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An Ethnography of Design Pedagogy**

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Portrait of the Oxford Design Studio: An Ethnography of Design Pedagogy

David Williamson Shaffer¹

Images of pedagogy are often formed with images of practice in mind. In recent years, design and the practices of designers have been used as models for experimental learning environments and progressive curricula (see, e.g., Cossentino & Shaffer, 1999; Erickson & Lehrer, 1998; Greeno & the Middle School Mathematics Through Applications Project, 1997; Hmelo, Holton, & Kolodner, 2000; Jacobson & Lehrer, 2000; Kolodner, Crismond, Gray, Holbrook, & Puntambekar, 1998; Loeb, 1993; Perkins & Blythe, 1994; Shaffer, 1996). As in many endeavors, though, images of design work and actual enactment of design practices are not necessarily the same: what we see on casual observation is not always the same as what we understand from closer study. Accordingly, interest in design as a pedagogical model has produced a number of studies of design practices, particularly of architectural design, which is often seen as a canonical exemplar of the design process.

One way that researchers have studied design has been to look at the practices of professional designers in the workplace (see, e.g., Hall & Stevens, 1996; Hawkins, 1993; Stevens, 2000). Examining the psychology of the design process through study of individual designers has provided another window into design practice (see, e.g., Akin, 1986; Branki, Edmonds, & Jones, 1993; Coyne & Snodgrass, 1993; Davies, 1987; Goldschmidt, 1989; Jansson, 1993; Mitchell, 1994; Rowe, 1987; Schon, 1988b; Simon, 1996). Yet another approach is to look not at the setting of professional practice, but at the setting in which designers are initiated into that practice.

This study describes practices in the Oxford Studio, an architectural design course at the Massachusetts Institute of Technology (MIT) Department of Architecture. My aim is to shed light on both the practices of design and the practices of learning to design. An advantage to this approach is that one of the goals of the Oxford Studio (or any design studio course) is to help young architects understand what it means to be a designer. Activities in the Oxford Studio were thus explicitly organized to clarify as well as to enact design practices and the principles they embody. Design studios at MIT aspire to be model exemplars of this process, and in so doing, they provide a window into the ideals of designing—and the process by which learning to design enacts these ideals in practice.

A number of previous studies have explored particular aspects of design studios in some detail (see, e.g., Anthony, 1987; Craig & Zimring, 2000; Crowe & Hurtt, 1986; Flemming, 1998; Frederickson & Anderton, 1990; Kvan, 2001; Loeb, 1993; Schon, 1985; Uluoglu, 2000). Other studies have examined the social and epistemological implications of studio practices (see, e.g., Dutton, 1987; Heylighen, Bouwen, & Neuckermans, 1999; Ledewitz, 1985; Sancar, 1996; Schon, 1988a). The goal of this study is to investigate the ways in which these elements of

¹ The author would like to thank the faculty and students of the Oxford Studio; Bill Mitchell for his invaluable advice and support; and Seymour Papert, Mitchel Resnick, Jim Kaput, and Rich Lehrer for their generous guidance and feedback.

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design practice are constituted as a coherent system of activity: to examine the underlying structure of the practices of one design studio.

Such a mission suggests an ethnographic perspective. This ethnographic perspective frames both the methodology of the study (observational data collection, interpretive analysis, and descriptive presentation) and its attention to what the participants in one particular studio did, how they understood the significance of their activities, and what we as observers can interpret from that activity about the norms, values, and perspectives that support the practices of design.

As in any ethnographic study, there are not discrete “hypotheses,” “results,” and “conclusions” to present in the analysis that follows. Rather, I present this study of the Oxford Studio in four parts. First is a discussion of prior theoretical and empirical work that frames and informs observations and interpretations of the Oxford Studio. Next is a description of the elements of the Oxford Studio, including its organization in time and space, the sequence of assignments, and the activities that made up those assignments. This description, which covers activities that took place over a semester in a mid-level graduate/undergraduate design studio, necessarily presents a view of the design process that is both telescopic and technical. The goal is to represent a complex set of relatively specialized activities and interactions in a manner that will be coherent and comprehensible for readers interested in pedagogy but not experts in architectural design.

Following this description of the elements of the Oxford Studio is a discussion of the way in which those elements interacted to form a coherent system of activity. The relationships that made up this system are described on three levels: (a) surface structures (time, space, resources, and materials), (b) pedagogy (activities, feedback, and assessment), and (c) epistemology (the substantive underpinning of the studio in expressive activity). Obviously, the elements of the design studio and the interactions among those elements are inseparable in practice; they are distinguished here for rhetorical convenience and conceptual clarity, and only to the extent possible while still reflecting the observed experiences of the participants in the Oxford Studio. Finally, the study concludes with a brief discussion of the implications of such an analysis for our understanding of how to create learning environments based on the principles and practices of design.

The analysis looks, in other words, at how design practices were enacted in one design studio, focusing on the relationships among surface structures of the studio, the activities that those surface structures supported, and the view of knowledge that those activities fostered. The study is thus a structural ethnography rather than a hypothesis-driven or micro-genetic account of learning: it attempts to describe phenomena that are local, rather than directly generalizable, but that operate at a relatively broad scale—and thus appear through observation at a more intermediate level of analysis. This is ethnography closer in spirit and practice to Geertz’ (1973a) well-known analysis of conventions for time and identity in Bali than it is to Cobb’s (1986) case study of the emergence of abstract mathematical thinking in the concrete activities of one learner.

In a field such as design, where much is already known about specific cognitive and pedagogical processes, such a structural analysis is useful in extending our understanding of the

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systemic nature of activity. The analysis of the Oxford Studio that follows suggests that expression and expressive activity are a significant underpinning of the design studio system. To the extent that elements of design practice are interconnected, the study also suggests key features and relationships of the studio that should ideally be preserved in any adaptation of design to the creation of learning environments in other fields.

Background

The design studio can trace its roots back more than a century to the Ecole des Beaux-Arts in France (Chafee, 1977). The focus of a designer's training today still follows the Beaux-Arts tradition of open-ended projects and a variety of structured conversations that culminate in a public presentation of work. Scholars of design education have studied this tradition in some depth. Schon (1985), for example, analyzed a key interaction of the design studio, the *desk crit*: an extended and loosely structured interaction between designer and critic (expert or peer) involving discussion of and collaborative work on a design in progress. Schon suggested the crit is central to the development of a student's ability to design thoughtfully. In Schon's description, the desk crit functions as an instantiation of Vygotsky's (1978) *zone of proximal development*, with development taking place as learners progressively internalize processes they can first do only with the help of others.

Another central tool of the design studio, the *review* or *jury*, similarly mediates the interactions between learner, peers, and experts. The review or jury is a formal group discussion of student work: individuals display their work, present their plans, and get feedback from professionals outside the studio. This model of critical review has been central to architectural training since the foundation of the ateliers at the Ecole des Beaux-Arts in Paris (Chafee, 1977). Reviews were brought to the United States with the founding of the first architecture schools in the 19th century. The problems with the review process—particularly the stressful nature of the experience and the dangers of excessive subjectivity on the part of reviewers—are openly discussed in the architecture community (Anthony, 1987; Frederickson & Anderton, 1990). Nonetheless, external reviews remain a mainstay of the process of architectural design and a powerful tool for connecting work in the studio to professional practice.

Elements of the design process itself have received similar scholarly attention. Schon (1985) and Simon (1996) have discussed the iterative nature of design, in which problems are revisited repeatedly in a generative process. The designer chooses to address a particular issue. A solution is proposed. Strengths and weaknesses of the solution are analyzed (often in a public setting and usually in the form of feedback from others). Based on this analysis, the designer refines the original approach. The new solution is again analyzed, and so the process continues until the analysis of one of the iterations suggests that it is a satisfactory way to resolve the issue. Mitchell and McCullough (1991; see also Akin, 1986; Schon, 1985) discussed the role that media play in this process. They suggested that physical models, digital models, and renderings—as well as more traditional plan, elevation, and freehand drawings—emphasize different aspects of an emerging design. A change in materials produces a change in perspective, and is thus often an important part of the iterative cycle of production and analysis central to design. Schon (1985) has described the cognitive foundation of design practice as a process of reflection-in-action. In this model, designers make judgments and show skills for which they cannot describe rules or provide explanations. Understanding develops as practitioners refine

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tacit knowledge through work on subsequent iterations of the design process. In articulating the concept of *communities of practice*, Wenger (1998) argued that practice and theory are always intertwined in this way in the context of social norms and interactions that shape (and are shaped by) activity.

In introducing novice architects to the practices of design, the studio enacts principles that have also been studied in depth. More than a century ago, Dewey (1915, 1958) and Parker (1894/1969) discussed the power of expressive activity. Parker suggested that “attention” and “expression” are inseparably connected: creating an expressive product is an integral part of taking in any new experience. Dewey argued that expression involves overcoming obstacles in the expressive medium and that understanding develops when those obstacles are relevant to the expressive goal (see Dewey, 1958).

I have argued elsewhere (Shaffer, 1998; see also diSessa, 2000; Erickson & Lehrer, 1998) that the norms of a community of practice are a key element in this process. The demands of producing work for a critical audience provide an important set of constraints. Like overcoming obstacles in the medium of expression, working within the norms of a community demands reflective thinking. Wenger (1998) suggested that learning is always a process whereby an individual comes to participate in the practices of a community: a process that is both inherently social and deeply individual. Following the work of socio-cultural theorists (see, e.g., Vygotsky, 1978; Wertsch, 1998), in previous studies I have explored how learners develop understanding in such situations by internalizing social processes of evaluation (Shaffer, 1998). The norms of the community become a framework for individual thinking and individual identity.

