ARCHITECTURAL ENGINEERING IN THE CURRICULUM: The Case Study on AE and its Relationship to Architecture

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ABSTRACT

This paper studies the curricular development of an early architectural engineering program in a department of architecture seeking to add to the discourse on the position of technology in architectural education. In 1891 the first known university program for Architectural Engineering was started at the University of Illinois in conjunction with the architecture program. In essence, it is an early example of an intentional specialization of architectural education to focus on the teaching of technology. This program will be used as a case study to investigate its origins and how its creation influenced the teaching of architecture. Was this curricular focus on architecture and engineering in 1891 at the University of Illinois unique or did other architecture programs have architectural engineering components? Did the architecture program at Illinois change once this additional focus was added? Where is architectural engineering today? To begin to answer these questions, this paper will study the relationship between architecture and architectural engineering at the early stages of this program and briefly outline what followed.

KEYWORDS

architectural education, architectural engineering, architectural technology, history

INTRODUCTION

The term ‘architectural engineering’ inherently addresses technology in architecture. The field, it appears, began to come together as a discipline in the United States in the 1890s when universities sought to create curricula with architectural engineering as its focus. The first program was formed in conjunction with a school of architecture. The questions that arose from the discovery of this program will be the focus of this study. Was this curricular focus on architecture and engineering in 1891 at the University of Illinois unique or did other architecture programs have architectural engineering components? Did the architecture program at Illinois change once this additional focus was added? Where is architectural engineering today?

To begin to answer these questions, this paper will study the relationship between architecture and architectural engineering at the early stages of one program, that of the University of Illinois. An overview of architectural engineering in schools of architecture will provide context to this program. In addition, a broad look at AE programs will be used to gauge the tone of architecture’s approach to technology.

RICKER’S PROGRAM

The University of Illinois was chosen for study because it appears to be the original self-identified architectural engineering program; it was created in conjunction with an architectural program; and the ease of access to the records. This university was one of the early architecture programs as well. An examination of the two curricula provides an opportunity to seek answers to questions such as: What was the division between technology classes in the two types of programs? Did this change with the arrival of an architectural engineering curriculum? A
comparison of the two programs can provide insight into both educational areas and their development.

N. Clifford Ricker’s Development
The Illinois Industrial University (later to become the University of Illinois) began an architecture program within the College of Engineering in 1868. This was the second formal architectural program in the United States behind the Massachusetts Institute of Technology in the university system. N. Clifford Ricker enrolled in the program in January 1870 and studied under a Swedish architect, Harald M. Hansen, who himself had studied at the Bauakademie, in Berlin. Through his own personal endeavors, Ricker graduated in March 1873. His was the first architecture degree conferred by a university in the United States. Upon graduation, Ricker was approached by Regent John Milton Gregory to become an instructor in the program. Ricker accepted the appointment with the condition that he was to travel and study in Europe for six months. Upon his return to the campus, Ricker advanced quickly. By 1875, he was a full professor and appointed dean of the College of Engineering in 1878. Ricker was the sole instructor for the School of Architecture for the next decade. He not only taught but revised the curriculum. The architecture program became very much his own.

Ricker found inspiration for his architectural philosophy from the German polytechnical model of the Bauakademie, where he had briefly studied, and the ‘Russian Tool System’ led by Victor Della Vos, which he saw at the 1873 Vienna Exposition. He incorporated these educational models into his curriculum. The German polytechnical model was a common influence in early architectural education that would eventually be replaced by the ubiquitous Beaux Arts pedagogy. Nonetheless, Ricker’s program has been described as ‘practical,’ technical, and meeting the needs of a ‘speculation-based real estate economy.’ Whatever the case, the tone of the adjectives gives an indication that Illinois’ architecture program placed emphasis on understanding building technology. Ricker commented on this perception,

Possibly the aesthetical side of the education of the architect has been less fully developed than the practical and scientific side because it has been my aim to send out graduates who were well grounded in the principles of scientific construction.

An example of this is Ricker’s introduction of graphic statics to the program in 1878, believed to be first in any architecture program. However, Ricker understood the importance of design. As he stated in the same discussion, ‘Correct taste and power of designing form the keystone in the education of the architect…” The structure of the University of Illinois’ architecture curriculum can thus be examined through the multiple emphases of design and technology.

