Integrating Material Selection and Specification Writing into Architecture Education and Practice

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Abstract

The launch of the Construction Specification Institute (CSI) in 1948 established a codified relationship between materials and architecture in the United States through standardized divisions for specification writing. These divisions, including frameworks such as CSI MasterFormat and UniFormat, developed to aid architects in organizing material and technological systems in building projects. Over time, these standards evolved, with the expansion of MasterFormat from sixteen to fifty divisions in 2000 and further signaling a shift in both technological advancements and the specifier's role. Between 2010 and 2020, over two thousand revisions to MasterFormat divisions highlighted the growing complexity of building systems, particularly in the fields of mechanical, electrical, and sustainable technologies—domains where architects often lack full decision-making authority but are adjacent to critical decisions.

Despite these changes, architectural education largely maintains a separation between material selection, addressed in studio or building technology courses, and specification writing, typically confined to professional practice curricula. This disconnect prevents students from understanding how material selection directly informs specification decisions. This paper analyzes the evolution of specification practices and their relationship with technological advancements and sustainability pressures, focusing on the shifts within the CSI MasterFormat. By highlighting the increasing complexity of specification formats, it argues for integrating material selection with specification writing within architectural education to better prepare students for contemporary practice. From this analysis, the paper offers curricular strategies to bridge the gap between material selection and specification writing, suggesting a more holistic approach that considers the evolving role of the specifier in addressing the growing demands of sustainability and technological innovation in construction.

Keywords

Construction Specifications, MasterFormat, Architectural Education, Material Selection.

Introduction

Since its inception in 1948, the Construction Specification Institute (CSI) has standardized the relationship between materials and architecture in the United States through regulated divisions and methods for writing specifications. This codification emerged from a century-long evolution of professional practice standards and patterns, defining how raw resources become building materials and assemblies for integration into a building site. Architecture education has largely adhered to these standards, treating specification writing as part of the architect's professional skills alongside drawing and modeling through technical documentation. However, the gap between material selection and specification writing is much narrower in professional practice than in architecture education. In practice, material selection is tied to available products and components provided by manufacturers, while specification writing addresses legal requirements, regulations, and certifications though manufacturers' specifications or equivalents. In architecture education, this complexity has led to an intentional separation: material selection is often explored through design thinking in the studio sequence or evaluated in building technology classes, while specification writing is often relegated to the professional practice sequence as a contractual and legal component.

Beyond the gap between professional practice and education, certain technological adaptations and norms indicate an increasing complexity in building construction, primarily within the realm of mechanical, electrical, and sustainable systems—areas in which architects do not have full decision-making capabilities but are adjacent to them. From 2000 to present, changes to the CSI MasterFormat reflect this complexity through the complete overhaul of the specification formatting framework. This overhaul has largely flown under the radar to architecture students who spend more time practicing broad material selection than specification writing. How, then, may architectural educators better connect material selection to specification writing in order to better articulate the architect's role?

This paper explores the historical evolution of specification writing and its relationship with education standards in the United States, emphasizing their institutionalization through standardization and technological integration. It analyzes the growing complexity of specification writing and material selection, driven by technological and sustainable demands, as reflected in the changes to the MasterFormat since 2000. Finally, it examines the disconnect between evolving professional practices and their inconsistent inclusion in architectural education, advocating for a more integrated approach to prepare students for the complexities of contemporary practice. By examining these shifts, the paper proposes strategies to bridge the gap between material selection and specification writing in architecture education, offering insights to better align educational practices with the realities of professional work.

Emergence of Specification & Education Standards

Origins of Specification Writing in the United States

To understand the present version of specification formats in the United States (U.S.), it is important to discuss their origin. Specification writing in the U.S. traces to practices adopted from England during the mid-eighteenth century. Like other architectural and construction practices during this time, the responsibilities and roles on building sites changed. In England, for example, the direct supervision of the construction had shifted from the architect to the contractor.[1] Because contractors issued oral directives, written directives allowed architects to conduct work remotely without defining the means and methods for construction. Most architects in England and the U.S. borrowed original specification formats from English patent directives used to supplement drawings. Newly industrialized tools and equipment needed writing to instruct operation. As Michael Osman indicates in *Specifying: The Generality of Clerical Labor*, written directives were carried into patent law in the U.S. starting in the 1790's. In the lumber and timber industry, for example, new machines powered by steam required explanation through writing rather than drawing—specification writing subsequently swept through the manufacturing industry.[2] Under industrial, architectural production, specifications allowed control over the operation of equipment or the construction site in the absence of oral directives.