Resnick and I have argued (Shaffer & Resnick, 1999) that these elements work together to create *thickly authentic* environments. We suggested that authenticity is an alignment between learning activities and some combination of (a) goals that matter to the community outside the classroom, (b) goals that are personally meaningful to the student, (c) ways of thinking within an established discipline, and (d) the means of assessment. Thickly authentic environments, we argued, create all of these alignments simultaneously—as happens, for example, in the design studio when personally meaningful projects are produced and assessed according to the epistemological and procedural norms of an external community.

There are, in other words, a number of pedagogical processes and theoretical perspectives that come together in the practices of the design studio. Brown and Campione (1996) suggested that any effective learning environment is not a set of isolated procedures, but rather a coherent system. They argued that such systems depend on a clear articulation not only of “surface procedures,” but also of the underlying “principles of learning” that lead to the creation of pedagogical strategies (p. 291). The Oxford Studio was created to teach young architects the basic principles and practices of design, but it was created within a tradition that had evolved over several centuries. This does not mean that the Oxford Studio—or the tradition it exemplifies—lacks coherence, any more than cultures lack coherence because they emerge over time rather than as the product of coordinated development (see Geertz, 1973b). However, the underlying coherence of the design studio as a system must be teased out through analyses of existing practices. The challenge of articulating the connections between theory and practice in the studio is a problem of cognitive anthropology and descriptive ethnography. This study examines how surface structures, pedagogy, and epistemology combined in one design studio to

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create a coherent whole. The aim is to describe how a coherent system was created by the practices in one architectural studio class: an MIT studio course focused on the design of a new business school for Oxford University.

Methods

The Oxford Studio was a one-semester, mid-level architecture course for undergraduate and graduate students, taught by Nigel,² an experienced architect and studio teacher, and a member of MIT's junior faculty. The Oxford Studio had a single professor and two teaching assistants (both doctoral students in the Department of Architecture). There were 11 students in the course. Three were advanced undergraduates majoring in architecture; the remainder were graduate students. Specific demographic information was not collected on the students. All students enrolled in the Oxford Studio course in the semester in question were included in the study; however, the portrait presented here focuses on the work of three students in the course (Arnold, Belinda, and Dan) who were studying toward their Master of Architecture (MArch) degree, a program structured to prepare students for professional registration as architects in the United States. These students were chosen because of the proximity of their individual workspaces within the studio, which made it possible to observe the individual work of multiple students, and because of their willingness to be interviewed over the course of the semester. I was present, taking field notes, for roughly one quarter of the studio's teaching hours, and these observations were supplemented by interviews with students and teaching staff. As the semester progressed, one student (Arnold) agreed to participate in a closer examination of his learning process, which forms the centerpiece of the portrait below.

Field and interview notes were analyzed using *case-focused analysis* (Weiss, 1994). Such analysis attempts to understand phenomena by gathering a rich set of data for a limited number of instances to create a thick description (Geertz, 1973) in which specific examples of experience can be described so as to illustrate how participants understand and organize their activity. Accordingly, notes were coded into thematic categories based on issues that emerged from Nigel's, Arnold's, Belinda's, and Dan's activity and from their explanations of activity in the studio. The analytic descriptions of key elements of the studio and the interactions among those elements that follow were based on these thematic categories, drawing together significant themes from the data collected.

Elements of the Oxford Studio

The Studio Environment

Walking into the Oxford Studio at MIT was quite unlike walking into a lecture hall, seminar room, or classroom in a typical school or college. A well-equipped science lab, with its open plan and benches for student experiments, captures some of the flavor of a studio space, yet still misses certain essential elements of the design environment.

² Names reported in this study are all pseudonyms.

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Space

Most apparent in the Oxford Studio was the amount of space allocated to students. In the Oxford Studio, 11 students had more space for their individual drafting areas than many high schools provide for a class of 30 (see Figure 1). In addition, the studio offered a meeting space the size of a seminar room for a college course. The students had access to computers and printers within the studio and to woodworking machinery in a nearby room (not shown in Figure 1). The studio was connected to an external corridor by rolling garage doors so the hall outside could be used to post students' work for discussion and comment. Finally, the studio had access to additional space for formal presentations of student work. All of these spaces (except the students' individual workspaces) were shared by other studio classes but were available as needed for Oxford Studio activities.

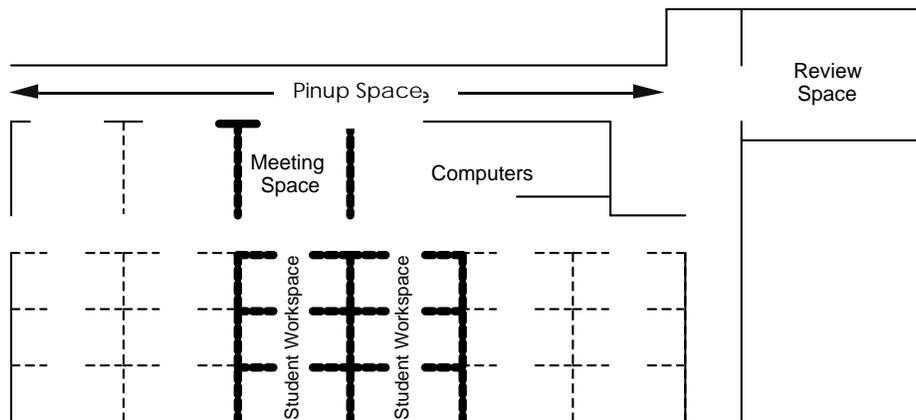


Figure 1: Diagram of studio space at MIT, in which each student had individual workspace.

The fact that each student had his or her own workspace distinguished the Oxford Studio from a typical classroom. In many science labs and art classrooms, students share workspaces, and a significant amount of time is spent setting up before experiments or projects and cleaning up afterwards. In the Oxford Studio, students worked on a single project over a long period of time in the same space. They were able to adapt their work area to their own needs and working style, and no two studio desks looked the same by the second week in the semester. The low walls of the cubicles were covered with sketches, postcards, inspirational examples of architectural design, and even candy and other junk-food wrappers pinned up as merit badges for work done through the hours of the night. Locked drawers crammed with drafting tools, modeling knives, and rolls of trace paper made each space a workshop; Belinda brought in her computer and secured it with a cable to her desk.

Time

The pace of work in the Oxford Studio was also quite unlike that in a traditional class. Studios at MIT officially met 3 days a week from 2:00 to 6:00 p.m.. But for the Oxford Studio, this timetable was more a rough guideline than a fixed schedule. Students and teaching staff routinely came to the Oxford Studio before or after 2:00 p.m. depending on the work they had to

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do on a particular day. Students and staff often came in at night or on weekends as project deadlines approached. At any given time during official studio hours, the professor and students might be meeting around a seminar table to discuss projects. Or students might be working on their own at their desks. Or checking e-mail. Or stepping out for a cup of coffee. Or meeting with faculty.

This informal approach to time in the studio made it difficult, sometimes, to organize activities. Students were not always present for class discussions, and even major events in the semester, like final reviews, started late and had participants drifting in and out. Time management was an issue for students in the Oxford Studio: work was routinely left until the last minute and sometimes suffered as a result. However, the large blocks of time allotted and the flexibility of the routine also made it possible for different studios to share spaces for meetings and presentation.

Assignments

The *project brief* (the design specifications) for the Oxford Studio was taken from a closed competition of prospective plans for a new business school at Oxford University. The proposed site for this new school was on the edge of the urban development of Oxford, so the relationship of the building and site to the larger context was a central design issue in the project. The project as a whole was quite complex, and Nigel remarked at the start of the semester that it was “about as difficult a project as students at this level could handle.” The project was divided into a series of six assignments, taking students through progressively more detailed examinations of the architectural issues involved in creating a business school in Oxford.

Assignment 1: Precedent

The first assignment asked students to examine a *precedent* for the Oxford project: a building that showed how other architects had dealt with issues of context and community in similar settings. Students chose from a list of buildings provided by the professor, then researched their building and represented their findings in a *conceptual model*: a physical representation of some key design principle at work in the building. Belinda studied the Strawberry Vale Elementary School in Victoria, British Columbia, a building notable for the way its architects integrated the building’s design into the irregular landscape of the site. Belinda made a model of the school’s irregular central corridor, showing how the zigs and zags of the corridor (shown in an aerial view of her model in Figure 2) created a network of informal gathering places (marked by arrows in Figure 2) for students and teachers. Arnold examined the main hall of Singapore Polytechnic, comparing its hierarchical organization to the decentralized plan of the Oxford campus.

