Lessons from an Integrated Design Course

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ABSTRACT: *Integrated design is an activity that promises improved built outcomes by factoring technical and performance goals throughout the entire design process. It acknowledges that technical knowledge, typically provided by engineering consultants, is generally layered onto schematic design ideas. Often these specialists do not internalize the visions of architects and stubbornly assert themselves. Additionally, environmentally responsible architecture is best conceived of holistically, especially if passive design strategies are to offset mechanical and electrical solutions that are historically accepted as the appropriate way to solve for larger objectives of thermal and visual comfort.*

In architecture school, knowledge understood to be necessary to achieve integrated design has largely been relegated to technical courses executed in a lecture format. A benefit of utilizing a lecture format for these courses is that they are suitable to foregrounding and evaluating factual information. Drawbacks to relying on a lecture class format for technical subjects include large class sizes and limited opportunities for project work; factors that are compounded by limits of time in required courses for addressing technical knowledge. Challenges to integrating technical knowledge into studio courses includes the notion that foundational knowledge is best introduced outside of the studio, although some programs have incorporated engineers as studio consultants and studio instructors.

A premise of the experiment addressed in this paper is that architects are synthesizers of knowledge and better qualified than engineers at recognizing social, programmatic and visual factors as relate to design and building. In other words, the art of architecture cannot be separated from creating a material artifact. This means that effective architects are needed if integrated design is to be realized consistently and that relying on practice as the place where integrated design skills are introduced is not adequate. Another premise is that integrated design outcomes need to be assessed in relation to criteria unique to the project as well as criteria from outside such as code. Like architecture in general, there is no single litmus test for successful integrated design. In this light, integrated design is not achievable without a program tailored to the project and designers who value the expressive potential of design, building construction and building performance.

Given the opportunity of running an elective graduate research seminar, the author of this paper introduced a design problem for a small building (artist's studio) with the expectation that students could manage and recognized conflicts related to program objectives and technical factors. Key to this effort was forcing students to identify and acknowledge design criteria that they developed. Prior to engaging in design, students participated in discussions on readings related to integrated design theory. At the conclusion of the design process, students were tasked with reflecting on the theory and their experience balancing tensions between design criteria which were unique to each student. Challenges included showing students that art and construction realities are compatible.

KEYWORDS: Integrated, Sustainability, Goals, Criteria, Programming

1. INTRODUCTION

The challenge of preparing future architects to practice integrated design is in many ways similar to the challenge of preparing students for sustainable practice. Overlaps between the two contribute to a misunderstanding that they are the same, as are the fundamental competencies required for success. Both approaches require significant technical knowledge which has proven difficult to instill in school and require the ability to weigh the impacts of design well beyond building completion. Limits to both topics are imbedded in traditional curriculum structures and cultures that resist expansion of their scope in architecture schools. However, unlike sustainable design, design objectives includes specific environmental factors as represented in assessment programs such as LEED but are less tightly bound to them as other considerations can take priority and drive the design process. These can include a greater variety of design objectives, such as safety, durability and maintenance, but are often discounted in pursuit of goals that align with sustainability measures. Another major difference is that integrated design objectives, and the means to achieve them, have to be deliberately acknowledged and weighed against each other.

Currently, a comprehensive design studio, but not an integrated design course, is required at this author's school, so he took the opportunity of offering a graduate level elective seminar to address the subject directly. As a registered architect with significant practice experience and an academic who teaches technical courses in addition to design studio, the author decided to craft a course that combined theory with a design project meant to allow students to come to grips with issues fundamental to integrated design. Unlike integrated design case studies that typically involved complex mechanically driven environmental control solutions, a small building problem was introduced to factor out mechanical systems that student were not facile with yet. The result was a hybrid course the spanned approaches used in studio and non-studio formats.