As the U.S. took control of new material territories during the nineteenth century, specification writing supported the development of newly settled building sites and continuous nation-state building. By the mid-nineteenth century, the U.S. architecture and construction community launched a radical restructuring of agreements through organizations that governed the social, economic and labor conditions of building sites. The founding of the American Institute of Architects in 1857 led to architectural professionalization in the US through the spread of uniform instruments of practice.[3] As industrialization advanced, enabling new methods of material extraction and production, specification writing emerged as a key tool for connecting the expansion of newly formed U.S. territories to the extraction of raw materials. It also allowed architects in established cities like New York and the Mid-Atlantic to specify work remotely by using drawings and contract documents to control material selection and manage building sites from a distance.

Standards for Specification Writing

The establishment of the Construction Specifications Institute (CSI) in 1948 reflected U.S. industrialization and expansion. Launched by a group of federal government specification writers and trade association member, early goals of the institute included a forum for individuals to exchange information about specification writing.[4] The CSI identified a critical gap in the transfer of knowledge surrounding material successes and failures among architects. To address this, they established a set of internationally recognized standards and launched *Construction Specifier*, a publication allowing spokesmen and specification writers the opportunity to put forth their knowledgeable views on specification writing.

In April 1963, after several years of gathering and analyzing information, the CSI introduced MasterFormat. This new standard organized specification writing by categorizing the trades into sixteen major divisions, each containing corresponding technical sections. These divisions further correlated to the extensive use of advancing materials, like steel, in post-World War II construction and the increasing complexity of buildings, which now included electrical and mechanical systems. With this shift, the specifier's role evolved to systematically organize construction sequences according to a standardized taxonomy.

Standards for Architecture Education

Alongside the standardization of specification writing was the introduction of professional criteria for architecture education. After World War II, architecture education and practice increasingly standardized into a body of professional knowledge by combining scientific principles and business practices. Regulation, economics, and management emerged as grounding principles in Professional Practice, a foundation further solidified through accreditation guidelines. The establishment of the National Architectural Accrediting Board (NAAB) in 1939 stemmed from the combined efforts of the National Council of Architectural Registration (NCARB), the American Institute of Architects (AIA), and the ACSA (Association of Collegiate Schools of Architecture) to create uniform objectives for architectural students. The intentions of these institutions supported the production of professional, licensed architects who could safeguard the health, safety, and welfare of the general public. The role of the profession to provide internship training influenced the perceived role of professional practice in architectural education. Educators questioned whether Professional Practice courses should initiate training through technological and economic standards versus an education in the social and political dimension over the potential of combined theory and practice objectives. Either way, homogeneity amplified across typical Professional Practice courses as the NAAB student performance criteria expanded and increased across U.S. architecture education.[5]

Professional Practice Standards

Institutions such as the AIA, CSI, and NAAB continued to establish practice standards for both the architectural profession and education. Regarding material selection, practices shifted from direct extraction near the building site to the specification of industrialized materials, distributed by a manufacturer. Beginning in the twentieth century, this meant architects could "shop" for materials needed for a project.[6] In the timber industry, for example, early specifications named the timber according to the genus and species-based classifications of natural history. As timber and wood became engineered into plywood, for example, the possibility of naming materials by species was impossible. Manufactured products offered different properties. As Katie Lloyd Thomas writes, "A material's defining characteristic may be nothing to do with what it is made out of, but rather, as is the case of insulation, to do with its use in the building."[7] This proprietary specification, which emerged in Britain during the interwar period and later became pervasive, allowed for the practice of specifying according to manufacture or product name.

