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# Student Pre-Perceptions of Integrated Design and the Role of Technical Courses in the Architectural Studio

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Amber has designed and managed award-winning projects for competition, bid & design build processes in the United States, China, Kuwait, and the United Arab Emirates. Recent design work saw exhibition in the U.S. at Design Miami and in Italy at SPECIMEN and the Milan Furniture Fair.

In 2011 she moved to upstate New York from sunny California to begin her teaching career at Cornell University, and she is currently in her fourth year of teaching at Syracuse University.

Amber's current research is invested in "mediated environments" – an exploration of the capacity of technology to arbitrate deficiencies and extend capabilities within architecture through digital, chemical, and virtual means.

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Dr. Bess Krietemeyer is an architectural designer and researcher focused on the ways in which emerging material technologies, human interaction, and computational simulations influence the design of sustainable built environments. Prior to joining the faculty at Syracuse, Bess was a HASS Fellow at Rensselaer Polytechnic Institute's Center for Architecture Science and Ecology (CASE), where she received her Ph.D. in Architectural Sciences. She has practiced with Lubrano Ciavarra Architects and with Skidmore, Owings, & Merrill (SOM) on the design of international projects that integrate next-generation building technologies. Bess teaches technical and design courses focused on the integration of building systems, environmental data, and user feedback loops into design processes. She leads the Interactive Design and Visualization Lab at the Syracuse Center of Excellence (COE) where she conducts interdisciplinary research on advanced building technologies and human interaction using immersive simulation techniques. Her current research is developing hybrid-reality simulations for interactive design and energy performance testing at the building envelope and urban scales.

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## Student Pre-Perceptions of Integrated Design and the Role of Technical Courses in the Architectural Studio

Among those who teach technology to architecture students there is the perception that many students (and indeed the occasional studio critic) view the "support courses" of structures and building technology as ancillary at best and as an obstacle at worst. We, the authors, worry however, that those students who fail to engage with this material are not prepared for the real world of design and as there is a danger that as practicing architects they will to often cede control of their designs to engineers, contractors, and outside consultants.

The authors set out to study student pre-perceptions ahead of Integrated Design Studio, a studio course required by most NAAB accredited programs that is typically regarded as the most significant opportunity for students to display mastery of technical issues through the vehicle of design. We constructed a study to evaluate students' pre-perceptions of the importance of their required technical courses, the role of those technical courses in their development as designers, their confidence in their ability to apply classroom knowledge in the studio context, and their enthusiasm for doing so.

This paper presents the results of that study and a set of goals and assessment metrics that will be applied and tested in the subsequent Integrated Design Studio course aimed at improving student capacity to deploy technical knowledge in their design work.

### Background

The teaching of structures and other technological concerns is often viewed as marginal in the overall architecture curriculum. A search of JAE archives produces very few articles devoted to the subject. Introducing one the of the few JAE issues dedicated to the topic Cavanagh notes

> "Curriculum choices include such thorny pedagogical decisions as the considered introduction of construction conventions or the early emphasis on technological innovation. Of course, it's possible that some schools do not make these decisions consciously, and it's clear that the engagement with the teaching of architectural technology varies from the perfunctory to the pervasive. Nevertheless, it's fair to suggest that each school of architecture in North America is defined by its choice among the variables of teaching architectural technology."[1]

This observation suggests that the issue of technology teaching for architecture students is not given significant weight in academic discourse. Further weight is leant to this argument by Cary's reflection in a 2003 Design Intelligence article about that publication's planned Skills Assessment survey. He notes the relative paucity of longitudinal studies of architecture students' professional preparedness.

> "If these were unprecedented findings or if individual schools, firms or our national organizations were already conducting longitudinal studies to measure their progress in these areas, we would have no reason to worry. We know, however,

> that's rarely the case. A 1980 study by the ACSA, *Tracking Study of Architecture Graduates*, revealed almost identical concerns, as did the 1996 *Building Community* report as well as others before and after. None of these studies concluded that education is hopelessly flawed, but instead, that there is ample room for improvement on all fronts—if we do, in fact, agree that these are crucial skill sets needed to operate in the design and construction industries."[2]

Previous studies by one of our authors have found that architecture students value technical competency and see themselves as needing more exposure to technical material in order to successfully practice architecture.[3] But these findings are not necessarily supported by faculty observations. One of the authors, a structures instructor, regularly surveys the students on the first day of their first structures course and less than 30% say they would take the course if it were not required. Senior architecture colleagues report that they have seen the number, and complexity, of required structures and technology courses decline over the course of their teaching careers. Many faculty who also practice architecture express reservations about how well the academy is preparing architecture students for both technical aspects of their jobs and the capacity to collaborate with technical experts.[4] John Ochsendorf, who teaches engineering and architecture at MIT warns that those students being explicitly trained in technical methodologies (engineers) are too isolated from design, while architecture students are not being held to high enough technical standards "In engineering education today the problems are over constrained, but in architecture education I really believe that the problems are under constrained."[5]