2. INTEGRATED DESIGN DEFINED

Integrated design is an activity that directly engages the fact that engineered building systems, especially mechanical, are such a large part of buildings that architects must be more proactive in making them part of well resolved buildings. It also acknowledges that quality design solutions involve more than system integration to encompass complex problems that are often cultural. These are problems that can't be exclusively understood and resolved through a lens that author Leonard Bachman categorizes in his book Integrated Buildings: The Systems Basis of Architecture as industrial (scientifically grounded). Integrated design promises more holistic outcomes by factoring technical and performance goals throughout the entire design process. It acknowledges that a better balance between the objective and technical parts of building knowledge need to align with the components of architecture culture that includes meaning.1

Like sustainable design, building performance in integrated design is fundamental for success. One of the reasons is that managing and reducing reliance on engineered systems are intertwined with methods for making buildings. Another reason is that both require the architect to provide leadership on how questions of performance are solved, putting architects at odds with the prevalent culture in which engineered solutions are supplemental to architecture and often run counter to architectural objectives. Examples are the goals of utilizing passive thermal comfort and daylighting techniques in which investment in elements such as insulation, shading devices, venting and strategically placed windows can reduce mechanical systems size. Integrated design can also place value on expressive and experiential outcomes such as views, functional relationships and sense of place. Considering that it is difficult to optimize all goals, integrated design encourages compromise and negotiation.

3. PROBLEMS OF EDUCATION AND REPLICATION

Components of integrated design are baked into the DNA of design education but does not ensure efficacy in practice. Practitioners who find success can learn while doing after formal training provided they are persistent and effective learners and can work in situations that where their actions are appreciated. However, successes of some practitioners does not guarantee that the majority of practitioners are able to replicate those accomplishment. As is the case with celebrated designs and designers, the profession of architecture is content with success at the margins despite arguments for broad diffusion of well-integrated buildings. Rather than relying on the current cadre of architect practitioners, a better guarantee of capable integrated designers, is to prepare graduates in greater number that will be able to demonstrate success in practice scenarios big or small.

The subject of scale is one that challenges school culture as it is susceptible to an all-or-nothing approach in which students are expected to impress a design jury who have not observed the process the student engaged in. This experience is valuable in that it simulates the experience of selling a schematic design to a client, but it misses other opportunities for designers to establish expectations and educate owners. Design reviews are conducted in a context in which the simulated clients are more experienced designers who are unlikely to be swayed or informed by the student. In reality, success in an architecture project need not be compelling and combined with a dazzling presentation. Success can be measured statistically, experientially and ultimately should be measured over long durations.

Another issue with architecture school is that it centers on the design studio where students are immersed in the unique aspects of the design process while honing representation and presentation skills. Projects simulate actual building programs allowing students to build confidence and familiarity with practical factors while learning how to push the envelope on conventional solutions that in practice are constrained by regulations, financing and limits of client preconceptions. Educational content that is more closely related to fact than process are largely constrained to non-studio courses delivered in a lecture or seminar format. A result is that concrete knowledge is inconsistently applied in studio where practices approaches are ingrained, and design activity is largely absent from non-studio courses. The adoption of comprehensives studios have helped ground systems related knowledge in the studio sequence, although requiring students to incorporates mechanical systems into large building designs does not necessarily allow for alternative paths that deemphases normative engineering solutions. Language on integrated design in the most recent NAAB Conditions for Accreditation are distinct from definitions of design synthesis in the document and assessment structure. This can lead to misconceptions the two can be independent and bind notions of integrated design too bound to closely to engineered systems integration.

Resistance to incorporating concrete knowledge and real-world design constraints into design courses is a result of emphasis on soft skills, encouraging originally in studio and the notion that introducing practical constraints will dampen fluid creativity. Thus, a significant amount of acclimation to practical concerns occurs in practice with some structure provided by the AXP apprentice program. Apprenticeship builds on knowledge instilled in school by situating in the realities of practice, but it does not introduce theoretical and technical knowledge consistently, or contribute to the development of design problem solving skills. This allocation of academic and practical learning has been maintained despite the erosion of architects' influence on the construction site, sustainability goals and other performance objectives that building owners desire. A downside of limited exposure to real-world factors, and performance objectives, in school is that architecture school graduates are ill prepared to achieve concrete sustainable and integrated design results if not closely associated with practitioners who can mentor them.