Following these shifts, the CSI introduced several key initiatives to standardize and streamline the specifying process. In 1965, they released Spec-Data, the Uniform System, and established the Technical Review Board. Spec-Data standardized manufacturers' literature on their products through a uniform document and allowed specifiers to more easily assess and evaluate a manufacturer's product. This pivoted specification writing from a craft-focused discipline to one centered on product viability. The Uniform System, which was established by the CSI in cooperation with the American Institute of Architects (AIA) and the Association of General Contractors (AGC), established a standard matrix for specifications, manufacturers' literature, and contractors' estimates to be compared and cross-referenced. The Technical Review Board of the CSI ensured these standard documents were implemented by participants in the construction industry.[8] By the end of the decade and into the second half of the twentieth century, these institutions, formats, and standards achieved universal acceptance by both private and public agencies in architecture and in education.

CSI Masterformat Sixteen Divisions

Division 01 — General Requirement
Division 02 — Site Works
Division 03 — Concrete
Division 04 — Masonry
Division 05 — Metals
Division 06 — Wood and Plastics
Division 07 — Thermal and Moisture Protection
Division 08 — Doors and Windows
Division 09 — Finishes
Division 10 — Specialties
Division 11 — Equipment
Division 12 — Furnishings
Division 13 — Special Construction
Division 14 — Conveying Systems
Division 15 — Mechanical/Plumbing
Division 16 — Electrical

Fig. 1. CSI original MasterFormat Divisions.

Shifting Patterns in Specification Writing & Material Selection

MasterFormat Divisions Expansion

In 2000, the CSI underwent a thorough expansion of MasterFormat divisions from sixteen (See Fig. 1.). to fifty, reflecting technological shifts and twenty-first century changes in the role of material selection. To fulfill these new divisions, a total of two-thousand, two-hundred and twenty (2,220) instances of titles and numbers within groups and subgroups were added, revised, and/or deleted from MasterFormat from 2010 to 2020. Most shifts primarily occurred within the realm of mechanical, electrical, and sustainable systems, areas in which architects work adjacently to other consultants. Beyond certain technological adaptations, these patterns indicate an increasing complexity in standards for building construction.

For this study, the MasterFormat 2020 edition[9], along with CSI's published resources[10], was used as a foundation for analyzing specification patterns since 2010. Specifications were categorized according to the total quantity of activity they experienced (summing the number of "addition," "revision," or "deletion" specifications) over the period from 2010 to 2020, considering 2010, 2011, 2012, 2014, 2018, and 2020 as the edition years. (See Fig. 2.) From this analysis, 2014 emerged as a year with major activity: 667 new specifications and divisions were added; 295 revisions; and there were 75 deletions. This accounts for 46.7% of all the activity between 2010 and 2020, indicating a comprehensive overhaul of the specification framework.

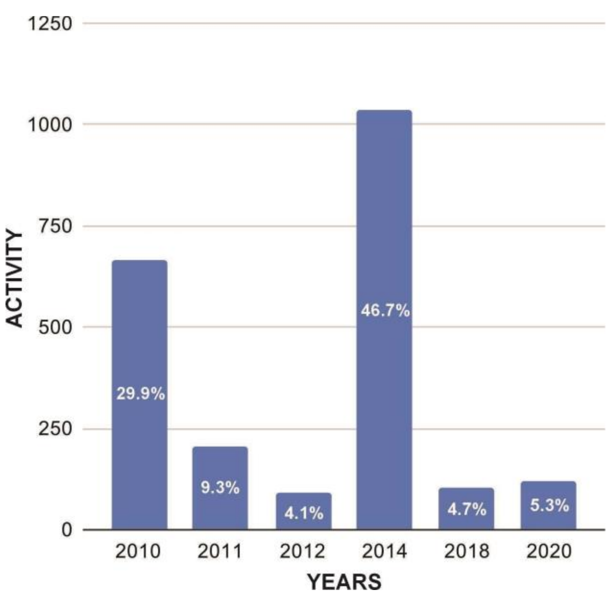

Fig. 2. Quantification of Specification Activities over the years.