Assignment 2: Urban Structure

The second assignment asked students to research the city of Oxford and represent their understanding of the city and its surrounding landscape in *diagrams* (drawings that convey design concepts without specific or consistent scale or format). Students also produced a *model*

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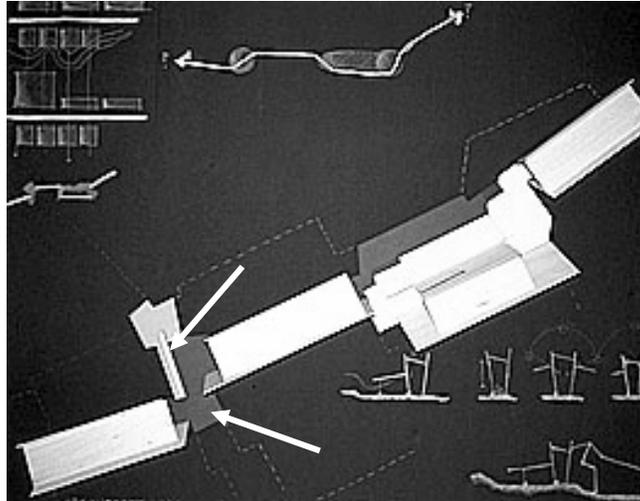


Figure 2. Belinda's conceptual model of Strawberry Vale Elementary School's main corridor (shown here in aerial view) shows informal gathering spaces (marked by arrows) for teachers and students.

(a three-dimensional representation of architectural forms with consistent scale) showing their general plan for dealing with the Oxford landscape in their proposed design for the business school. Arnold's research focused on the history of Oxford's growth, focusing on the courtyards formed by the university's many residential colleges as architectural descendants of medieval monasteries: the academic equivalent of the isolation of the cloister. Arnold's diagram (see Figure 3) depicts the courtyards as "the cells of the Oxford quadrangles." Arnold's analysis of this "cellular growth" shows thick lines representing the buildings that form the quadrangles of Oxford's colleges, which Arnold suggested function like semipermeable membranes. The arrows represent the paths people take through these membranes and the spaces they create. Arnold identified his site as an opportunity to "bring a graceful end" to Oxford's urban development. Another student's analysis, in contrast, focused on the social fissure between the community and the university (the "town and gown"); her proposal was to design a "nonhierarchical building" that would symbolically break down the traditional English class structure and integrate the city residents and students.

Assignment 3: Conceptual Strategy and the Brief

In the third assignment, students were given the project brief from the original competition, including the *program* (list of requirements) for the building. They were asked to produce a model of the school, as well as a large-scale³ *plan* (scale drawing made as a view from above showing structural elements of a building). The plan and model were supposed to show how students would address the school's specific requirements within the broader conceptual scheme outlined in the previous assignment. Arnold, for example, extended the logic of his

³ The language of architectural practice regarding scale is logically consistent but sometimes confusing to nondesigners. *Larger scales* (such as 500:1) produce drawings and models that are *smaller in size*; *smaller scales* (such as 100:1) produce *larger images*. Large-scale representations thus give an overview of a structure without much detail; smaller scales are used to focus on specific details of a structure.

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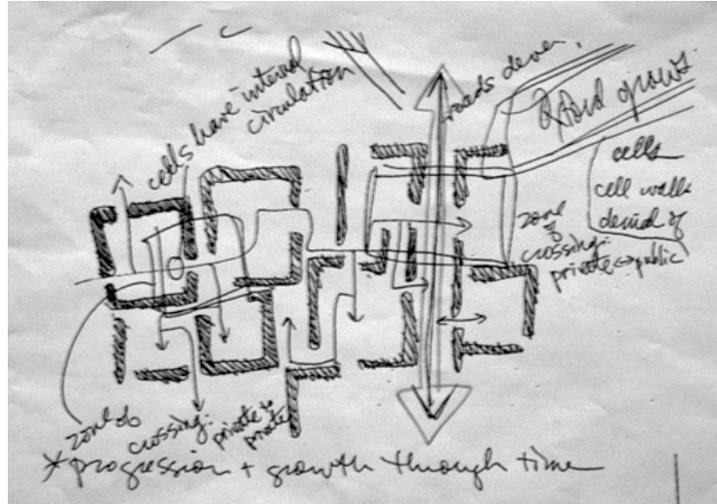


Figure 3. Arnold's analysis of Oxford's "cellular growth."

The thick lines represent the buildings that form the quadrangles of Oxford's colleges, which Arnold suggested function like the semipermeable membranes of cells. The arrows represent the paths people take through these membranes and the spaces they create.

previous investigations, suggesting that a "spiral courtyard" at the center of his proposed building (see Figure 4) would provide the graceful transition from the Oxford quadrangles to the rural landscape by "dissipating" the energy of the city.

Assignments 4 and 5: Integrating Ideas in Three Dimensions

The fourth assignment asked students to provide more detail for the basic models they had proposed. Students were to show how their building would function spatially through *sections* and *elevations* (scale drawings made as a view from the side showing structural details or rendered views of a building). This led to the fifth assignment: a smaller-scale (that is, more detailed) examination of one or more elements of the building, focusing on how these elements related to the overall design strategy. Dan made a model of the school's "learning resource center" (library). Belinda focused on her building's corridors and the informal gathering places they created in her proposed design. Arnold looked at the relationship of his building to its site, exploring how the roof connected his building visually to other buildings nearby.

Assignment 6: Final Review

The final assignment of the studio was to bring these various investigations of the project—from the context of Oxford to the detail of one part of the building—into a presentation showing both a proposal for the project and the thinking process by which the proposal was developed.

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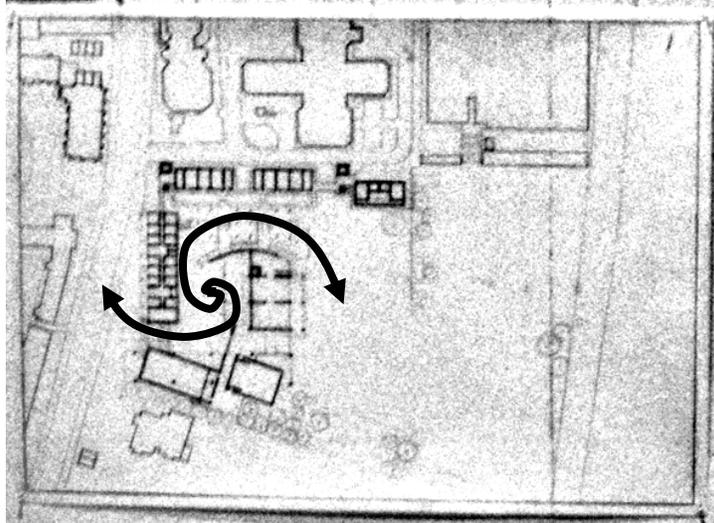


Figure 4. Arnold's plan shows his conceptual scheme to end the growth of Oxford's quadrangles with a spiraling courtyard (indicated conceptually by the spiraling black arrows, which were not part of the original plan drawing).

Workflow

Introduction to the Assignment

For each of the assignments in the Oxford Studio, students received a page of written instructions from the professor, which the class discussed as a group. This written description included a summary of the assignment's requirements, an explanation of the reason for the assignment, a description of the professor's expectations, and almost always examples of work for students to use as models. For example, for the third assignment (on site and context), Nigel explained that he wanted students to understand the "inherent characteristics of university space" and show "what it represents" using a series of interpretive sketches. He asked students, through their sketches, to "address an attitude towards the context and site." He suggested that they focus not on details, such as where the entrance or the building should be, but on "the spirit, the opportunities of the site." Nigel explained that for this assignment students needed to integrate three elements: (a) the lessons of the precedents they had examined in the first assignment, (b) their analysis of Oxford with its issues of urban form and growth, and (c) the program of the building. Strategy at the macro scale, he explained, "brings all three together" and "must contain an idea: a creative leap."

Nigel began his explanation by giving an example, sketching on trace paper as he described the "three ugly sisters"—the unattractive buildings adjacent to the business school site—and explaining that students would need to develop a strategy, an "architectural idea," to address issues such as this contiguous architecture. Nigel showed the class sketch diagrams made by noted architect and designer Henry Foster as examples of how to communicate architectural ideas in this way.

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Crits and Design Work

After the initial introduction to each assignment, students began work at the leisurely pace characteristic of work on the early stages of the design process in the studio. When students came up with questions, ran into problems in their emerging designs, or finished some coherent stage of their design process, they would sign up for individual conferences with the professor or a teaching assistant.

These conferences, known as *desk crits*, were the heart of the Oxford Studio. Crits were of varying lengths, though they usually lasted somewhere between 20 and 40 minutes. During a crit, a student described his or her work to a *critic*—the professor, a teaching assistant, or another student who had agreed to help the student with his or her design. The student gave an overview of the design process to date, focusing on some area or areas of particular interest or concern. The critic then asked clarifying questions about the design process and design intent. Finally, discussion turned to potential problem areas identified by the critic, which often were not the same areas about which the student had originally been concerned. The goal of the critic was to understand what the student was trying to do with his or her design and then to help him or her develop that design idea. Nigel explained that in a crit with a student he was “trying to get into their head,” and “help them flesh out their own ideas, their own perceptions.”

For example, in the course of the fourth assignment (showing building details through section and elevation), Arnold met with Nigel for a desk crit, focusing on the roof form of his design. Arnold explained that he was concerned about the relationship between his building, which was modern in design, and the adjacent buildings, which were traditional Oxford buildings with pitched roofs.

“You feel the need to be contextual,” suggested Nigel.

“I want to be a good neighbor,” replied Arnold.

“What does that mean?” asked Nigel. “How do you define that? Is it pitched roofs?”

Nigel pointed out that that Oxford had a long history of change, suggesting that Arnold did not need to mimic existing building types. But Arnold was still not sure “how to make the building distinctive.” This led to an extended discussion about the relationship between design and materials. Arnold wondered whether he should use traditional materials to fit into the existing landscape. In the end, Nigel suggested that Arnold should “let the building be what it wants to be. Don’t pander to superficial gestures to adjacent buildings.”