Sustainable design is largely tied to specific design outcomes that are measurable and can be managed with a standard scoring system as demonstrated with LEED and Passive House. An advantage of this is that designs can be shaped to meet scoring criteria reducing the necessity for specific programing goals in order to achieve certification. A standard scoring system for integrated design does not currently exist, and by definition defies existence. Parts of integrated design, such as sustainability, can be accommodated by a scoring template, or measured against existing benchmarks and regulations, but many accomplishments have to be measured against goals specific to the project. Identifying goals and metrics related to measuring success is largely up to the designer and project owners. This implies a programing process that is seldom rigorous in practice.

4. ASSIGNMENTS

The semester's activities were divided into three portions. First, prior to engaging in a design process, students read, assessed and discussed chapters of Leonard R Bachman's book *Integrated Buildings: The Systems Basis of Architecture*. Despite a paucity of books on integrated design, Bachman's framing of integrated design was not passively accepted, but rather scrutinized by the class in a seminar format. The thirteen enrolled students found the reading, much of it dense, interesting, especially when provoked by the instructor's personal views and experiences on practice and education. To provide additional context, students also read chapters from the author of this paper's book, *Constructing Building Enclosures: Architectural History, Technology and Poetics in the Postwar Era*, which highlighted collaborations between architects, engineers and builders. The aim in this case was to demonstrate that integrated design is best achieved when different parties in the design and construction process work collaboratively.

Central the course was creating a design problem (second part) that forced students to identify design goals on their own and to reflect on the impact of the goals on their designs. The site provided to the students was a lot near the school for which the author is designing an art gallery addition. Instead of a gallery addition, students were asked to design a free standing one-room artist's studio with fixed plan dimension at a specific point on the site. By limiting dimensions and location, students were given objective constraints that would prevent diversions such as creating geometrically complicated plans and volumes. By encouraging and open space, students would not be arranging rooms and could focus on space qualities.

Before designing, students were asked to develop their own project objectives, prioritize them and write them down so that they could be referenced through the deign process. (Interestingly this is not done in studio courses and instead students are often asked to develop a concept that eludes specificity.) Objectives were to address qualities of outcomes which in practice could be qualitative, such as lumens, but in this case were qualitative since students were not familiar enough with qualitative goals such as insulation metrics. Instead, quantitative goals were baked into goals such as favoring daylighting over artificial lighting. During class working sessions and in individual crits, students were asked to refer to their goals. They were dissuaded from changing their goal, but were permitted to do so. Updating design goals was discouraged, but permitted as knowledge is gained through developing designs.

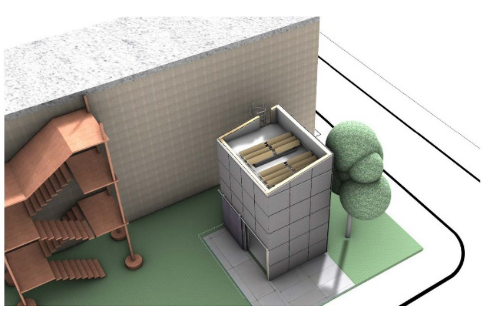

Figure 1: Digital Model Capture from Above. Source: (Author 2023)

Two reviews, a mid-project and a final, during the semester involved bringing in outside critics. Both critics were practicing architects who were teaching, or had taught, Materials & Methods at the school. Both were also grounded in the fundamentals of sustainable design. This, and the size of the building, made for and unusual discussions which included detailing and construction. During the reviews, students shared drawings of their designs and provided access to their digital models (Fig. 1). Colorful renders were not required and discouraged to focus students and critics on the material of the designs. The first act of each student when presenting their designs was to highlight their most important design objectives (Fig. 2).

Figure 2: Student Presentation Slide. Source: (Author 2023)

After the final review, students were tasked by the instructor to produce a report (third part) that reflected on the tensions, trade-offs and challenges encounters while designing. They were also asked to reference the readings introduced at the beginning of the semester. A reflective exercise was a deviation from the traditional end of project review in design studios after which feedback is limited when provided. Prompting reflection encouraged students to evaluate their process, and improve on it, as the goal of the design project as opposed to producing an impressive product. It was also a valuable opportunity to revisit the theoretical component of the course which is often perceived as supplemental to design.

