Developing Evidence-based Tools and Resources for Material Selection

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Abstract

Building construction costs over a trillion dollars and accounts for half of the non-renewable resources consumed on an annual basis in the US, with materials and equipment comprising three-quarters of these costs. While not the final arbiters, architects play a critical role in determining what materials are specified for construction projects. Material selection in architecture has historically been taught through high-level lectures accompanied by empirical, evidence-based exercises and precedent studies during school followed by "in the field" experience for interns in practice. While there are many great resources that discuss material properties and analyze the use of specific materials in iconic projects through a case study approach, there is a significant gap in the literature and support materials when it comes to how and why materials are selected in the first place. With the rapidly evolving nature of digital tools, ever-expanding range of materials available on the market, and increasing standards for building performance, there has never been a greater need for comprehensive resources to support architects' and educators' understanding of the interconnected factors that influence and support informed decisions that are justifiable to all project stakeholders.

This paper presents the problem-setting process; findings from first-hand interviews with almost twenty practitioners at leading firms in New York City, Chicago, and San Francisco that have been recognized for their thoughtful use of materials; and plans for the next targeted phase of the work. University research seed funding supported the initial phase of this research, which was designed to validate assumptions about the unique nature of the material selection process. We plan that this study will serve as the first step toward developing codified resources to support a more evidence-based approach in education and practice.

Keywords: Materials and Construction, Professional Practice, Pedagogy

Introduction

The development of materials collections to support architecture and design programs is a growing trend in university libraries across the country. Architecture librarians, always searching for ways to engage with students and faculty, have leaped at the chance to acquire new collections and tackle the difficult task of cataloging, preserving, and displaying new materials. From the architecture educator's perspective, these collections are sought after to aid in materials instruction and to familiarize students with the diversity and depth material science has to offer. At least in theory.

The J. Willard Marriott Library at the University of Utah followed this trend in 2015 by acquiring a 1500-item materials collection from the New York firm, Material ConneXion. The library was encouraged to make this investment by faculty in the university's School of Architecture and its Multi-Disciplinary Design Program. Material ConneXion was chosen for a variety of reasons including the company's strategy to "select cutting-edge materials in collaboration with our research team" and their dedication to provide access to smaller, boutique manufacturers. The Material ConneXion subscription is

accompanied by a database with descriptions of all the physical materials included in the Marriott's collection as well as those in the New York flagship collection. The Marriott rolled out its collection in 2016 and has been maintaining and promoting it ever since.

However, since the very beginning it was not entirely clear how to leverage the new acquisition to its fullest potential. Class visits from architecture and design students were often met with polite interest and little follow up. One-on-one consultations with librarians sometimes left the students frustrated with the limits of the collection in terms of the size of the samples, the focus on cutting-edge versus more foundational materials, and the limits of the Material ConneXion database in doing research on material properties. These setbacks forced a reexamination of the collection's intended use relative to its support needs.

Material Research and Selection Competency

The 2014 NAAB's Conditions for Student Performance in its Conditions for Accreditation require architecture students to have knowledge of the "technical aspects of design, systems and materials," as well as the ability to successfully select appropriate materials based on "their

inherent performance, including environmental impact and reuse." Simply having the materials collection did not seem to be helping the students to a better understanding of how to perform material selection and research. In fact, the database sometimes seems to be a hindrance, as students viewed it as a one-stop website for all the information they needed about a material.

Librarians have also laid out competency standards for students, which help to drive the purchasing and programming decisions in the profession. The Art Libraries Society of North America, a professional association for art and architecture librarians, lists the "ability to collect information on specialized topics" like "sustainable and energy efficient materials" as an intermediate skill requirement for architecture students in its Information Competencies for Students in Design Disciplines. It goes on to suggest the use of handbooks, manuals, and catalogs as methods of discovery. The competency document does not specifically mention materials collections, but the advantage of having access to the physical objects for research seems to follow. Unfortunately, neither entity provides a standardized method to teach these skills or integrate various collections into the curriculum.