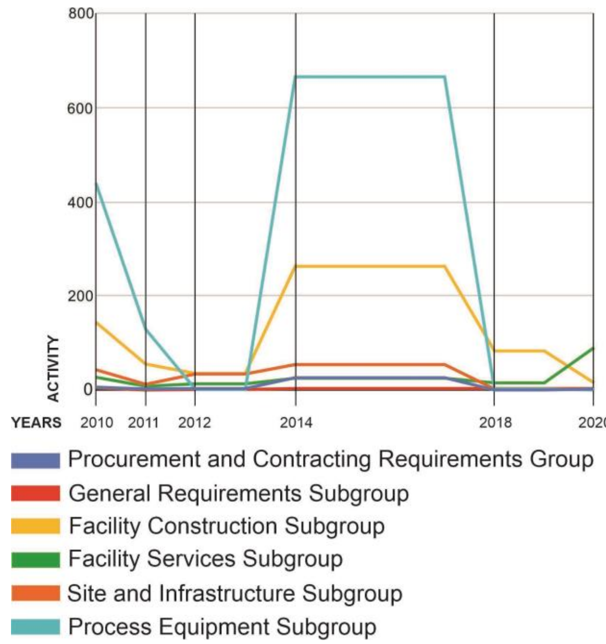

Fig. 3. Quantification of Specification Activities by Subgroups.

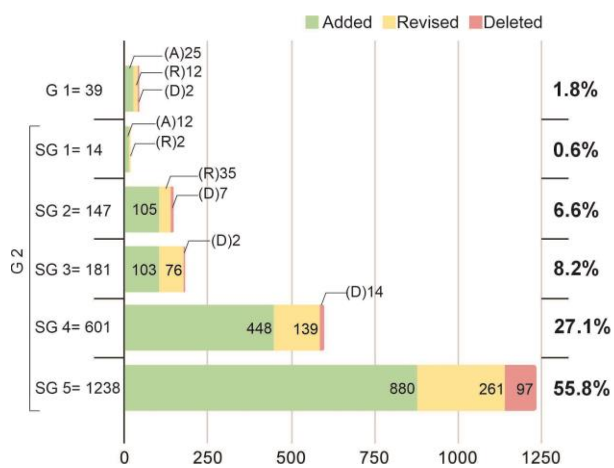

Fig. 4. From 2010 to 2020, a total of 2,220 specifications were added, revised, or deleted in MasterFormat, spanning groups and subgroups. (A) Added, (R) Revised, (D) Deleted; G 1: Procurement and Contracting Requirements Group, G 2: Specifications Group; SG 1: General Requirements, SG 2: Site and Infrastructure, SG 3: Facility Services, SG 4: Facility Construction, SG 5: Process Equipment.

Additionally, activity within divisions across subgroups was quantified. Across all subgroups, those with the highest levels of activity were Facility Construction and Process Equipment (See Fig. 3.). The Facility Construction subgroup encompasses construction trades, materials, and methods, holding the original sixteen divisions defined by trade-based material selection. With six hundred and one (601) specifications added, revised, and deleted, it occupies 27.1% of the total activity over the years. The divisions within this subgroup include Existing Conditions, Concrete, Masonry, Metals, Wood, Plastics and Composites, Thermal and Moisture Protection, Openings, Finishes, Specialties, Equipment, Furnishings, Special Construction, and Conveying Equipment. Specifications within these divisions cover a wide array of materials, including glass fiber, organic fiber, carbon fiber, wood, concrete, steel, masonry, resin, fiberglass, PVC, aluminum, metal, fabric, brick, stone, asphalt, galvanized steel, plastic, and ceramic. Notably, many “natural” materials have been supplanted by manufactured alternatives, reflecting technological advancements and evolving industry practices.

Process Equipment Subgroup

Activity in the area of Process Equipment comprised most of the shifts (See Fig. 4). This subgroup outlines specifications for equipment and systems designed to handle, process, and manage materials, fluids, gases, and energy within industrial and commercial facilities. With one-thousand, two-hundred, thirty-eight (1,238) specifications added, revised, and deleted, it occupies 55.8% of the total activity over the years.