Architecture at Illinois
In the 1871 Annual Circular, the architecture curriculum was described as very similar to the civil engineering program with the addition of “Architectural drawing, the principles and styles of Architecture, the history of Architecture, and plans and estimates for buildings of all kinds.” Hansen’s influence can be seen in the later and more articulated ‘Course of Study.’ The differences between the civil and architectural program started to increase and architectural design was added to the final year of the curriculum. In the 1873-74 academic year, when Ricker began as an instructor, the intent of the program went from training someone for the ‘profession of Architect’ to an elaborated list of three objective points. These goals included ‘knowledge of scientific principles,’ ‘furnishing…an extensive, varied, and thorough course of practice,’ and ‘knowledge of construction.’ Courses that were devised to meet these new intentions included ‘Elements of Construction,’ ‘Heat and Ventilation,’ and ‘Shop Practice’ modeled after the Russian program. In addition, two terms of design courses were added for a total of three.

In a report to the AIA in 1887, Ricker expressed some frustration with the need for economy that required architects to take classes with other units in the college. As he stated, “The technical instruction proper must therefore be arranged with reference to this fact,…” which meant that the courses could not be specialized for the educational needs of the architects. Ricker’s revised architectural course structure, with minor exceptions, remained a combination of mathematics, physics, shop practice, languages,
history-architectural and otherwise, drawing, building construction, and architectural design until the fall of 1893. The multiple goals of architectural, practical, scientific training as well as educating well-rounded intellectuals can be seen in the examination of the list of classes.

The First Architectural Engineering Program
In 1891, N. Clifford Ricker started architectural engineering at the University of Illinois. In the 1890s, one of the primary factors that appeared to be influencing Ricker’s decision to start the program was a significant change in building construction that was occurring with the advent of the skeleton frame in the decade prior. The proximity of the program to Chicago may have also been a contributor to its creation. In any case, it was clear that a new type of construction was going to be incorporated into the field and needed to be learned. Among other things, the architectural engineering program captured this change and its description stated as much. It was “…for those who wish to acquire a thorough knowledge of iron and steel construction as it is now executed in architectural structure.”

The term architectural engineering existed before Ricker’s titling of the curriculum, but it was not found often and no clear definition seemed to be in use. He wrote of the choice of the term and said that it was a natural description of the course of study and work. The careers that could be gained from this education were stated in the course catalogue, “The especial purpose of this course of study is to qualify graduates for the profession of architecture, and particularly as architects, structural draughtsmen, and computers, as well as superintendents of construction.” (Emphasis added.) Ricker was the Dean of the College of Engineering when he created this degree program. He had first-hand knowledge of what civil and other engineers were doing at the time. This program was for architects and it was the engineering needed to create architecture, hence architectural engineering.

What did the original architectural engineering course contain? In 1891, it was very similar to the architectural course at the University of Illinois. It was a four-year program. The first three years were identical with the exception of ‘Hydraulics’ being added to the third year of the architectural engineering students. The base program contained mathematics (Algebra through Integral Calculus), languages, drawing, architectural history, sanitary construction, and construction methods, which included shop work for wood, stone, brick, and metal. Many courses were also similar in the fourth year. Both bodies of students were to take further drawing (architectural perspective), ‘Heating and Ventilation’, ‘Superintendence, Estimates, and Specifications, and design. The architecture students went on to have more drawing/water color classes, modeling, and the ‘Esthetics of Architecture.’ The architectural engineering students added three courses in building structures, “Masonry Construction, Bridge Analysis, and Bridge Design.”

Some observations about the initial program can be made. Keeping to Ricker’s idea that these students serve the architecture profession, the amount of architectural design was equal in both programs. Architectural engineers, at the onset, were to understand the creation of a building as well as the architects being trained beside them. Additionally, the ‘engineering’ courses were for building structures. Therefore, this architectural engineering program was really about one type of engineering. Also, note that the structural design of buildings is being learned through the eyes of bridge design or bridge engineering. This is demonstrated by the lack of building structural design courses elsewhere. In fact, in the civil engineering curriculum only one course can be found directed towards buildings and it was the same course as taken by the architectural students: ‘Roofs.’ Instead, the bridge courses had to serve the need and add to the structural focus. Bridge engineers were very familiar with the use of iron and steel, so knowledge of these materials was gained through these courses.