Framing the Question

It was these issues that prompted an initial, exploratory study into the current materials research and selection practices of architects in the United States. The study was designed to examine how materials research and selection are currently done in professional practice, what training practitioners identified as beneficial and/or lacking with respect to skills needed to do so, what resources were commonly used in the process, and if current methodologies were adequate for the needs of practitioners. The results of this study would then be applied in several ways within the university setting and help direct future research agendas. Below are several areas of inquiry the exploratory research hoped to address.

One of the study's main areas of focus was to determine how current practitioners were educated in the area of materials research and selection.[1] Do practitioners feel as if their education provided a systematic and rigorous approach to the research process? Did they have coursework in research methods? What did their materials education look like? Finally, how have they applied their education, or lack thereof, into their professional work? The hypothesis was that most practitioners would report very little formal education in this area, and that many rely on a non-systematic approach in their selection process.

The materials research and selection process is differentiated from knowledge about material properties

and construction methods, which are clearly covered in the curricula of all architecture programs, by the incorporation of a rigorous, exploratory research process and the appropriateness of the architect's response to the complex environmental, cultural, aesthetic, performative, and budgetary requirements of a project. Beyond initial intuitive decisions by practitioners about the materiality and tectonic response appropriate to a project, the assumption was that much of architects' research and selection process was happenstantial, directed by products presented at firm lunch and learns, materials seen in other buildings, and those used by the firm in previous projects. The hypothesis here was that architecture practices may mirror the old physician/pharmaceutical-sales model, where the selection of a particular version of a drug is heavily influenced by vendor visits and the education provided therein.

The resources architects use in their exploratory research process was another area of interest. Determining if firms had materials collections and how they used them, as well as what other supporting material (e.g. manuals, journals, databases, etc.) were commonly used would help to determine current trends in practice. Additionally, whether or not firms evaluated the success/failure of materials used in previous jobs would be helpful in understanding how reflecting on past work informed future projects, effectively closing the loop of the traditional research process. A use of primary source information in addition to secondary sources seemed a logical approach to this type of research, which determined the need to interview practitioners in leading firms of varying types and sizes across the country.

Finally, the study was designed to uncover the wide array of experts around architects who assist with material research and selection. The relationship between architects and specification writers, engineers, and manufacturers was explored in an attempt to articulate the intricate back and forth that happens on every project. It was important to acknowledge the team approach common in architectural practice, and attempt to define its benefits and limitations. To this end, interviews were conducted as often as possible with multiple firm members who filled these roles within the practice.

Answers to some of these basic questions have provided the initial steps to improving student preparation for architectural practice and clarified areas where more in depth research will be conducted. From a library perspective, better information provides important feedback into how collections are managed and presented to students. From the architecture instructor perspective, it shines light on current strengths and deficiencies in education, and points toward where future focus and research needs to be applied.

Research Overview

Rigorous research practices in architecture education and practice have been identified as lacking by many despite initiatives as early as the late 1940s to promote these practices. Stephen Kieran outlined the need for more rigorous research processes to be taught in a 2007 article in JAE entitled, "Research in Design: Planning Doing Monitoring Learning," where he contrasts architecture and product design education. He states that architecture educators overemphasize the "planning" and "doing" stages of design without also insisting on measuring performance and learning to inform subsequent iterations like product designers do. "The bulk of our curriculum remains embedded in the nineteenth-century design studio where we plan, then we plan again and again, with little real growth in the quality and productivity of what we do either artistically or technically. While an ever-increasing number of schools have included ["doing" or building] in the curriculum, few schools of architecture teach research skills and fewer yet insist upon critical reflection and learning based upon research findings."2 Kieran goes on to outline the research culture intentionally fostered at KieranTimberlake as requiring the rigor to constantly

interrogate projects and processes in order to learn and improve as well as the skills needed to "frame questions and seek out measurable data that we can act upon to improve what we have done."[3]

Since little research has been done on how material research and selection are taught and practiced by architects, it was determined that an exploratory research study was needed to refine base assumptions, vet survey and interview techniques, and determine if further exploration on the topic was in fact needed. The framework of an exploratory study was chosen to test foundational assumptions about larger issues within architecture education and practice and confirm that the right questions were being asked prior to embarking on larger-scale efforts. In his book, *Qualitative Research Design: An Interactive Approach*, Joseph A. Maxwell states that exploratory or pilot studies are valuable tools in any qualitative research project because they allow researchers to test, clarify, and shore up aspects of their research design and to identify features of the study that could only have been established through the study itself.[4]

