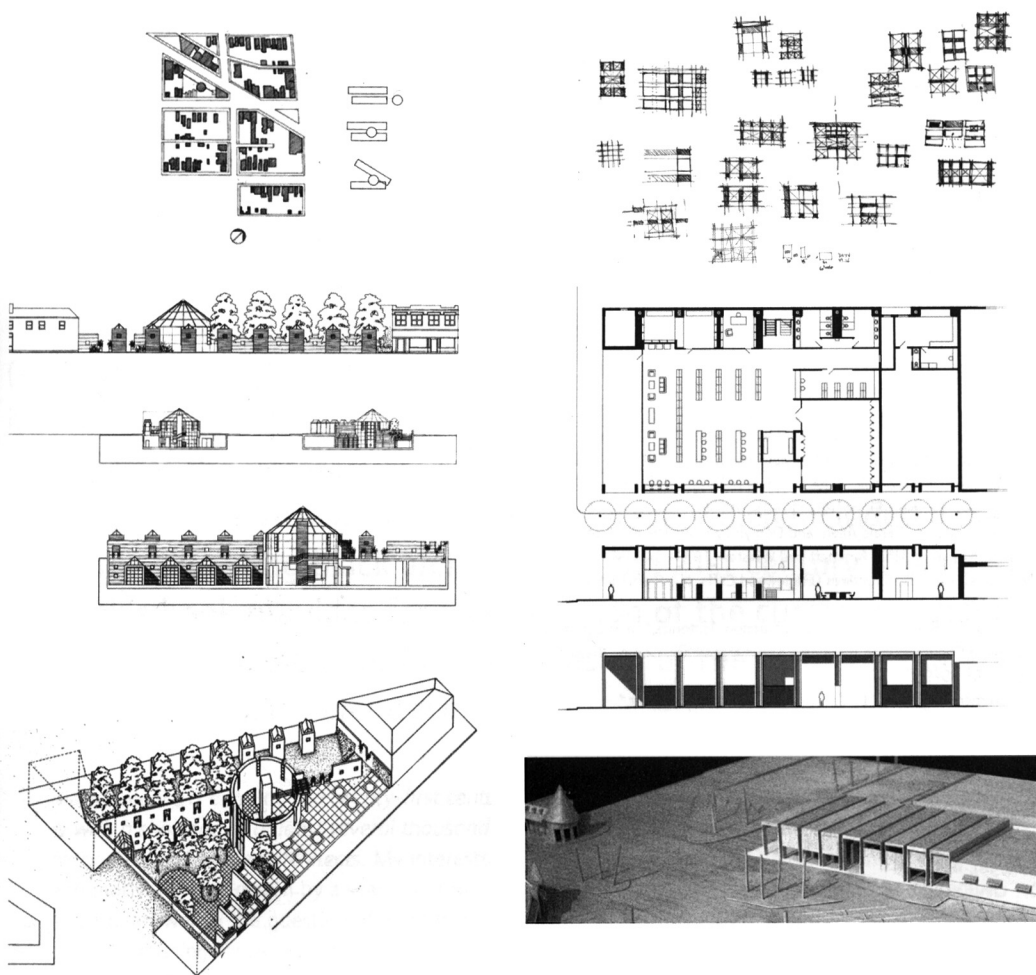
Figure 9. Student work: Comprehensive II: Branch library (left: J. Dreyfuss*, right: J. Batts**).

The lecture for this assignment looks at the broad topic of siting as well as providing illustrative examples of the three given types. The readings support the discourse, starting with "Fitting the House to the Land" from *The Place of Houses*.[30] Schumacher's "Contextualism: Urban Ideals and Deformations"[31] summarizes much current thinking on siting. And the third article, Stan Allen's "From Object to Field,"[32] discusses emerging ideas regarding the urban fabric.

Weeks 8–10: Comprehensive Exercise I: Program B

After seven weeks and five exercises using Program A, the student now designs a public indoor swimming pool—Program B—on one of the two local sites he or she has not yet worked on. The swimming pool has one large principal space, unlike

the many similar smaller spaces of the previous program. Gross area is the same as the former one (9000 square feet); holding the size constant highlights the quite different patterns of space and usage demanded in the new program.

While the site for the pool is "new" it is not unfamiliar. Having observed classmates work with Program A on the site, the student already knows some of its issues and opportunities. Progress in the term's work can command greater comprehensiveness in the student's design proposal. In addition to the usual orthographic drawings, physical and digital models are required (Figure 8). The pool's longer spanning conditions and hard use naturally focuses on structure and materials.

Weeks 11–14: Comprehensive Exercise II: Program C

The concluding design assignment in the course is the longest, four weeks, and is the occasion for proposing a branch library—Program C—on the last of the three sites available to the student. The library contains a rich hybrid of spaces, from the open planning of reading areas to closed rooms for services and meetings. It offers mainly quiet activities for moderate periods of time. The gross area remains 9000 square feet, preserving comparability to highlight differences in site and use issues. In addition to the previous documentation, the expectations for the student's work in this exercise include more comprehensive study of enclosure and interior space (Figure 9). At the review the student brings examples of his or her earlier studies in the course and uses them to discuss and offer perspective to this final project.

Conclusion and Prospects

"Anatomy Lessons" addresses *how* design students learn as much as *what* they learn. It uses pedagogical ideas that have proven effective in other fields to make the beginning architecture studio more productive and engaging.