5. PROJECT HIGHLIGHTS

Considering that the course did not have the duration and a complementary output expectation, of a design studio most of the students in the class were able to respond to the building program in a manner that was not too personal and respected the need to support various types of individuals. (Overly personally derived responses to program briefs are characteristic of most students design proposals from the perspective of the author.) With integrated design, impetus from the program lays at the opposite spectrum from external environment and site in terms of shaping designs. Program also introduces a human perspective that informs the dimension, layout and details of an interior environment.

Extra attention was placed on providing apertures that acknowledge views in addition to the daylighting (particular to art spaces) and the heating potential of the sun. The fact the site is located in one of the poorest areas of Philadelphia prompted issues of security and sense of safety. Since art studios accommodate different sized media, students were reminded that access and mounting options for work. This necessitated modelling different types of artwork such as sculptures. It also influenced the operation of doors by including overhead and sliders.

Wall construction, cladding and roofing became another area of unusual attention on contrast to typical design studio. This was especially true with storm water management as students were pushed to incorporate gutters and downspouts into their designs. In some cases, students incorporated water retention vessels which is particularly valuable in Philadelphia were an antiquated stormwater system is overburdened and there are too many impervious surfaces (Fig 3). With some encouragement, students came to see accommodation as an opportunity and not an obstacle to creativity.

Figure 3: Digital Model Capture. Source: (Author 2023)

6. CHALLENGES

Challenges in the course included limits on the amount of technical knowledge they brought to the course which reflected the curriculum. Most of the students had not taken Materials & Methods within a couple of years, and knowledge of basic construction was not reinforced in subsequent courses. Knowledge from their structural courses was either impractical, too abstract or focused on case-studies for large buildings. Knowledge of basic environmental control approaches were addressed in a required sophomore level course most of this cohort had completed, and the Environmental Control Systems course most of them had, difficult to relate to small buildings. These experiential factors contributed to inconsistencies in sustainably design knowledge. Students also had little to no experience researching materials and products as well as little experience detailing for design. Challenges also included showing students that art and construction realities are compatible and that large gestures were not necessary for good design. Some students overreached by attempting to design a novel assembly without an idea of what architects who established similar precedent were seeking and without an ability to follow through on their ideas.

7. CONCLUSION

As an elective course was implemented in the school for the first time, the class was well received. Students were engaged and demonstrated interest in the subject manner. They were able to produce design proposals that they were willing to invest in and present with confidence and candidness. Students were attentive at the reviews and engaged in productive dialogue. More importantly, the quality of their input suggested that they were grasping the subject at hand. When queered at the end of the semester, students found design a realistic building at a small scale satisfying. Some students shared that they wished there had the opportunity to design without being pushed toward the novel at the expense of solving complex problems. For the instructor, testing the premise of an integrated design course in in the context of his program was an important way of learning what students are capable of and interested in. (The latter notion being particularly important if students are to internalize lessons and seek to build on them.) It was also an opportunity to reduce the scale of design project and reduce the tendency for heroic gestures as a proxy for resolved proposals.

Integrated design can be incorporated into a curriculum in multiple ways. Since concrete knowledge of construction systems and materials are important, it is necessary to acknowledge the subject in standard foundational building technology courses. This entails discussing how material and systems choices relate to design outcomes. Integrated design courses should be offered as electives and, if possible, required courses. They should include some basics of building programing if programming courses are not offered. Since non-studio courses do not have the schedule band-width of studio courses design problem, if utilized, must be streamlined and manageable. Traditional studio courses are the most desirable location for integrated design, provided related theory is present. Many comprehensive studio courses involve systems integration, but large scale project generally leave little room for producing and evaluating alternatives. Considering these challenges and achievements, there is significant work to be done to make integrated design a more robust and normative part of architecture curriculums.[2]

REFERENCES

Leonard R Bachman, Integrated Buildings: The Systems Basis of Architecture (Wiley: Hoboken, 2003).

ENDNOTES

[1] Leonard R Bachman, Integrated Buildings: The Systems Basis of Architecture (Wiley: Hoboken, 2003). p. 10.

[2] After multiple years of discussion at the authors institution about implementing a required integration course, a course is closer to becoming a reality despite related course content that is difficult to relinquish or reassign.