Changes to the Curricula
In the 1893-94 course catalogue, a change to the architecture course list appeared, just two years after the architectural engineering program came into existence. The second year of mathematics was removed for the architecture students. Two classes were developed for the architecture students as simplified versions of mechanics, which moved from analytical mechanics to applied, and material studies, which went from resistance to strength of materials. This change gave Ricker the opportunity and the resources to tailor these science courses for architects, as he
A letter to the Board of Trustees of the University of Illinois from Ricker revealed the intent behind the change. The first is his observation that architectural students seem to be mathematically or artistically inclined, but rarely both. He described those architecture students that were poor in math, "This is simply the result of the fact that the two lines of intellectual work are quite incompatible, just as much as theology and real estate, or poetry and business." This line of thinking indicates a separation in the perceived talents of students and at a very early stage in architectural education. More importantly, Ricker’s changes indicated that he believed that these two types of architects—the design and technical—should be educated differently.

Another reason Ricker gave for the change was that architects in practice did not use such mathematics. It was '…condemned as practically useless by the architectural profession and is forgotten as quickly as possible after the examinations are over....' This instance demonstrated a correlation between the pull of academia and practice with practice being used as a motive to change an architectural curriculum. Ricker had previously expressed his intent to provide a practical education for architecture students and continued to modify the curriculum to do so.

A separation between technical and creative architects had begun to occur at the institutional level. Some mathematics had been removed and some of the engineering courses were reduced in complexity. Courses were added to provide more ‘valuable professional studies.’ The architecture program description was modified to encapsulate the changes to the focus. The ‘scientific principles of construction’ remained and the ‘principles of design’ were added. Architecture students continued to study physics, chemistry, ‘Stone, Brick, and Metal Construction,’ ‘Heating and Ventilation,’ and sanitary construction. The focus of the architectural program shifted, but still included solid technical education. The architectural engineering program experienced few changes and remained very similar to the original program.

In the 1895-96, there were some subtle, but noticeable changes to the curricula. One major change was the dropping of shop courses for the architecture students. These courses were still included, however, for the architectural engineers. The removal of shop classes for the architects indicates a separation for the architectural students from first-hand knowledge of construction. In Ricker’s early description of the classes, he indicated specific intentions:

1. To acquire a knowledge of tools and manual processes.
2. To distinguish between good and bad work as inspector.
3. To learn peculiarities of materials, modes of working with them, etc., very essential to a designer.

Each of these goals related directly to construction methods and material studies. The loss of these courses meant the architecture students in this program were further removed from the construction process and limits. Another change was the drop in the number of architectural design courses for the architectural engineers.

Cumulatively, the changes to the two programs were significant. The architectural engineering program, which began to allow for studies on iron and steel construction for architects, became more specialized and focused on engineering. The architecture program, which would be described today as a very technical curriculum, moved to more fully include design, but relinquished some of the practical knowledge of materials and construction. The architectural engineering program, which was intended to train architects, was losing its connection to the architectural design process, while remaining focused on building engineering. A clear divide was opening between the two programs.

Ricker, when determining the educational paths of architects at University of Illinois, voiced his ideas of the design architect and the technical architect and began to concretize this separation in the curricula. While this is an example of just one program, in the realm of architectural education, Ricker’s program had a long reach. In 1896, the University of Illinois educated 25 percent of the 273 architecture students in the United States and in 1911, one-fifth of the 1450
students. However, in both cases, the number of architects being trained at a university was quite small when compared to the field and those trained through non-academic models. Like that of architectural education, the impact of architectural engineering was just beginning.