For over three decades, by several instructors, and at different schools, the course presented above has proven a very successful learning vehicle for introducing elements of architectural design in a structured, sequential way. Its attention to fundamentals, specificity, continuous comparisons, sense of acceleration, and the chance to use information and experience over and over again make it rewarding for the student and instructor alike. Student course evaluations have always been very high.

The course presented here should be seen mainly as a matrix of sorts. If there is a new contribution or innovation it is in the attention to pedagogical organization, not in a new way of seeing architecture; indeed, the architectural ideas are quite traditional, purposefully so to offer the student an understanding of connection and continuity. The organization of the course invites other instructors to

make modifications that fit their own situations and imperatives. The worth of the course will be measured not just in the results produced, but also to the degree others find it useful in their teaching.

There are some avenues of exploration that come to mind. Can the structure and methods be applied to a sequence of semesters, a true "core," in addition to a single term? Can they be applied to an "upper-level" design course? Almost certainly yes, but it has yet to be demonstrated.

A large part of the educational theory cited above concerns the *cognitive* domain, the realm that uses the intellect to understand and use concepts. Another domain is the *affective*, also previously mentioned, that deals with attitudes, values, motivations, enthusiasms—more in the area of feeling than thinking. The affective domain has always been a critical part of the design studio experience; another exploration might well begin there.

Notes

1. Rafael Moneo, "The Solitude of Buildings," Harvard Graduate School of Design Kenzo Tange Lecture (March 9, 1985), 5.
2. Benjamin S. Bloom, ed., *Taxonomy of Educational Objectives: The Classification of Educational Goals, Handbook I: Cognitive Domain* (New York: Longman, 1956), 1.
3. Ibid18.
4. Ibid., 62–88.
5. Ibid., 162.
6. Ibid., 201.
7. See David Wood, Jerome S. Bruner, and Gail Ross, "The Role of Tutoring in Problem Solving," *Journal of Child Psychology and Psychiatry* 17, no. 2 (1976): 17.
8. See Jamie McKenzie, "Scaffolding for Success," *The Education Technology Journal* 9, no. 4 (1999): 12.
9. These words come from William James, the great psychologist and philosopher, in his address "The Social Value of the College Bred," given to the Association of American Alumnae at Radcliffe in 1907: "Real culture lives by sympathies and admirations, not by dislikes and disdains, and in all misleading wrappings pounces unerringly upon the human core." I can think of no better endorsement of the "affective" domain in education than this quotation given to me by a beloved teacher, Jerzy Soltan. The James address can be found in William James, *Essays, Comments, and Reviews* (Boston: Harvard University Press, 1987), 108–14.
10. Bloom, *Taxonomy* (note 2), 20.
11. See Edward M. Baum, "Problem Syllabus: A Public Shelter Place" (unpublished, 1977), pdf available by request from the author.
12. First published in 1802 by the author at the *École Polytechnique* in Paris.

13. *Recueil et parallèle des edifices de tout genre, anciens et moderns*, first published by l'Imprimerie de Gillé fils in 1800 or 1801.
14. First published in 1896 in London by Athlone Press.
15. Malcolm Gladwell, *Outliers: The Story of Success* (Boston: Back Bay Books, 2011), 35.
16. Moneo, "The Solitude of Buildings" (note 1), 1–24.
17. Rafael Moneo, "On Typology," *Oppositions* 13 (1978): 22–45.
18. Alan Colquhoun, "Typology and Design Method," in *Collected Essays in Architectural Criticism* (London: Black Dog, 2009), 45–51.
19. Richard C. MacCormac, "The Anatomy of Wright's Aesthetic," *Architectural Review* 143, no. 852 (1968): 143–46.
20. Charles Moore, Gerald Allen, and Donlyn Lyndon, *The Place of Houses* (New York: Holt, Rinehart and Winston, 1979), 147–87.
21. Daniel Schodek, *Structures* (Englewood Cliffs, NJ: Prentice Hall, 1980), 437–71.
22. Eduard F. Sekler, "Structure, Construction, Tectonics," in *Structure in Art and in Science*, edited by Georgy Kepes (New York: George Braziller, Inc, 1965), 89–95.
23. Werner Seligmann, "Le Corbusier as Structural Engineer," *Architectural Record*, no. 10 (1987): 142–51.
24. Colin Rowe, *The Mathematics of the Ideal Villa and Other Essays* (Cambridge, MA: MIT Press, 1982), 1–28.
25. Peter Eisenman, "Real and English: The Destruction of the Box, I," *Oppositions* 4 (1974): 6–34.
26. Colquhoun, "Centraal Beheer," in *Essays in Architectural Criticism* (note 18), 78–81.
27. Christian Schittich, ed., *Building Skins* (Basel: Birkhauser Verlag, 2006), 9–27.
28. Colin Rowe and Robert Slutzky, "Transparency: Literal and Phenomenal…Part II," *Perspecta* 13 (1971): 287–301.
29. Thomas Schumacher, "The Skull and the Mask: The Modern Movement and the Dilemma of the Façade," *Cornell Architectural Journal* 3 (1987): 4–11.
30. Moore, Allen, and Lyndon, *The Place of Houses* (note 20), 188–206.
31. Thomas Schumacher, "Contextualism: Urban Ideals and Deformations," *Casabella* 35 (1971): 78–86.
32. Stan Allen, "From Object to Field," *Architectural Design* 67, no. 5–6 (1997): 24–31.