“That’s reassuring,” replied Arnold. But he was not sure what his next step should be. They discussed creating a section drawing of the building, focusing on the structural mechanics of the roof. Perhaps understanding how the roof would be constructed would help Arnold decide what it should look like.

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Presentation

Each of the assignments in the Oxford Studio culminated in a presentation. Three of the assignments led to a *pinup*: a group discussion of student work in which individuals pinned their working drawings and models on the wall, described their works-in-progress, and got feedback from the teaching staff and the other students. In a pinup before the midterm review, Arnold presented his idea of Oxford's cellular growth and his plan to use a spiral courtyard to gracefully blend the landscape of quadrangles into the surrounding floodplain. When Arnold finished his presentation, other students suggested that his spiral idea seemed forced and that the current design had too many hard edges to gently end urban growth. Nigel pointed out that the central idea in Arnold's project was clearer at an earlier stage, but was lost when Arnold added a massive overhanging roof in an effort to integrate the building with nearby structures. Nigel suggested that the big roof obscured the spiral form that was supposed to dissipate the growth of the city. He wanted to "rip the roof off" to expose the underlying spiral courtyard more clearly. During the pinup, Arnold tore the roof off of his model, and the other students made a number of suggestions about the design possibilities suggested by this change.

In pinups, each student's work was discussed at a similar level of detail by the professor, the teaching assistants, and the other students. In one case—after the concept and strategy assignment—feedback came from outside the studio. This *guest crit* had essentially the same form as a pinup, but with professors and other professionals in the field of architecture invited to comment on students' work. Two of the assignments (and the studio course as a whole) led to formal *reviews* or *juries*, again with critics from outside the studio.

The essential elements of the presentation process were the same in these reviews as in the pinups, but reviews demanded a higher level of preparation and organization—and the feedback reflected higher expectations for the quality of the designs presented. In the midterm review, Arnold made a formal presentation of the major theme in his design proposal. He described his idea that Oxford's quadrangles function as cell walls that "hold the outside out and the inside in," and explained that the spiral at the center of his building was designed to make a transition between the walls of the city and the open space of the surrounding countryside. The critics asked about details of the proposed design: How would people move through the buildings? How long would the corridors be? Why was the building around the spiral courtyard basically "a long corridor and rows of offices?" One critic suggested that the challenge of the cell model was to show how the "outside can become inside"—to which another critic replied: "Cells! Cells! Cells! But it looks like a dock!" "The central space seems weak," suggested the first critic, and Nigel agreed that "it has weakened over time." The second critic added that in her opinion the problem was that the tension between "hard and soft, inside and out" had not been fully resolved. In the review, the critics thus explored the tension between Arnold's stated design goal and its articulation in his emerging design. In the end, the critics suggested that Arnold was "trying to solve too many perspectives at once" and thus "falling in between" his multiple goals without sufficiently addressing any of them.

Pinups, guest crits, and reviews in the Oxford Studio all brought assignments—and with them, stages of the design process—to a close with pointed criticism that students used to refine their projects.

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Lessons Learned

At the end of the midterm review, Nigel explained to the students that “the relationship to landscape came up over and over” in the critics’ comments. Moving forward, he asked students to develop this key idea by sketching “one exemplary piece of the building” (the fifth assignment in the studio). Speaking for the students, Arnold suggested, somewhat dispiritedly, that “everyone got taken back a couple of models” in the review—meaning the critics had suggested that students’ recent work had lost touch with their original design ideas. Nigel replied: “Steps back don’t worry me. . . . We pushed the envelope. Now we need time to understand how to express those ideas.”

After thinking about Nigel’s response, Arnold realized that the reviewers had helped him “unhook himself” from old ideas and “invert” his perspective. As a result, he recognized that he needed to “design the space versus design the buildings”—a critical insight about the fundamental nature of architecture and architectural design. This young designer had come to understand that people inhabit the spaces that buildings create rather than the buildings themselves. His next task was to use that insight to inform his work.

A crit with Dan helped Arnold identify the key ideas of this project: the concept of the quadrangle as a cell, the diffusion of the Oxford edge, and the layering of inside and outside (public and private) space. Then Arnold turned to Nigel for help “looking at the space.” He wanted to know “how to place the [building] masses to form the spaces” that his design needed.

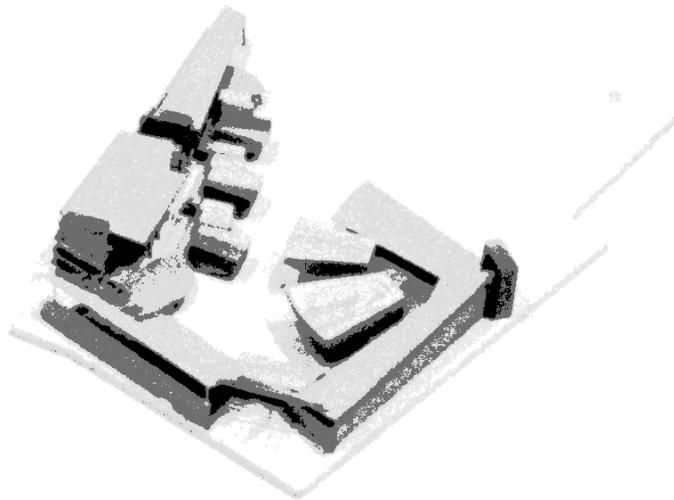


Figure 5. A model of Arnold’s building after the midterm review.

Nigel and Arnold discussed how space flowed through the center of Arnold’s proposed building plan. Arnold said he was “trying to create a pocket, a reservoir” (see Figure 5). Nigel suggested that “words like movement and flow are really about the ability to walk.” They talked about “the importance of view” and how “connectivity is key [in] creating an awareness of the space beyond.” As a result of the conversation, Arnold created a computer model of his building

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to help visualize movement through the spaces. Later, Arnold, Dan, and Nigel “walked” through the virtual building to understand the views created by Arnold’s building.

Arnold’s project began with an exploration of Oxford’s architectural heritage of monastic isolation. By the final review, he was working with computer-generated visualizations of the spaces created by his proposed building, exploring how movement through the building could gracefully link Oxford to the surrounding countryside. At the final review, the critics suggested that Arnold’s organizing metaphor—the structure of Oxford’s quadrangles—needed to be “opened up” more than his design proposed if he wanted to express the idea of a quadrangle at the scale of a single building. The space at the center of an Oxford quadrangle is peaceful, they argued. The spaces Arnold had created felt confining.

Through six assignments and presentations, with more than a dozen crits and literally hundreds of sketches, diagrams, and models (physical and virtual), Arnold had created, and now was able to present, a sophisticated architectural proposal (see Figure 6). His diagrams and models let jurors at the final review see not just a general design concept, but enough details of a possible building to visualize—and criticize—the “mood” of the spaces he had created.



Figure 6. Professors and design professionals from outside the studio critique a student’s work.

Putting the Pieces Together: Surface Structures, Pedagogy, Epistemology

The Oxford Studio was characterized by (a) a fluid organization of time and space, (b) a series of assignments that revisited a central design problem from multiple perspectives, and (c) feedback from instructors and peers in one-on-one desk crits leading to public presentations of work. As Brown and Campione (1996) have suggested, however, the elements of effective learning environments do not exist in isolation: each helps to create conditions for the success of the others. The challenge is not only to understand how individual elements function, but also to understand the relationships between them. In the sections that follow, these relationships are analyzed on three levels:

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1. The relationships among surface structures;
2. The relationships among pedagogical practices and the way in which those practices are supported by surface structures; and
3. The way in which these pedagogical practices enact the epistemology of design.

Surface Structures

Time and Space

As described above, the logistical organization of the Oxford Studio differed substantially from a typical K-12 or college class in a traditional subject. The total amount of space per student was greater in the Oxford Studio, and students were given designated spaces in which they could work on their projects throughout the course. The studio met officially for large blocks of time (4 hours a day, 3 days a week), and unofficially students and staff worked in the studio at all hours of the day and night.

These elements were intimately connected. The permanence of individual workspace meant that students could leave work in progress rather than start anew each time they came to class, and thus made it possible for students to work in the studio whenever they pleased. Perhaps more important to an interpretation of the Oxford Studio, however, is the architectural principle that the ordering of space affects human activity. Time and space are two of the media through which learning takes place in any environment. As McLuhan (1964) argued, “the medium is the message,” and the organization of the Oxford Studio was part of the message to students that design is a process that evolves over time rather than a series of quick answers to short problems.

Access to Experts

The Oxford Studio had a single professor and two teaching assistants for 11 students, creating a student-teacher ratio of just over 3:1. In addition to the regular presence of these experts, outside reviewers came to give feedback on students’ work at three different points during the Oxford Studio course. These reviews were usually 4–5 hours long, taking up most of an afternoon and evening, and demanded from the critics high levels of stamina, architectural sophistication, and sensitivity in giving feedback on student designs.

Ideally, such critics should be thoughtful, skilled, and professional, responding to issues of interest to the student in their comments and criticisms. In the Oxford Studio, students recognized that this ideal is not always met. After a dispiriting midterm review, one student suggested that “sometimes the critics are thinking about Architecture with the capital A,” rather than about a student’s particular building. The design aesthetics of critics and students were not always aligned in the Oxford Studio, and thus students sometimes experienced criticism as disconnected and harsh. But, as Arnold commented, “guest critics come and guest critics go,” and students took their feedback with a grain of salt.