THE AE IN ARCHITECTURE

In addition to the program at Illinois, architectural engineering programs begin to appear elsewhere. In 1897, MIT designed an AE program, but this time it was centered around the training for engineers on architecture. By 1912, the number of architecture programs had increased to around thirty and the number of architectural engineering had increased to eleven. In 1914, the Association of Collegiate Schools of Architecture established a 'standard minima for a course in Architecture' with which its members needed to abide. The document described requirements for the university, breadth of subject matter, and prescribed the proportions which the program was to spend in each area. For architecture programs it was 25 percent time for design, 14 percent for construction, 7 percent for History, and 14 percent for drawing. Also included is a description for architectural engineering programs, which “Owing to the heavy engineering and allied requirements it is not possible to exact the same amount of architecture and drawing as in the above for architectural students.” The distribution of time for these programs was required to be 14 percent for design, 30 percent for construction, 6 percent for History, and 10 percent for drawing. Noticeable is the inclusion of architectural engineering. This demonstrates that architectural engineering programs were prevalent enough within schools of architecture that it was appropriate to included them in the standards. The percentages of design and construction are valued differently in the two programs, but both course works included each and did not eliminate either.

In 1920, Edward A. Roth, a practicing architectural engineer of Philadelphia, set out to define the field in which he then practiced. In 1921, he determined that there were eight higher educational institutions that had architectural engineering programs and six of the programs were, “...run in parallel to the course in general architecture and diverging from it in either the third or fourth year.” Architectural engineering programs were in roughly ten percent of the architectural programs. The other two programs were run independently. This was a decrease in the number of programs from 1912, but an increase in the partnering with schools of architecture, from two to six. Also, within that time span the number of graduates increased from 112 in 1913 to what Roth estimated as close to 850 in 1921. Roth also noted that there was no standardization of the architectural engineering curriculums. In all cases, however, architectural engineering referred to the study of architectural structures.

In the following decade, A Study of Architectural Schools by Bosworth and Jones found that the number of architecture schools was fifty-two and that the number of architectural engineering programs had increased to twenty-four or nearly forty-five percent of the architectural programs. A fifth of all architectural students were enrolled in the architectural engineering specialization. Programs at this time seemed to have separated into two specialties, the ‘architectural or design option’ and the ‘architectural engineering or construction option.’ Bosworth’s study also found that the amount of construction addressed by either varied by school and by specialty, with no clear distinction able to be made. Neither architecture programs nor architectural engineering had standard educational aims.

The ‘pure’ architecture programs were noted as de-emphasizing the teaching of technology. As the authors noted, “It is interesting to observe that schools in the United States have shown a tendency in general to minimize construction in the so-called straight architectural courses.” Many schools appeared to be quite happy to have civil engineers teach these courses, perhaps for this reason. However, when architects taught them, the value of the course was seen to increase as was the case with certain schools that are noted for having, “...unified courses with a definitively architectural objective.” The message is mixed with a lack of enthusiasm for the courses in general, but a praising of those courses that can incorporate architecture and construction holistically.

Architectural engineering programs continued to focus on structural technology and were labeled,
‘structural options.’ Students who were found to be technically inclined had an uninspiring distinction. Those who found themselves in the architectural engineering programs, as the authors suggested, may be, “…the students who have ‘trouble’ with design are shunted off into the structural option.”31 This study noted the increase in the architectural engineering programs, the apparent separation of design and construction, recognized successful methods and personnel to teach technology, and confirmed a marginalization of students with technical skills.

Another major research effort into architecture occurred with The Architect at Mid-Century. It was a study conducted by the American Institute of Architects on the profession, education, and registration of architects to gain a significant understanding of the field and to mark the half-century. The study noted that in 1950, there remained twenty-four architectural engineering programs, and that there were 1748 students enrolled in these programs with this being approximately eighteen percent of the students.32 The number of architectural schools had increased to sixty-two. Also noted, “The 1950 Survey determined that 13.6 per cent of all degrees held by registered architects were in architectural engineering.”33

The report acknowledged the importance of technical knowledge and construction.34 There appeared to be a desire to wrestle technology education back into architecture. Architectural engineering, however, was not the place for these needed courses and there is a distinct difference in tone towards the field in this study. When addressing architectural engineering, the authors demonstrated a general disdain. Architectural engineers were described as, “…handicapped by their incomplete training…” and that the name, “…leads to public confusion and encourages graduates to aspire for registration as architects.”35 It concluded that the term architectural engineering was both ‘ambivalent’ and shorthand for ‘practical’ architecture as opposed to ‘decorative.’36 As the report continued that there is a place for such programs, but that, “…their graduates cannot properly seek professional careers in architecture.”37 The argument is taken further with one of the report’s suggestions. One of the detailed recommendations advised that the word ‘architectural’ be removed from the phrase architectural engineering and that the term be abandoned completely.38 These criticisms occurred even while a sizeable portion of registered architects held an architectural engineering degree. The association of architectural engineering programs with schools of architecture has taken a pronounced turn and a decline is inevitable. By 1960, only nine such AE programs remained in place.39