These findings reveal two significant trends in specification practices. First, there is a marked expansion of material options beyond traditional choices such as wood and brick, with a growing emphasis on engineered materials like fiberglass and PVC. This shift underscores the evolving nature of construction materials, driven by technological advancements and changing industry demands. Second, as building construction and systems become more complex, an increasing focus on equipment supports sustainable practices, reflecting substantial shifts in categories related to renewable energy technologies, advanced water management, and overall energy performance.

Changes in specification formats also signal an evolution in the architect's role. Architects are now tasked with managing the integration of process equipment, including Process Interconnections, Process Gas and Liquid Handling and Storage Equipment, Water and Wastewater Equipment, and Pollution and Waste Control Equipment. These divisions, which have seen the highest levels of activity within this subgroup over the years (See Fig. 5.), illustrate the growing importance of process equipment in architectural practice and the increasing complexity of material selection.

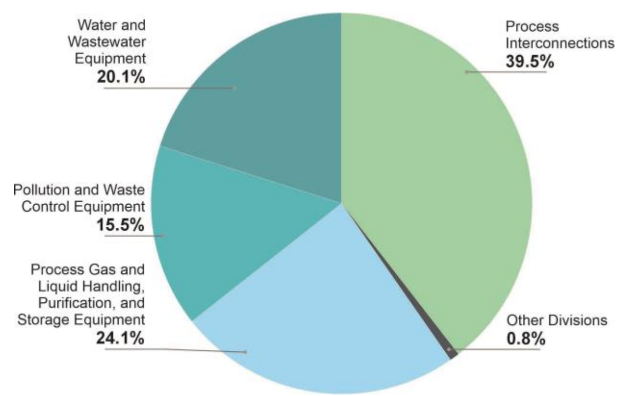

Fig. 5. Activity in Divisions within “Process Equipment” Subgroup (2010-2020). The 100% represents a total of one thousand two hundred thirty-eight (1,238) instances of additions, revisions, and deletions in the subgroup during this period.

Ultimately, these categorial shifts reflect both technical and social factors that impact specification writing. As construction and architectural design becomes more concerned with sustainable practices and performance, patterns in specification standards are adapting to accommodate. As the role of the specifier expands, particularly from materials and processes toward equipment focused environmental systems, specifiers must navigate increasingly complex sustainability and energy efficiency requirements.

Specification Writing & Material Selection in Architecture Education and Practice

The findings from the analysis above indicates a critical shift in twenty-first century specification writing practices alongside emerging options for material selection. As the role of the specifier expands, to include more equipment focused environmental systems, specifiers and future specifiers are tasked with navigating increasingly complex sustainability and energy efficiency requirements across multiple disciplines and industries. To address this, representational tools such as Building Information Modeling (BIM) have already begun to support collaboration and coordination. In addition, certifications such as the Leadership in Energy and Environmental Design (LEED) have encouraged sustainability goals. In architecture education, the question of when, where, and if these instruments and practices should be introduced to architecture students remains a point of debate among educators. Still, the separation between specification writing and material selection in architecture education is vast. Although professional specification writing formats and material selection standards changed significantly in the twenty-first century, education standards for addressing these practices have not.

National Architectural Accrediting Board (NAAB) Conditions for Accreditation offer some insight into these patterns. Since 2000, NAAB has issued four versions of its Conditions for Accreditation with the aim to prepare architecture students for professional licensure through B.Arch and M.Arch programs. As part of their conditions, NAAB has and continues to establish various realms and performance criteria for programs and students by defining areas of “Understanding” and areas of “Ability”. “Understanding—means the assimilation and comprehension of information without necessarily being able to see its full implication, whereas “Ability—means the skill in using specific information to accomplish a task, in correctly selecting the appropriate information, and in applying it to the solution of a specific problem.”[11] These these standard definitions for accreditation are consistent across various releases of the Conditions. The realms and student performance criteria, on the other hand, oscillate especially for specification writing. For comparison, all students who receive a professional education must demonstrate an understanding of “Building Materials and Assemblies” through met criteria. From 2004 to 2020, this criteria changed very little. In 2004, the criteria expanded to a category under Realm B in 2009 and 2014. Realm B addresses technical skills and knowledge as well as integrated building practices. Throughout these subtle changes, understanding is required, meaning these criteria may be demonstrated through an examination in a building technology course.