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Moreover, everyone trained as an architect has gone through the review process, and most recognize it as a crucial part of learning to design. Every studio professor knows that he or she has to serve as a critic in order to get critics for his or her own studio. This tradition of mutual obligation meant that the Oxford Studio had a pool of potential reviewers. Moreover, temporal, spatial, and personnel resources functioned well together in the Oxford Studio. The open organization of time and space allowed teaching staff to spend a substantial amount of time in desk crits with students and also made it possible to organize extended design reviews with outside critics.

Media

In the Oxford Studio, assignments asked students to explore the problem of designing a business school at a variety of levels and in a range of media. Each change in materials and scale shifted the students' focus from one part of the problem to another (see Figure 7). As Nigel put it, a wall that appears as a thin line on a plan at 1:500 scale has dimension and weight at a scale of 1:100. It is only at smaller scale that one can tell whether it will feel ponderous or playful, whether it will bear a load or require structural support. This idea is well developed in the literature on design (see Akin, 1986; Mitchell & McCullough, 1991; Schon, 1985) and is central to the practice of good design. "Design means understanding at many scales," explained Nigel. "[It means asking:] how do the scales relate?"

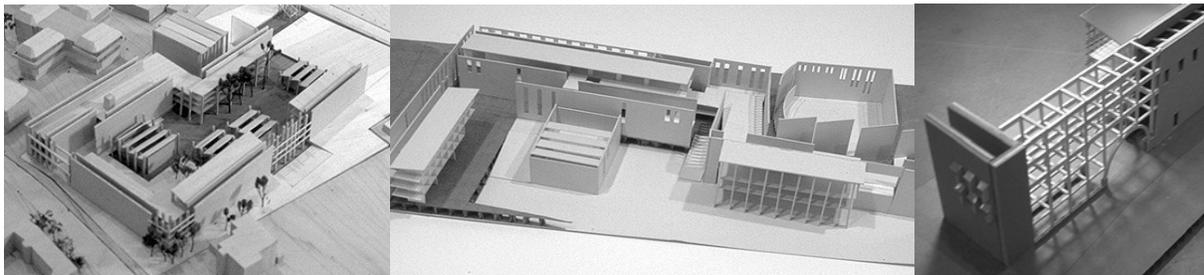


Figure 7. Models of Belinda's project at 1:500, 1:200, and 1:100 scale. A change in scale focuses attention on different aspects of a design problem.

The assignments in the Oxford Studio asked students to investigate their projects at progressively smaller scales—and thus at increasing levels of detail. This approach made it possible for the Oxford Studio to focus on a single project in great depth over an extended period of time. Each assignment asked students to look at the same basic design problem, but at a different scale—and therefore from a slightly different point of view. In part because students were working at different scales and in different media, they were able to focus on different aspects of a single project over a long time—to revisit a central set of design questions—without getting bored. Feedback from outside reviewers could be incorporated in later work in part because a change in medium and/or a change in scale meant that students were *reworking* rather than *revising* their ideas. The class was able to move forward even as students circled the same set of fundamental design questions, developing an ever richer understanding of the problem of the Oxford business school and the principles of good design.

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Interdependence of Structures

The surface structures of the Oxford Studio were thus fundamentally interconnected. Some of these key relationships are shown schematically in Figure 8, where solid lines connect structural features of the studio that are mutually enabling or reinforcing. As the analysis above and the diagram below suggest, the Oxford Studio was not simply characterized by a block schedule, personal space, a variety of media, and public presentation to external reviewers as means of assessment. Fluid organization of time, individual workspaces, a range of media, and access to experts in a review process were mutually interdependent, and all helped the Oxford Studio function.

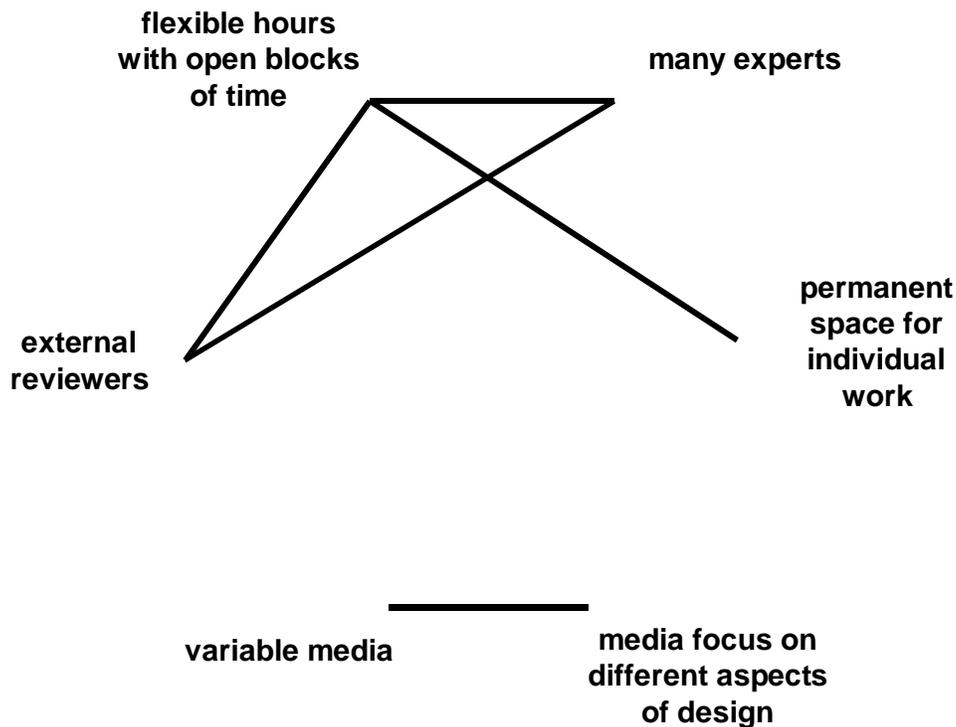


Figure 8. Conceptual relationships among surface structure elements in the Oxford Studio.

Pedagogy

The interconnected surface structures of the Oxford Studio did not exist as ends in themselves. Time, space, materials, and expert feedback were organized so as to support each other. But more important, they were arranged to support the cyclical processes of learning to design.

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Cycles of Design

The design process in the Oxford Studio was a cumulative series of individual assignments and presentations, creating cycles of production and reflection. Each assignment built on the work of the previous assignments, but also on the feedback that came from presenting that work (see Figure 9).

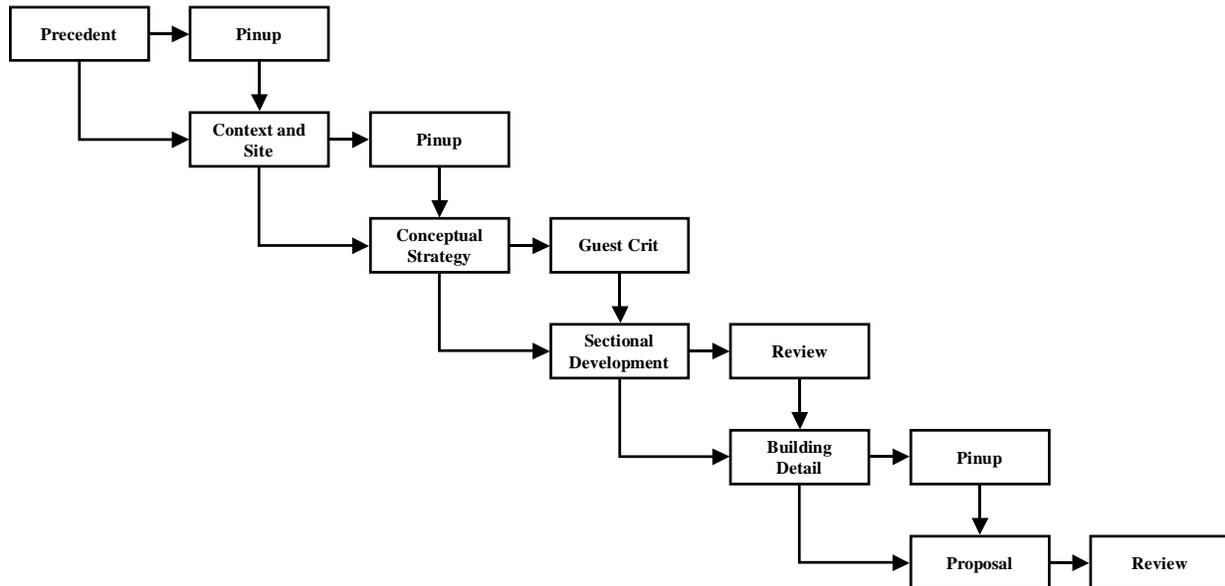


Figure 9. The assessments of the Oxford Studio as a series of presentations.

These cycles were made possible, in part, by the nature of the feedback given during presentations. In a typical classroom, much of the feedback students receive from formal evaluations is *summative* rather than *generative*: even if it makes suggestions for improvement, the intent is more to evaluate than to stimulate further work (see Perkins & Blythe, 1994). In contrast, the Oxford Studio implemented pinups, guest crits, and reviews with the explicit idea that students would use the criticism to improve their designs. As Nigel explained, a good critic gains “entry into the thinking of the student”; the critic is able to “lay out the reasoning for criticism” and thus “identify areas for further growth.” (The final review was something of an exception in this sense, and it comes as no surprise that students, professors, and practicing architects feel overall that interim presentations are more useful learning experiences than final reviews; see Anthony, 1987.)