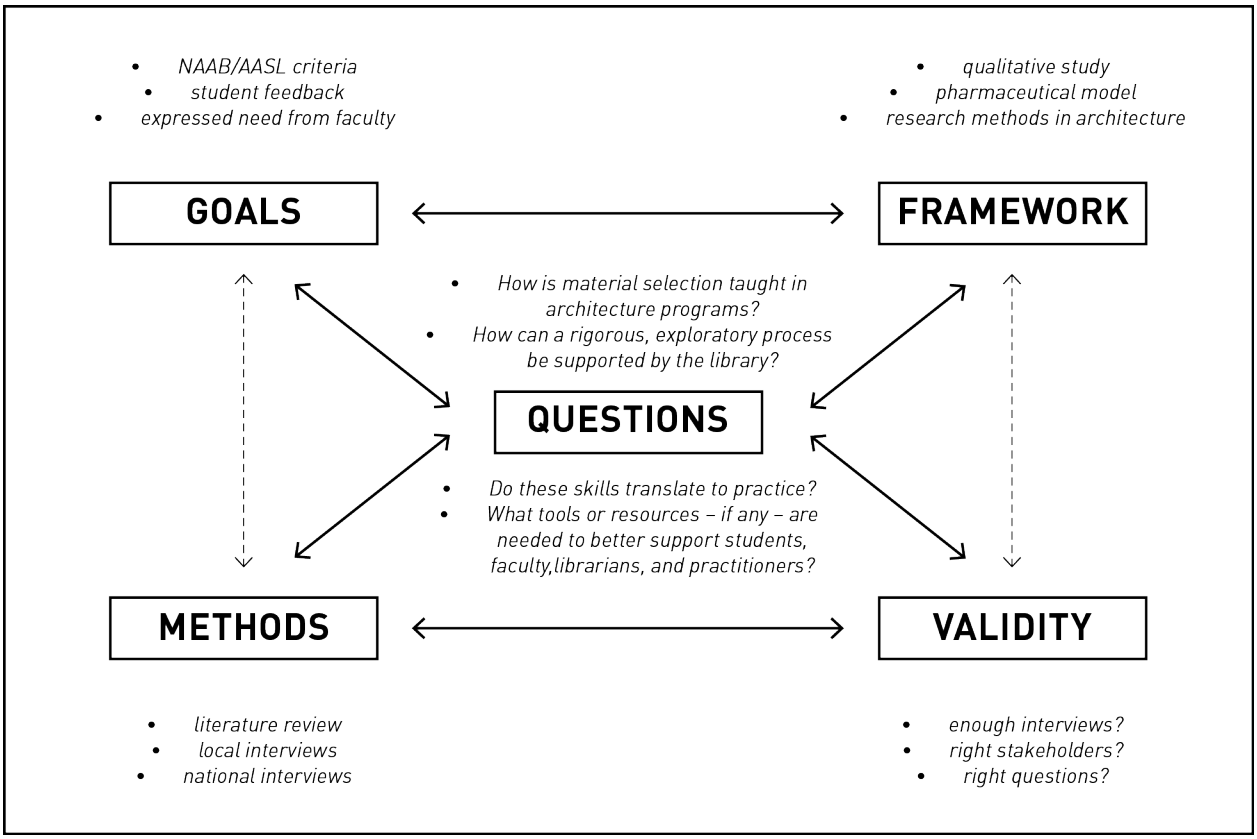

Fig. 1. Research Framework – (Based on "An Interactive Model of Research Design" From *Qualitative Research Design: An Interactive Approach*, by J. A. Maxwell, 2005. Copyright by SAGE.)

In parallel, the researchers intended to identify if any tools and resources are needed to better educate students and support practitioners in an evidence-based process of material selection that best achieves project objectives. Using the idea of scaffolding research funding as a strategy from past collaborations that has proven to lead to long-term success, the researchers applied for and were awarded a college seed grant to support these efforts. As with most exploratory research, the goal was to prepare the way for more targeted research in the future. A "beta" phase was performed locally through interviews of faculty, students, and practitioners

connected to the university, attempting to ascertain how important they feel material selection is in practice and how prepared they feel to make informed design decisions about materials based on their education. Findings from this process informed the development of the questions for the field research conducted with leading national architecture firms.