ARCHITECTURAL ENGINEERING TODAY

Today, Architectural Engineering is almost entirely the domain of engineering schools. In 1993, a subset of the American Society of Civil Engineers’ (ACSE) was formed and called the Architectural Engineering Division. This division later became the AEI, or Architectural Engineering Institute which is one of the eight institutes of ASCE. Celebrating the tenth anniversary of the AEI, the opening editorial of their Journal delineated their interests:

The AEI promotes an integrated, multidisciplinary approach to the design, construction, and operation of buildings, whereby engineers of various disciplines can unite, interact, and share knowledge in an effort to advance the state of the building industry.”40 (Emphasis added.)

In its brief history, the Institute has become an advocate for Architectural Engineering programs in engineering schools and successfully created an architectural engineering specialization for the professional engineering licensing exam and written architectural engineering program criteria to be included in the engineering accreditation evaluation documents. These are significant steps in the much defined world of engineer. At the same, this indicates an entrenchment of the architectural engineering field in engineering. Architectural engineering programs now provide educational opportunities for engineers to become familiar with not only a larger breadth of architecture but also more iterative and creative design than pure engineering programs. All of this training is a benefit to engineers that go on to take part in building design and for the architects that work with them.
CONCLUSION

From this brief investigation, it can be concluded that there have been pedagogical discussions on the technical education of the architect for over a century. This can been seen in Ricker’s recognition of skill sets of his students and his effort to create educational programs to suit them as well as meet the needs of the architectural community. While he created a program to specialize in building structures, he also lessened the concentration on construction for the architects. The existence of the architectural engineering program gave Ricker the room to add and remove classes from the architecture curriculum. After the initial launching of the program, architectural engineering did increase in number significantly and in conjunction with architectural programs. Ricker’s program was not an anomaly.

Though architectural engineering courses once had a large presence within schools of architecture, it appears though that the field itself never found an easy home. Edward Roth remarked on this in his article on the subject. Is an architectural engineer a “structural engineer whose function is principally to assist the work of architects” or “an architect...who is a specialist in the design and supervision of a certain type of structures”?[41] In 1932, *A Study of Architectural School,* reflected some conflicted views. Courses of study were divided into ‘architecture’ and ‘construction’ specialties and students were ‘banished’ from design to architectural engineering. Building technology education was found to be important, but uninteresting and in decline. In the 1950s, the pairing of architecture and architectural engineering was seen as even less of a match and the modification or removal of architectural engineering programs began. Architectural engineering today is supported as a minor Institute by the ASCE where it struggles to gain acceptance, despite all the groups’ efforts.

Architectural engineering is a technical approach to the design and construction of buildings. While mostly removed from architecture schools, the impact of these programs on architectural curricula may still remain. If the University of Illinois can again be used as an example, the architectural engineering program now exists as an optional specialization in the graduate education. When the architectural engineering programs left architecture programs, what happened to the technological course work? Were some integrated back into the architecture schedule or were they removed? What imprints remain in the education of the architect from these programs? A detailed analysis of several curricula would bring more insight into this.

The second area of influence of architectural engineering is in the field of practice. *The Architect at Mid-Century* found that 50 percent of the architecture firms surveyed designed their own structure in 1950 and, at the same time, around 14 percent of licensed architects were trained as architectural engineers. While the figure is unknown, this number would be hard to be believed today. Perhaps architects will never return to designing their own structure nor should they, but this does mean that there has been a change of who does the work and how are they educated. The loss of architectural engineering from the field of architecture means that architects have little say in the education of such engineers, whereas sixty years ago they did. These two points, the potential footprint of architectural engineering in architectural education and in the field of practice, indicates that architectural engineering has ties to both the making of the architect and architecture. The history and loss of architectural engineering in architecture needs further investigation. Perhaps, its impact is only starting to be understood.

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