There can be little question that our architecture graduates will practice in a world of hyper-specialization and an ever more technologically complex environment. The imperative that we find appropriate ways to prepare them for both the status quo and the technical challenges yet to come, cannot be overstated. Unfortunately, it not unreasonable to argue that, in general, architecture students, are not always interested in or qualified for advanced technical courses at the university level. It is easy to point to lower mathematics standards of graduating high school students and to paint the millennial generation as especially lacking, but the issue of mathematical capacity and its impact on architectural technology teaching is not new to the literature. Speaking about teaching structures to architects in 1958 at a meeting of the ACSA, the legendary Mario Salvadori bemoaned "you don't know anyone who would boast in public of not understanding Shakespeare's HAMLET, but you find thousands of people who boast about not understanding mathematics at all"[6]

In the role of the project manager the architect has a tremendous responsibility to coordinate among an array of technical expertizes. While they receive a rigorous technical education, most engineers and technical experts are not formally trained to understand the goals and ideals of the architect. Salvadori observed that while there is an enthusiasm to work together, the two groups simply do not share a common vocabulary.[7] Given the managerial role of the architect in the typical contemporary project, we as architecture educators must prepare our graduates to bridge that divide. While a lack of understanding of fundamental technical ideas can stymie the creativity of architectural design, an aversion to mathematics does not preclude an understanding of, and an intuition for, how buildings work. Writing about structures specifically, Plesums argued "knowledge of mathematical methods, however, does not assure a feeling for structural behavior."[8] Similarly Severud argued the importance of architecture students understanding basic fundamentals of how structures work with the figures left to the engineers.[9] We would further argue here that it is this very intuitive understanding of structural form and its possibilities that newly-trained engineers lack, making it all the more vital that architects can argue persuasively and competently for innovative structural solutions in their design work.

There is disheartening evidence to suggest that although architecture students do (by requirement) take a significant number of technical courses, they do not absorb this knowledge (or indeed many other types of knowledge) when it presented in lecture format without a design context. John Folan, professor at Carnegie Melon University notes that

> "Delivered outside the context of a design scenario, already abstract concepts of social, legal, economic, and contractual performance become entirely opaque, or even impenetrable for most students. As a result, the content remains entirely irrelevant in the academic setting and many students emerge into the profession without the capacity to evaluate priorities as they relate to performance."[10]

This finding aligns well with higher education research across disciplines that advocates "just in time" learning where students engage with specific complex tools and skills exactly when they have immediate need of that tool to achieve some other immediate work goal.[11]

If there is relatively sparse writing on the topic of technical preparedness for architecture students from the academic side it is somewhat easier to find concerns expressed by those in the industry. Many practitioners argue for additional education in the skills that will facilitate effective collaborations between architectural and structural designers. Ben Mickus, Associate at Skidmore Owings and Merrill (SOM), notes that the burden is on architects to learn how to communicate effectively in order to integrate structural reasoning with architectural goals.[12] When architects can effectively understand, connect and contribute to the structural conversation, the result is a better building because they encourage the engineer's qualitative abilities in addition to the quantitative expertise. Hanif Kara, structural engineer, co-founder and design director of AKT points out, "Just as good architecture relies on good clients, good architects make for good engineering. They understand the basic technical role played by engineers, but can also push engineers to think of questions they have not thought of themselves. In this way, good architects know how to get the best out of engineers."[13] Furthermore, architect and educator Neil Denari supports increased discussions about technical integration saying, "It's very important to get the message across to the student that all the elements of building are part of a palate of tools that are instrumental to constructing a set of ideas and sensibilities… Structures, in particular should be taught as much poetically and conceptually as it is professionally." [14] He goes on to argue that architects need to be taught how to talk about architectural values and specific project design objectives with engineers.[15] This is essential because there are ever increasing technical complexities at play in contemporary architecture and architects in training will grapple with these issues through collaboration once they've entered the professional realm.

**Objectives**

In an effort to better understand how disciplinary challenges of professional collaboration might stem from architectural training, this paper presents a study of students' pre-perceptions associated with required technical coursework in a professional architecture degree program. Through a closed and open-ended survey, the authors analyzed student pre-perceptions ahead of Integrated Design Studio, a course required by most NAAB accredited programs that is typically regarded as the most significant opportunity for students to display mastery of technical issues through the vehicle of design. The objective was to evaluate student pre-perceptions of the importance of their required technical courses, the role of those technical courses in their development as designers, their confidence in their ability to apply classroom knowledge in the studio context, and their enthusiasm for doing so.