In-person interviews were held with approximately twenty design professionals in San Francisco, New York, and Chicago at leading firms of various sizes and types of practice. It was critical to perform these interviews in person, not only to obtain the most complete answers to questions, but also to allow for the observation and documentation of materials collections in situ within the office environment. Recorded interviews were transcribed and are in the process of being comprehensively coded using qualitative research methods to identify common themes and specific examples. A number of initial findings–both general ones that inform the framework of the research itself and specific ones that help clarify assumptions and direct future work–are outlined in the following sections. The general will be discussed first, followed by the specific.

General Findings

General findings include the following: (1) neither the unique model of architecture education nor the more "artistic" elements of practice are clear to those outside the discipline; (2) the lack of codified research practices and the challenge of each project being seen as a prototype are indications of a discipline historically lacking a rigorous research ethic; and finally, (3) the term "research" is often used differently by architects and librarians, and thus needs to be clearly defined throughout this study. In compiling the findings of this initial research, it is necessarily to first take a step back and clarify broader issues before outlining specific findings.

Architecture Education's Legacy

In his description of the curriculum for the first architecture program in the country, MIT's founding director, William R. Ware, mentions two fundamental and unique challenges for formalized architectural studies that can be argued have not yet been reconciled to this day: that architecture education cannot, by the nature of the discipline, cover the entire body of knowledge that students will need in order to practice, leaving "much of the ordinary detail of work" to be learned in architecture offices; and that the structural shift to a formalized model of higher education for architects continued the apprenticeship model's less formal methodologies of conveying information based on personal experience.[5]

Rather than seen as a continuum, the acquisition of knowledge in school versus the application of it in practice was seen as bifurcated by all of the practitioners interviewed as part of our study when asked how they learned to conduct research and select materials for buildings. Practitioners' constant refrain was the common "nothing they were taught in school prepared them for the realities of practice." While all agreed that materials and methods were covered in the core curriculum of their own education, their ability to conduct material research and selection in practice required a far different skill set – one that often had to be learned on the fly in practice. Said one senior practitioner with 40 years of experience, "We don't focus enough on [technical when compared to design] in school. I mean, it's not that you can teach students everything about how buildings go together and all of the issues that you need to deal with as an architect, but certainly we can do much better at providing a foundation of understanding of these things. Materials research and understanding all the issues -- the code issues, the chemical issues, just understanding the basics about flame spread -- all these things. [When] you get out of school, you don't have any of this, so you're starting from ground zero. Unless you are lucky enough to have a good mentor or be in an office that understands

the importance of mentoring and training young professionals on your own, it's a long road to figure it all out." Statements like this and many others also identified the internship phase as an important and previously overlooked component of the education process that will be added as part of future iterations of this study.

The "legacy teaching approach" in architecture studios reinforces the "rich legacy of principles and personalities that creates a common bond among veterans and novices alike"[6] and at the same time contributes to an insular culture that results in the profession struggling to communicate its value to those who have not experienced it. For this, the outside perspective of social scientists like Donald Schön and Ernest Boyer is helpful in describing the unique nature of architecture as an applied art.

Schön, a philosopher and urban planning professor at MIT, identified architecture education as occupying the "messy middle ground" between intuitive art processes and rational scientific ones. He stated: "I have become convinced that architectural designing is a prototype of the kind of artistry that other professionals need most to acquire; and the design studio, with its characteristic pattern of learning by doing and coaching, exemplifies the predicaments inherent in any reflective practicum and the conditions and processes essential to its success."[7] He equates learning the complex functions required to practice architecture to learning how to walk, speak, or ride a bike: one learns these skills by doing them, often with the aid of coaching. Once learned, a person may be able to perform such a skill–often at a level of mastery–but may not be able to explicitly verbalize how or why they are doing so.[8]

This does not mean that implicit knowledge cannot be taught; by observing and reflecting on the actions required to perform a task, Schön states that is possible to describe the tacit knowing implied within them. These descriptions need to be tested against the original actions and adjusted to the point where there is clear communication between parties. He goes on to differentiate design from other disciplines: "Designing in its broader sense involves complexity and synthesis. In contrast to analysts or critics, designers put things together and bring new things into being, dealing in the process with many variables and constraints, some initially knows and some discovered through designing. Almost always, designers' moves have consequences other than those intended for them. Designers juggle variables, reconcile conflicting values, and maneuver around constraints–a process in which, although some design products may be superior to others, there are no unique right answers."[9] Making this process explicit to those outside the discipline enables better collaboration on topics such as supporting the education of architecture students.