Specification Writing, on the other hand, continues to move among several criteria or in some versions, disappears completely. In the 2004 Conditions, the ability to “outline specifications” was included under “Technical Documentation” alongside technically precise drawings.[12] In 2009, “Technical Documentation” was moved to Realm A, which addresses “Critical Thinking and Representation”. Specification writing was removed altogether from the Conditions. For education, this was a radical shift. While “technically clear drawings” remained as a demonstrated ability, the removal of specifications divorced the criteria from specification writing practices. The 2014 Conditions reintroduced specification writing, this time into Realm B under “Technical Documentation” as an ability "to prepare outline specifications".[13] Yet again, NAAB removed any mention of specification writing or preparation in their most recent release of the 2020 Conditions.

Understanding building materials and assemblies is consistent across accreditation standards in the twenty-first century. The inclusion of specification writing and formatting oscillates significantly. This inconsistency not only demonstrates various interests for where specification writing should be included in architecture education, but also questions IF educators support specification writing as a necessary skill for professional education. This paper argues that specification writing and formatting, as an ability, is necessary to reflect the changing patterns and options for material selection. The question then, is how may architecture educators better connect material selection to specification writing in architectural pedagogy and curriculum.

Curricular Opportunities

Integrating Specification Writing and Material Selection

Key findings highlight significant shifts in specification writing and material selection within the U.S. architectural profession from the nineteenth to the twenty-first century. However, these changes are often excluded from the curricula of U.S. architectural education, revealing a disconnect between professional practice and academic training. The historical evolution of specification practices highlights the increasing complexity of building construction. In the nineteenth century, architects began using written directives to manage building sites remotely, a practice that laid the groundwork for the standardization of material and manufacturing categories in the twentieth century. Analysis of twenty-first-century format changes reveals a radical transformation in the profession, as material selection has expanded to encompass equipment selection. The integration of electrical, mechanical, and sustainable categories in 2014—through additions, revisions, and deletions—demonstrates this shift. It underscores the growing role of architects in coordinating these systems and their interconnected components through precise written directives, reflecting the profession's adaptation to contemporary demands for sustainability and technological complexity. Finally, acknowledgement of shifting practices is less emphasized in architectural education, especially professional tracks, which continually sway between inclusion and exclusion of specification writing as an ability to demonstrate competency.

However, there are several opportunities to close the gap between material selection and specification writing in architecture education, especially through instruments of practice and curricular shifts. Instruments such as BIM, sustainability certifications such as LEED, and now Artificial Intelligence (AI) allow for coordination and collaboration across various stakeholders and disciplines. Simulating these strengths of the tools in education is more challenging. Many educators not only question where these tools should be introduced in the trajectory of architecture education, but also whether they should be introduced to students at all. This likely stems from concerns surrounding the automation and the subsequent elimination of critical thinking. Architectural education should be the place where we confront these instruments and critically engage them, especially for specification writing and material selection. How then, may architecture education critically engage tools that support the connection between material selection and collaboration?

Professional Practice

To address this question, it is important to examine the courses within a typical architecture curriculum that include specification writing and material selection. Specification writing is often covered in professional practice courses or, at times, in building technology courses. Material selection, on the other hand, is typically explored in building technology courses and within the studio context (e.g., Integrated Studio requirements or Comprehensive Design). As adjacent courses, these may serve as platforms for assessing student performance criteria required for NAAB accreditation. The potential of these courses is to teach the history of specification writing within historical circumstances in order to contextualize shifts in patterns. The writing of specifications can be mapped through critical thinking exercises and according to past and present methods for specification writing.

Studio

On the other hand, early studios, design thinking, and representation often resist standardization in favor of open, critical thinking. The integration of BIM representation tools and AI in these courses are questionable largely due to the role of automated thinking. Many modeling softwares use mass, planes, etc., while BIM immediately works through components. These components are tied to pre-established specifications provided by manufacturers. AI software, such as those offered by Deltek and similar companies, further promotes the use of AI as an automation tool to streamline the specification writing process. However, educators have expressed resistance, arguing that these tools do not encourage critical thinking and perpetuate a transactional approach to material and product selection.