In the Oxford Studio, students responded to feedback from one presentation as they worked on the assignment that would lead to the next. As described above, with each iteration of the cycle the scale at which students were working moved from broad questions of context and strategy to more detailed questions about individual parts of the building. As their designs moved from larger to smaller scale, students’ attachment to their basic design ideas grew. Nigel explained that the midterm review was designed “to get students to commit to a design strategy” that would be worked out in more detail in the second half of the semester. In Arnold’s case, this

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meant focusing on his strategy to end the “cellular growth” of Oxford’s quadrangles. His commitment to that design goal helped him understand a fundamental principle about the relationship between a building’s form and the space it creates. In general, as the presentations moved from pinup to guest crit to review, there was an increase both in their formality and in the expectations for the quality of the work. With each loop around the cycle of production and reflection, students were asked to make deeper and more public statements about their architectural ideas (see Figure 9).

Cycles Within Cycles

Alternation of design and feedback was similarly present *within* the assignment-and-presentation cycle in the Oxford Studio. With each assignment, students met with members of the teaching staff or peers for a detailed discussion of their works-in-progress. They received extended and in-depth feedback through these desk crits and then returned to their projects. After working through the ideas generated in the crit, they might sign up for another crit with the professor or with a teaching assistant, or work out details of the assignment in a crit with another student, alternating back and forth between work and feedback within each assignment.

As we saw above in discussions between Arnold and Nigel, desk crits played multiple roles in supporting students’ design work in the Oxford Studio. Crits provided what Arnold described as “authorization and validation . . . confirmation of untested ideas.” They also gave students “a sense of where to go from here, including concrete suggestions.” Dan described crits as providing “someone to bounce ideas off of, to make sure that they’re sensible,” but also someone “to bring in other generating ideas,” such as (in Dan’s case) Nigel’s interest in energy-efficient design. Nigel described his role in a desk crit as helping students “focus on a generative idea” and “unlock the door to make the whole thing better.” But he also looked for potential problems in students’ emerging designs. His experience let him “look at things that you know are going to come home to roost,” to see issues that might arise later from current design choices. His role as critic was partly to “ask students to start anticipating [problems] now before they complete their design.”

This support for the design process took many forms in desk crits in the Oxford Studio. Critics offered suggestions, pointed out potential problems, or referred to examples of work by other architects that addressed issues similar to those the student was facing. Sometimes critic and student would design together, with the critic sketching a series of design possibilities, showing the student the consequences of possible design choices. In doing so, the critic both offered design ideas and modeled design thinking. In many cases, crits ended with a specific suggestion from the critic, not of a particular design direction to take, but of a way to think productively about the questions raised. Thus, at the end of the extended discussion of the roof of Arnold’s building, Nigel suggested not “Why don’t you cantilever the lecture hall over the courtyard?” but “Why don’t you try drawing that section at a smaller scale to see how the lecture hall relates to the courtyard?”

As Schon (1985) described in some detail, desk crits in the Oxford Studio were a venue in which professor, teaching assistants, and peers provided design skills and knowledge that students lacked. With the help of others, the students were able to work, as Vygotsky (1978) suggested, beyond their individual reach. As they became more sophisticated designers, feedback

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moved to a higher level, always showing the next steps on the path. And so the design process continued: a student expressed his or her design ideas; a critic responded with feedback to those ideas to help the student achieve a higher level of design; the student incorporated that feedback in a new expression; and finally, this epicycle of design and desk crit culminated in a public presentation at the end of each assignment.

Interlocking Rings

Cycles of assignment and presentation, and epicycles of design and desk crit, were related in the Oxford Studio. The tone of desk crits was almost always supportive and nonjudgmental. On the other hand, pinups and reviews, although constructive, were quite blunt and sometimes extremely critical—particularly in the case of formal reviews. Judgment was, in effect, offloaded from the more private desk crits to the more public presentations. (In K-12 classrooms, just the reverse is often the case: significant criticism is given only in private.) This offloading of judgment was explicit. In the last few days before the final review, Nigel repeatedly used the phrase “if I’m on the jury” when commenting on students’ work, suggesting that whatever point he was making was intended to help the student present the best possible project for review. Nigel suggested that Dan needed to “develop the concept” for his building—not by making the criticism directly, but by pointing out that “a design is vulnerable to criticism when it doesn’t have a compelling idea.” Understanding in the Oxford Studio developed as supportive feedback from peers and experts in the desk crits helped students incorporate the norms of the architectural community—personified by the critics—as part of the framework for their individual thinking (see diSessa, 2000; Erickson & Lehrer, 1998; Shaffer, 1998).

The basic pedagogical organization of the Oxford Studio was this pair of related cycles (see Figure 10), in which expression of an architectural idea led to feedback, then to expression, and then again to feedback, eventually producing a design for presentation. The presentation generated more response, leading to the next assignment and a larger cycle of production and reflection that culminated in a final presentation—and in meaningful learning about the process and practice of design. Thus, for example, the Oxford Studio helped Arnold understand a fundamental principle about the design of inhabited spaces in a fundamentally iterative process, in which a series of imperfect solutions to a problem were proposed, analyzed, and refined until they eventually converged on a form that satisfied the initial conditions (see Schon, 1985; Simon, 1996).

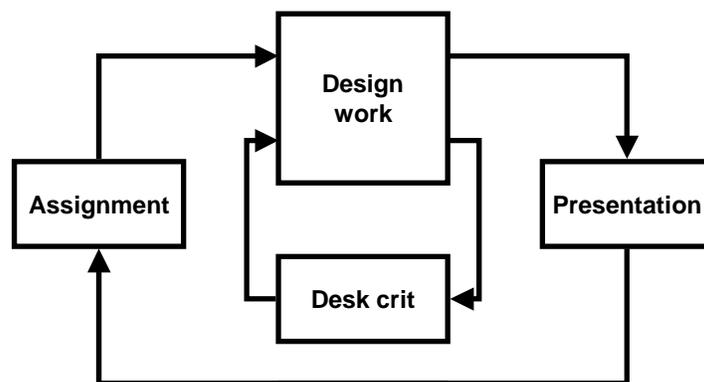


Figure 10. The cycles of expression and feedback in the design studio.

From Surface to Pedagogy

The surface structures of the Oxford Studio—the spatial and temporal organization of design activity, the resources of professor, teaching assistant and outside reviewers, the multiplicity of media—made desk crits, cumulative assignments, and public presentations possible. This is shown schematically in Figure 11, where the outer ring of structural elements supports an inner ring of pedagogical features. The dashed lines identify ways in which structural features support pedagogical elements. The pedagogical elements of the design studio, in turn, were also mutually enabling and reinforcing—a set of relationships shown schematically by the solid lines in Figure 11, which connect pedagogical elements that support one another.