"Closing the Loop" on Architectural Research Practices

Design thinking is an iterative and syncretic practice, a way of operating within complex frameworks that translate across scales and responds to changing technological, cultural, social, and material conditions. Though it doesn't readily comply with more traditional research practices, many would argue that the design process is also a process of experimenting. However, the experimenting is often limited to establishing the parameters and doing the work with very little if any time spent on reflecting on the outcomes or comparing them against the intended goals to inform future direction.

Stephen Kieran identifies the need for architecture education to approach the research process more like products rather than one-off prototypes: "Architects tend to see most acts of design as unique. Site and program together give rise to circumstance. Circumstance inspires intention. Design organizes intention into instruction. Builders construct from what we instruct. And we all move on to the next set of circumstances and program, none the wiser. Architecture exists in a world where all we ever do is design and build prototypes, with little real reflection and informed improvement from act of design to the

next."[10] Kieran describes the role of research as essential in architecture with the relationship between the two–architecture and research–as being divergent but complimentary.[11] Others argue against integrating the two and instead support the development of a "discipline-dependent scholarship" and that design itself is research.[12]

Defining Research as a Design Strategy

For librarians, research means a rigorous, systematic approach to investigation where hypotheses are developed, variables are identified and interrogated using a variety of research methods, and results are documented and compared to initial assumptions in order to validate or refute the hypothesis and direct future iterations. Architects, on the other hand, often conflate the overall research process with the methods used to conduct the research itself -- case studies, hands on experimentation, precedent analysis, etc. The lack of clarity within the discipline about the distinction between the two and their relative value is an ongoing debate.[13]

A fundamental distinction is in the type of problem being solved in architecture and design practices, which does not readily lend itself to isolating variables. Schön outlines the difference between "manageable problems" that lend themselves to solution through the application of research-based theory and technique and "confusing" or some might say "wicked problems" that defy a technical approach.[14] While linear processes can be defined to address problems that have clearly defined conditions, designers operate within indeterminate conditions, which often necessitates different approaches to both defining and then addressing the problem. "Design problems are 'indeterminate' and 'wicked' because design has no special subject matter of its own apart from what a designer conceives it to be. The subject matter of design is potentially universal in scope, because design thinking may be applied to any area of human experience."[15] For the purposes of this research study, the authors ascribe to Groat and Wang's definition of research as inclusive of "works of inquiry occurring across a range of disciplines (sciences, social sciences, the humanities) and professional fields."[16]

Research Findings

Three findings specific to the research on material research and selection include: (1) the need for more dialog among all parties seeking to support learning on this topic among studio and technical courses, architecture faculty and librarians, academics and practitioners, etc., especially where tools and resources are needed to conduct the work, (2) the need for architecture educators to collaboratively develop practicum for a reflective material research and selection process, including supporting tools and resources, to be addressed in school, and (3) the need for students, faculty, and practitioners to develop reflective communication skills in order to make explicit the oftentimes implicit aspects of practice.

The Need for More Communication among Stakeholders

Knowledge and application of materials and assemblies is clearly outlined in all aspects of architecture education, internship, licensure, and practice as a fundamental skill required to demonstrate competency. Students learn to intuitively choose materials in their studio projects to fulfill self-defined objectives regarding tectonics and materiality, but they do not often do so as part of a rigorous exploratory or investigative process. Materials and methods are taught in schools, with many courses incorporating hands on projects and visits to manufacturing plants and job sites. This approach provides an overall understanding of material properties by category (masonry, steel, wood, etc) and often is accompanied by hands on experiments with a material and/or projects that give students a more experiential understanding of how materials can be used. What is not taught as explicitly or rigorously is how to select materials for a project, particularly when using non-traditional materials or using traditional materials in non-traditional

ways, based on not only visual criteria but also performative requirements.