Cross-sequential

To resist consumption of the tool, educators may cross-coordinate curricular sequences to address concerns. A studio in which material selection is addressed, for example, can be coordinated with a professional practice course that engages specifications for the project. This may include a history and theory course in which the specification is unpacked over time. Ultimately, the cross-coordination and repeated emphasis on materials and specifications within an architecture curriculum may point to positions taken by the school in connection to larger issues of sustainability and environmental justice.

Cross-disciplinary

Regarding cross-disciplinary coordination, this may happen at the scale of the university and professional engagement. A forum, for example, in which architects, interior designers, construction managers, engineers, etc. come together to define how they address material selection and engage specification writing may point to the limits set by the CSI and other institutions. CSI impacts specification writing and now, largely impacts BIM too. Advocacy for collective and conscience decision-making surrounding the extraction of materials and their collective categorization, may be in the future.

Ultimately, specification writing remains a consistent practice in the architectural profession especially as it relates to material selection. Students should, at least, be aware and attempt to practice specification writing in connection with material selection. By linking shifting specification format patterns to the broader architectural educational context, the analysis outlined in this paper supports a framework for integrating specification writing to selection in order to reflect shifting patterns in material decisions.

Notes:

1 Katie Lloyd Thomas and Tilo Amhoff, “Writing Work: Changing Practices of Architectural Specification,” in *The Architecture as Worker, Immaterial Labor, the Creative Class, and the Politics of Design*, ed. Peggy Deamer (New York: Bloomsbury Academic, 2015), 121-143.

2 Michael Osman, "SPECIFYING: The Generality of Clerical Labor," in *Design Technics: Archaeologies of Architectural Practice,* ed. Zeynep Çelik Alexander and John May (Minneapolis: University of Minnesota Press, 2020), 129-162.

3 George Barnett Johnston, *Assembling the Architect: the History and Theory of Professional Practice* (London: Bloomsbury Visual Arts, 2020), 12-14.

4 Harold J. Rosen, *Construction Specifications Writing* (New York: John Wiley & Sons, Inc., 1999), 13.

5 George Barnett Johnston, "Professional Practice: Can Professionalism Be Taught in School," in *Architecture School Three Centuries of Educating Architects in North America*, ed. Joan Ockman, and Rebecca Willamson (Cambridge: The MIT Press, 2012), 370.

6 Katie Lloyd Thomas, "New Sites of Labour," moderated by Pier Vittorio Aureli, virtual lecture, posted December 3 2020, by AA School of Architecture, YouTube, https://www.youtube.com/watch?v=lYWe77Jddms&list=PLI1nDzeohfnmyPJyPSUGI7cBYysAYI2U0&index=5.

7 Katie Lloyd Thomas, *Building Materials: Material Theory and the Architectural Specification* (London: Bloomsbury Publishing, 2021), 58.

8 Harold J. Rosen, "CSI: 25 Years of Evolution," Progressive Architecture v. 54 (July): 108.

9 Construction Specifications Institute, Inc. and Construction Specifications Canada. MasterFormat® 2020: A Master List of Titles and Numbers for the Construction Industry. 2020 ed. Alexandria, VA: Construction Specifications Institute, Inc., 2020.

10 Construction Specification Institute (CSI). "Home." Accessed July 2024. https://www.csiresources.org/home.

11 "3.13 Student Performance Criteria." The National Architectural Accrediting Board, "NAAB Conditions for Accreditation for Professional Degree Programs in Architecture," 2004, 11.

12 "3.13 Student Performance Criteria." The National Architectural Accrediting Board, "NAAB Conditions for Accreditation for Professional Degree Programs in Architecture," 2004, 15.

13 "Part Two (II): Section 1- Student Performance- Educational Realms and Student Performance Criteria." The National Architectural Accrediting Board, "NAAB Conditions for Accreditation for Professional Degree Programs in Architecture," 2014, 17.