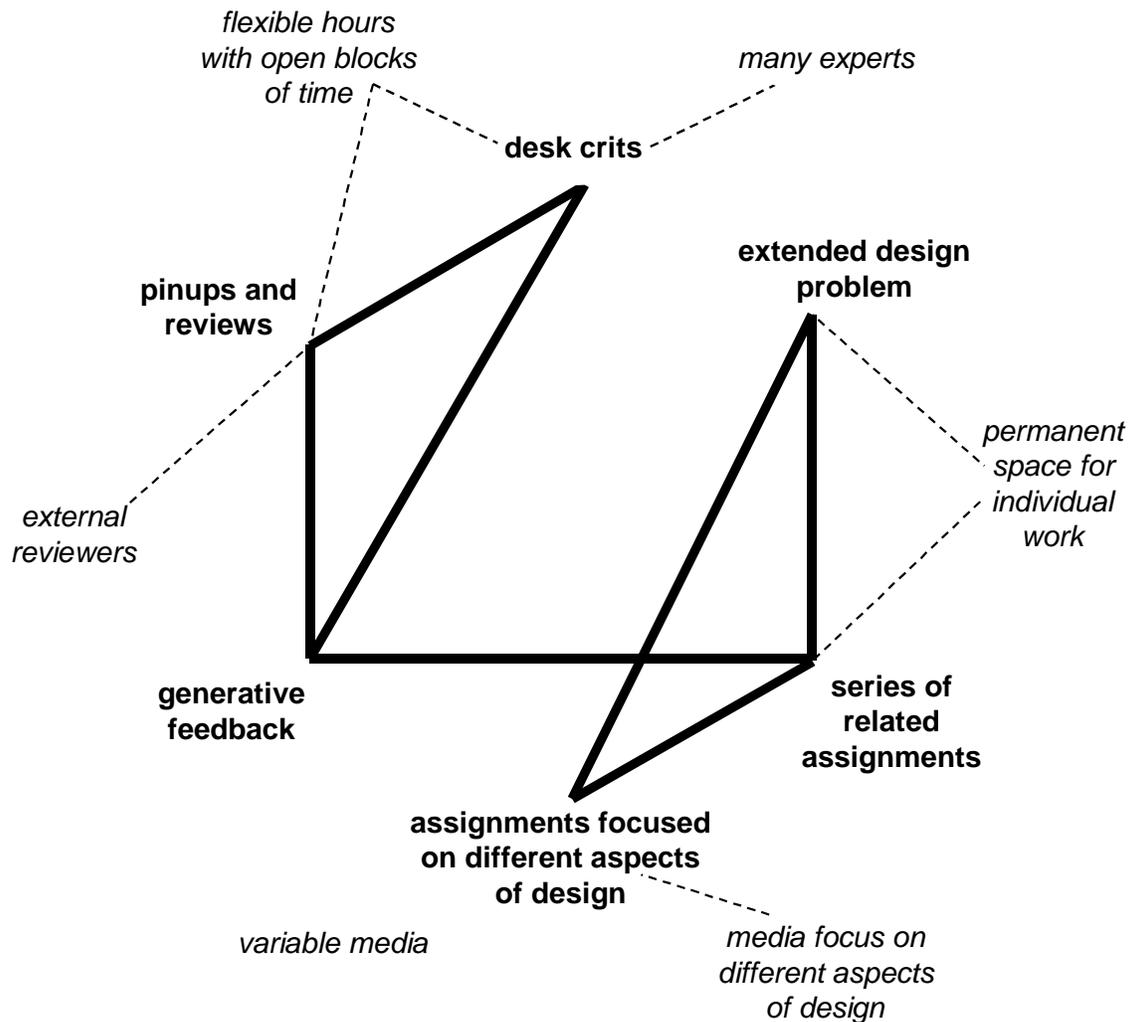


Figure 11. Conceptual relationships among pedagogical elements (solid lines) and between pedagogical elements and surface structure elements (dashed lines) in the Oxford Studio.

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This set of interrelated structural and pedagogical elements led to the cycles of design in the Oxford Studio. Design cycles unfolded in assignments that asked students to revisit the same basic design questions on different levels and from different perspectives. They unfolded in desk crits, where professor, teaching assistant, or peers supplied skills that students internalized over time. And they unfolded in presentations, where students were expected to incorporate criticism into subsequent work, rather than taking feedback as a measure of success or failure and moving on. These cycles of design, in turn, were the means through which students explored (and internalized) the fundamental epistemology of design.

Epistemology

Just as the surface structures of the Oxford Studio supported its pedagogy, the pedagogy of the Oxford Studio supported and depended on the expressive nature of design. Dewey (1915, 1958) and Parker (1894/1969) argued over a century ago that creating an expressive product is an integral part of thinking and learning. In more recent years, the theory of constructionism has suggested that building things is a particularly good way to build understanding (Papert, 1980, 1991, 1996). In the Oxford Studio, the expressive nature of architecture was a central epistemological principle in learning about—and through—design.

Architectural Ideas

Expression is the process through which thoughts, emotions, or sensations are instantiated in words, gestures, or physical creations in a way that reflects (and helps create) identity (see Shaffer, 1998). In design, the internal state to be represented is an architectural idea: an understanding about the creation of space based on a particular design problem. The existence of such underlying ideas in design is common in the literature on design (see Davies, 1987; Hewitt, 1985; Rowe, 1987) and was evident in the language and activities of the Oxford Studio. In the Oxford Studio, professors and critics spoke variously about the need to “develop an attitude,” “develop an architectural idea,” “find a valid architectural proposition,” “decide on a strategy,” “take a stand,” “take a stance,” “develop your criteria”—all expressions of the need to find an underlying idea or ideas to govern the development of a solution to the design problem. The early assignments of the Oxford Studio were deliberately constructed to help students develop such ideas about their projects.

A critical feature of the epistemology of architecture is that design ideas reflect an individual interpretation of an architectural problem. Students in the Oxford Studio were presented with a design challenge that had an infinite number of potential resolutions. Their task during the semester was to develop a unique solution, to understand that solution, and to convey in words, diagrams, and models how the solution they chose met the demands of the original problem. The idea they developed was to be of their own choosing—as long as they could develop a coherent design based on that idea and defend their rationale. As Nigel said to a student in an early desk crit: “You’re in control. Make it whatever size you want. Then I’ll ask: ‘Why is it that size?’ And you’ll say: ‘Because it’s doing this job.’ And you’ll develop your argument.”

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Expressive Activities

The activities of the Oxford Studio were organized around the development and articulation of expressive ideas. Conversations in desk crits were about developing these ideas. Representations presented in pinups and reviews were attempts to express these ideas. Criticism and feedback went toward understanding these ideas, refining them, and developing them further. Arnold described the key question of the cyclical design process in the Oxford Studio: “How does this expression of what’s in my head inform my underlying concept?” Because the architectural ideas explored in the Oxford Studio were unique to each student, critics could refer to examples from the work of other architects—or even other students—and still leave students free to develop their own thinking. And because the ideas were of the students’ own choosing, it was possible for each student to spend a semester refining a vision and turning it into architecture.

In the Oxford Studio, this focus on expressive ideas was supported by the lack of a single canon of design principles. There was no uniform curriculum of skills and concepts that students were required to master, no standardized test at the end of the semester. Individual students were free to focus on developing different design skills and understanding in response to the same series of assignments. Some, like Arnold, worked on developing an understanding of how people move through space; others, like Belinda, looked at the differences between formal and informal space, or, like Dan, examined energy efficiency; still others explored issues of exterior and interior forms, multiple use of spaces, or the relationship between hierarchy and order in a building’s organization. The freedom to express was made possible, in part, by freedom from a fixed set of learning objectives.

The Oxford Studio was designed to help students learn how to develop and express ideas about architecture through the iterative process of design. The pedagogical tools of the desk crit, cyclical assignments, and generative feedback were all means to this end. The surface structures of the Oxford Studio made extended desk crits, ongoing projects, and guest reviews possible. At the same time, the surface structures and pedagogical tools of the Oxford Studio worked because they were aligned and orchestrated by their relationship to the broader agenda of expressive and iterative activity. This is shown schematically in Figure 12, where an outer ring of pedagogical elements (the same elements that made up the *inner* ring in Figure 11) supports an inner core of epistemological stances and a central epistemic principle that design ideas express an individual’s unique perspective. Dashed lines illustrate relationships in which elements of pedagogy and epistemology support one another. Solid lines illustrate elements of epistemology that are mutually enabling and reinforcing. The nested layers of surface structure, pedagogy, and epistemology in the Oxford Studio, shown in Figure 13, were thus focused on a central idea about the importance of (and nature of) individual expression.

Discussion

Prior research has revealed a great deal about design and the processes of designing. This study of the Oxford Studio—which, it is true, represents a particularly well-appointed venue for design activity—reinforces a number of key ideas already established in that literature:

- Design is an iterative process.

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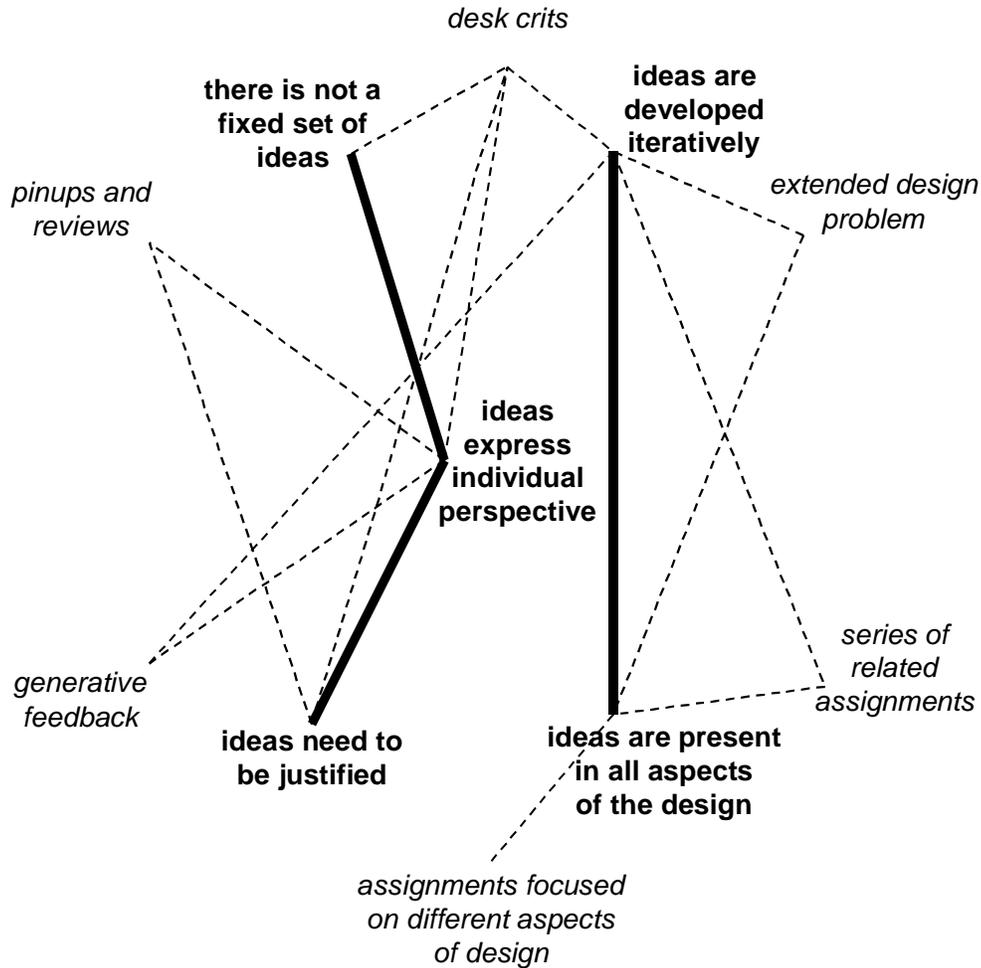


Figure 12. Conceptual relationships among epistemological elements (solid lines) and between epistemological elements and pedagogical elements (dashed lines) suggest that the iterative process of expression of individual perspective is central to the coherence of the Oxford Studio.