A senior specification writer at one leading firm expressed his frustration with passing along his decades of expertise to the next generation. He explained that a junior architect working on a drawing set may specify a material based on aesthetic characteristics that needs to be modified in the specifications based on performance characteristics. Because there is no specific mechanism for feedback within his firm, the junior architect often isn't aware that such a change was made or doesn't know why it was made. The spec writer doesn't expect students to be able to learn the nuanced nature of material selection in school but also finds it challenging to contribute to their continued education in practice.

Interviews such as this as well as past research point to the need for dialog among all parties seeking to support learning in the area of material research and selection, especially where tools and resources are needed. This includes communication among studio and technical courses; faculty and librarians; academic and industry partners in order to understand the different types of tools needed and how best to align these with the intended learning outcomes. The collateral organizations do this internal to the profession through the development of NAAB's Conditions for Accreditation and the Architecture Experience Program and Architecture Registration Exams, which are informed by NCARB's Survey of Practice. However robust, these tools don't approximate the collaborative nature of practice, in which specification writers, material vendors, manufacturers, engineers, and others are an integral part of the process.

Many programs bring outside experts into the studio to work with students in a consultancy model, and many multi-disciplinary projects have been conducted that partner architecture students with those in other disciplines. The findings of our surveys indicate the need to extend this model into the curriculum development process by including not just academics, students, and practitioners but also the stakeholders mentioned above to holistically map the process across education, internship, licensure, and practice toward a more rigorous and innovative approach.

The Need for a Research-Based Practicum

While academia cannot–and should not–replicate practice, the model of a practicum allows students the opportunity to practice the skillsets that are being learned within an approximated context. Schön describes the process as follows: "Beginning with situations that are at least in part uncertain, ill defined, complex, and incoherent...designers construct and impose a coherence of their own. Subsequently they discover consequences and implications of their constructions–some unintended–which they appreciate and evaluate. Analysis and criticism play critical roles within their larger process. Their designing is a web of projected moves and discovered consequences and implications, sometimes leading to reconstruction of the initial coherence–a reflective conversation of the materials of a situation."[17] Tools and resources that support the investigation process need to also be developed, including in particular research methods.

One of the fundamental issues addressed through this research was how to better support the use of material libraries within architecture curricula. Through the interview process, the researchers discovered that while material collections developed in libraries and firms may look similar, they are used very differently in practice than in academic settings. From librarians' perspective, material collections are ideally used for discovery and supporting exploratory research practices. Material libraries in firms, however, are very rarely used for these purposes instead serving to aggregate physical samples in order to communicate design intent to clients. While all practitioners interviewed indicated the need for tools to help better select materials, it does not appear that a material library is the best place to do this. Rather, initial feedback was that a standardized format for materials

themselves would be helpful in more broadly searching by aesthetic, performative, and cost qualities rather than by vendor collection or past experience.

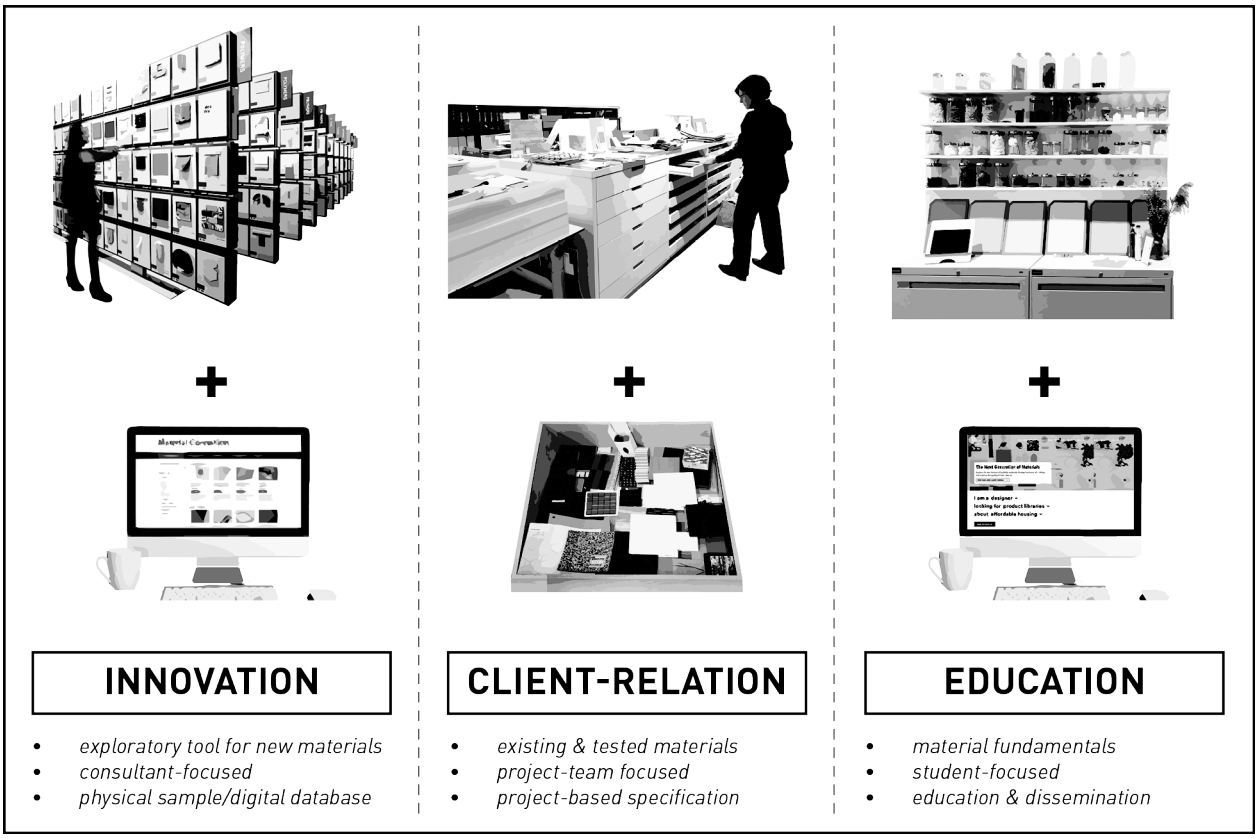

Fig. 2. Material Library Typologies

For new materials or materials that would be used for the first time in a firm, case studies and post-occupancy reports on how materials perform in application would be desired. Few firms interviewed had a formalized process for documenting material choices or following up on their success or failure beyond client presentation documents and submittals. One exception was a New York City-based firm where the librarian who manages the material collection and supports designers in the research and selection process documents each major project and observations about material performance in a series of binders for future reference.

In academic settings, having access to materials primarily for their qualitative characteristics or for preparing client boards is not a worthwhile objective for libraries when considering the cost, staffing, and space required to build and maintain a material collection. Instead, material collections are intended to serve as an educational tool that helps students understand materials at a more fundamental level and develop research skills–objectives that also align with the NAAB standards. The challenge for librarians then is to create a library that is useful for learning and research and provides hands on access to materials without duplicating the firm model. The library should have specific objectives (i.e. whether to focus on existing or innovative materials) that align with the needs of the academic program being supported.

One example of a collection that achieves this goal is the Healthy Materials Lab at Parsons, which is a living lab that collects and codifies information and examples of healthy materials. The lab houses not only products that meet the requirements of different rating systems such as LEED and Best, but it also has examples of the chemicals and materials that are used to create the products, giving students a holistic understanding of a material's lifecycle. This model is a good example of a material collection focused on supporting specific sustainability objectives within the academic program. Along with this focus on the full lifecycle of a material, other qualities that have been identified to supplement the current Material ConneXion collection of more innovative and emerging materials are basic architectural materials (glass, metal, wood, stone) as well as a series of "disposable" materials that can be used by students for personal experimentation and play.

Lastly, initial findings indicate that collections are best utilized–both in practice and academia–when managed by someone who is knowledgeable about both materials in application and collection management, indicating someone with a background in both design and library science as an ideal candidate. On the library side, this person should have a close relationship with faculty and students who are going to be using the collection; have a strategy for organizing, building, and weeding the collection; and most importantly devote a significant amount of time to cultivating relationships with manufacturers and material scientists so they can best direct designers who come to them with questions.