- Design resolves an open-ended problem through a series of intermediate solutions.
- The design process is mediated by generative feedback from social scaffolds such as desk crits, pinups, and reviews.
- Design is typically conducted in an open environment.
- Design learning progresses through a series of exercises that revisit a central problem in progressively more detail.

We know, moreover, that practices—particularly practices developed to promote learning—are more than just sets of activities in a particular setting. Effective learning

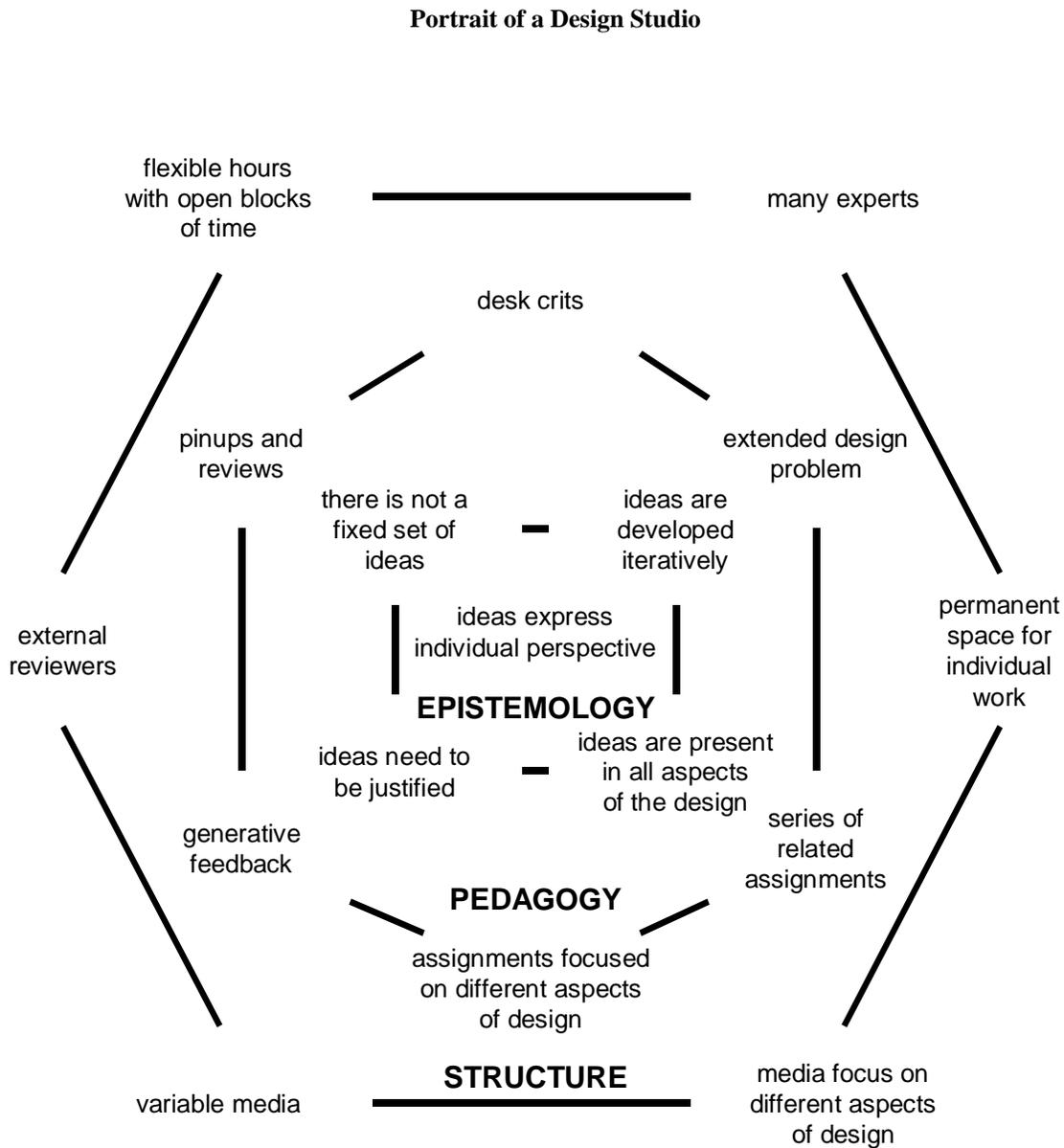


Figure 13. The nested layers of surface structure, pedagogy, and epistemology in the Oxford Studio. This figure combines Figure 11 and Figure 12, with the original connecting lines removed for clarity. The solid lines connect elements in the same layer (structure, pedagogy, or epistemology).

environments align structure, pedagogy, and epistemology. In the Oxford Studio, surface features such as time, space, access to experts, and media of expression came together to form a *structure* organized to support specific learning activities. That is, the learning activities provided consistent and coordinated relationships among the surface features of the environment. Similarly, learning activities came together to form a *pedagogy* by virtue of the fact that they were arranged to convey a particular approach to understanding based on the properties of architectural ideas. The understanding of architectural ideas, in turn, became a coherent *epistemology* when instantiated in the structure and pedagogy of the Oxford Studio. In this sense, as Wenger (1998) and Schon (1985) suggest, theory and activity were inseparably connected in

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the practices of the Oxford Studio, and the goal of this study was to investigate how elements of design practice were constituted in that system of activity. A key component of the coherence of design in the Oxford Studio was that students were not merely solving problems; they were engaged in an iterative process of expressing—and thus shaping—their identities. The design challenges in the Oxford Studio were personally meaningful to the students, and the solutions necessarily reflected students' unique individual perspectives. At the same time, solutions were assessed in the context of a larger community of practice. Thus, solving the problems required aligning individual and community—for the students, aligning self and critics—in the context of a set of practices that incorporated a particular approach to understanding.

The result was projects that were personally meaningful to students, relevant to central concerns of the field of architecture, and consistent with the norms of the community of designers as assessed by members of the architectural profession. In other words, the linkages among surface structures, pedagogical forms, and epistemological principles created an environment that was “thickly authentic” in the sense that Resnick and I (Shaffer & Resnick, 1999) have described. Activities were simultaneously aligned with (a) goals that mattered to the community outside the classroom, (b) goals that mattered to students, (c) ways of thinking within an established discipline, and (d) the means of assessment. The thickly authentic nature of the Oxford Studio helped initiate students into the architectural community of practice (see Wenger, 1998).

In recent years the design studio has been an appealing model for reformers interested in creating powerful connections among learners, teachers, and intellectual domains. The Middle School Math through Applications Program includes units on designing a dream home, designing quilts, and designing a research station in Antarctica (Greeno, 1997). The Geometry in Design curriculum materials (Jacobson & Lehrer, 2000; Lehrer & Curtis, 2000) use design activities as a context in which students from elementary school through college learn about traditional domains such as mathematics and science through design activities. The Learning by Design project (Hmelo et al., 2000; Kolodner et al., 1998) has demonstrated that design practices can help create effective learning environments for middle school students to learn science concepts and scientific reasoning through design activities.

However, to the extent that such projects are modeled on design, the approach is typically to extract and transform elements of professional practice to fit within the constraints of existing school curricula, organization, and tools. Such adaptations may not take full advantage of the potential of the design studio as a model. The present study suggests that the structures, activities, and ways of knowing of the Oxford Studio were highly integrated; in particular, pedagogical tools such as the desk crit and design review depended on both the open organization of the environment and on the expressive nature of the tasks at hand.

An important undertaking—although beyond the scope of the present study—is to understand in more detail how adaptations of design practices function, and the extent to which such adaptations benefit from close integration of elements of design practice such as those found in the Oxford Studio. One of my own studies, the Escher's World project (Cossentino & Shaffer, 1999; Shaffer, 1996, 1998, 2002a, 2002b), looked at graphic design projects and practices explicitly modeled on a design studio as a context for learning mathematics. Results showed that elements of the design studio model—expressive and iterative activities with

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generative feedback in desk crits, pinups, and reviews—supported the development of mathematical understanding. As Cossentino and I (Cossentino & Shaffer, 1999) argued, the success of that work was closely associated with the preservation of relationships among features of the design studio, rather than ad hoc adoption of isolated elements of design practice.

How closely the practices of design need to be followed in adaptations to other contexts remains a complex question, however. Hopefully the study presented here will prove a useful step in such efforts.

Conclusion

This study analyzed the practices enacted in an intermediate-level design studio course at the MIT School of Architecture. The goal was to explore the relationships among the surface structure, pedagogy, and epistemology of the design process—to examine the underlying structure of the practices of one design studio. The results suggest that the spatial organization and scheduling of the Oxford Studio made extended desk crits, ongoing cyclical projects, and guest reviews possible. These pedagogical tools, in turn, were the means by which the Oxford Studio fostered students' ability to develop expressive ideas about architecture. The Oxford Studio was thus an integrated system of practice built on the foundation of expressive activity. An understanding of how this framework was articulated in the Oxford Studio may be helpful in using the design studio as a model for developing learning environments in other contexts.

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