The Need for Reflective Communication Skills

As the discipline moves toward a more connected position within society, architecture, "by nature and tradition, holds vast potential as a model for integration and application of learning, largely because of its most distinctive feature—the design studio."[18] The design studio is central in architecture education as the site where each student's creative abilities and professional interests are fostered through the development of a strong connection with their studio professor and peers. During the exploration of increasingly complex architectural projects in studio courses, students work to holistically address program requirements, develop an artistic vision, and resolve technical issues within a broader social, environmental, and cultural context, aided by regular feedback. Education models like guided design, reflective practice, and active learning define the studio-based model. By providing transparency to educational practices and language to intuitive processes, design practice and design education can be demystified and strengthened.

Such an intervention may be especially useful during the internship stage where students or recent graduates are first asked to apply their skills in professional settings. Many practitioners interviewed described feeling like they were "thrown into the deep end" and had to figure out on their own how to accomplish prescribed tasks. They also indicated that much of a junior architect's success in this area was left to chance with regard to whether or not they worked under a project manager or had a mentor who was willing to teach them what they needed to know. While there may still be much a junior architect needs to learn when entering practice that can't be taught in school, they can learn how to ask the right questions and advocate to make sure they are getting the support and experiences needed to learn these skills.

Conclusions and Next Steps

This exploratory study has demonstrated the need for additional, targeted research in architecture and design schools. A more thorough understanding of how material research and selection is taught, what resources are provided to faculty and students, and how well prepared students feel is the next priority. Therefore, a survey for students, faculty, and support staff will be developed and distributed to address these issues. These data will help to inform recommendations for curriculum and supporting materials, including material collections.

Several interviewees expressed a desire to see a tool created to simplify the materials research process. One that would allow a user to input functional requirements as well as more extrinsic material qualities like aesthetics and sustainability ratings. The hypothetical tool would then list the materials and manufacturers that matched the specific query. This is an area being heavily scrutinized by businesses across the discipline, and will therefore not be a continued line of research from this study.

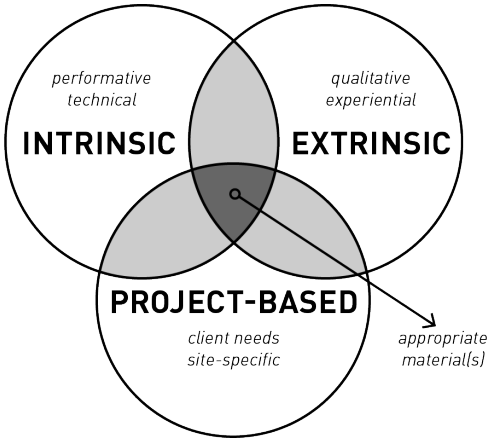

Fig. 3. Material Selection Framework

Architects are trained to think differently than most other professionals; they engage in reflective practice, which is an iterative, probing exploration of a complex project. As the architect works through design ideas, the project "talks back," according to Schön. This process takes on a reflective conversation between the architect and the situation by re-framing the problem to address local and global issues. The designer uses tools unique to his or her profession during this process: a "metalanguage" that combines drawing and talking, an examination of the impact of choices on an interconnected system of variables, and a shifting stance toward the design that allows unbiased examination of various alternatives. This process is unique, in its ability to question "the problem of the problem" through an "inquiry in action" approach. Though architects are intuitively reflective in their process, they are not reflective about their reflectiveness.[19]

Stephen Kieran emphasizes the importance of reconciling research and practice for architects: "Research brings science to our art. Responses to place and program provide intuition to guide form. Research provides information and insight that enhances the performance of our intuitions. Architecture education rightly focuses on developing design intuition. To move the art of architecture forward, however, we need to supplement intuition with science. Research skills need to be brought to the center of the architectural curriculum, providing the basis for a cycle of continuous reflection, learning, and improvement. We need a deep research ethic to guide the art of intuition."[20] By understanding the context in which faculty and supporting stakeholders like librarians are operating within, developments in fulfilling educational and practice-based objectives related to material research and selection can be thoughtfully addressed. This initial research study has confirmed the need for more work in this area discipline-wide and indicated several future research pathways in which to do so.

Notes or References:

1 "Material" in this paper refers to the external cladding material(s) that define a building's tectonic expression and primary enclosure.

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