**Curricular Context**

Students in both the BArch and MArch programs of Syracuse University were administered the survey. The study was administered to 264 BArch and MArch students and 72 students responded, yielding a response rate of 27.2%, which the authors find satisfactory given a significant percentage of the survey pool were studying abroad, a short response window was available, and online teaching evaluation response rates for this same population are currently averaging below 20%.

The required technical curriculum for the BArch students consists of three building technology courses taken in first, second and third year respectively, two structures courses taken in second and third year, and a final four credit case study based course called Advanced Building Systems taken sometime between third and fourth year (often in the summer as it is regarded as a strenuous course). The MArch program is almost identical to the BArch program with one fewer building technology course. It should be noted that the course work, instructors, and curricula for the structures sequence and the Advanced Building Systems courses are shared between the two programs while the building technology courses are taught separately. The students surveyed were largely finished with the required technical curriculum of their respective programs (with some students having the Advanced Building Systems course described above left to take). 53 students who were in either the third or fourth year of the five-year BArch program responded to the survey and 19 students who were in the second or third year of a 7 semester MArch program responded.

It should further be noted that given the relative size of the required technical courses as compared to a studio size, and the relative stability of technical instructors in the school over the tenure of the survey population, the students answering the survey largely had the same faculty for the required technical courses, but a significant number of different studio instructors over their time in their respective programs. However, it is perhaps significant to the issue of integration of technical issues in design teaching that, with the exception of one structures instructor, *all* instructors who teach required technical courses in the school are also design studio instructors.

**The Survey**

The goal of the survey was to elicit an initial understanding of how prepared students felt to undertake the Integrated Design Studio based on their experience in the required technical courses and on their practice at including technical constraints in previous studio courses. To meet the stated goal, students were asked about how they would rate their performance in those required technical courses, their interest in same, and how confident they were that they could apply the relevant material in the design context. Because students are often unable to recall the specific syllabus of a course or indeed the specific title of the course – they were reminded on the survey, when and with which instructor they had taken an individual course. To further tease out specifics, students were asked about the course material in a second way. In addition to asking students to describe how well they did or how confident they felt about applying material from course ARC XXX they were also asked to rate their confidence in resolving a list of named technical issues in the design context (Structural Systems, Mechanical Systems, Façade Systems, Lighting Design, Sustainability Issues, Acoustic Design, Life Safety/Code Issues).

In addition to issues of performance and confidence, students were also asked about their interests and priorities in the area of technical constraints in the design process. Students were asked to rate how important it was to them to integrate and resolve technical issues in their design work, and perhaps more significantly how much emphasis they perceived to be placed on these issues by their studio instructors.

**Survey Results**

The results of the survey are outlined in the charts that follow. The results from the undergraduate and graduate populations are not significantly different but could not fairly be conflated into common graphs due to the differences in the structure of their relative curriculum. Thus, in the interest of brevity, *only* the numerical analyses for the undergraduate population are presented.

At first observation, the students surveyed are largely quite confident in their performance in required technical courses, their capacity to integrate that knowledge in the design studio, and they claim to have considerable interest in so doing. But a more careful look at the data is warranted, especially as these data do not align with the authors' observations of same. Two sources of error must be considered. Firstly, the authors have prior experience in both teaching this population and surveying this population regarding self perceptions and have found them to be ambitious, serious, and invested in their own identity as students in a highly ranked BArch program. Second, it is reasonable to assume that the population who responded to the survey are among the higher performing students and are both invested in their education, and despite the anonymity of the survey, anxious to please the faculty who administered the survey. This assumption is bolstered by the fact the most "positive" responses regarding experiences in individual courses applied to the course Structures II and not coincidentally the email request to fill out the survey had come from the instructor in that course! For these reasons, in our analyses only the most positive ratings will be considered evidence of significant investment in the issue at hand. Further, since there is evidence of bias toward or against individual instructors in the way students responded to questions about individual courses, more emphasis will be placed on the questions that asked about technical topics more generally than specific course numbers.

Figure 6 shows students' self reported general interest in resolving technical issues in the design studio**.** Less than 30% of students claim that technical concerns are always a priority in their design work. Figure 7 shows students' perceptions of how important technical concerns are to their studio faculty. These results are among the most emphatic in the whole survey. Approximately 15 % of students agree with the statement that "Very few instructors think it is important" and 70% agree that "Some instructors think it is important, others do not." These perceptions (regardless of whether they are an accurate reflection of their studio instructors' actual values) elicit concern. If a significant majority of students do not get the message from their design faculty that technical considerations are worthy of investigation and are a source of creative inspiration rather than an obstacle thereto, we as technical instructors must at least attempt to counter that message, even if it will never be possible to fully reverse it.

Figure 3 shows students' ranking of their *interest* in investigating and resolving specific technical issues. The issues ranked as most important by the students where, in order, structural systems, façade systems, and life safety/code concerns. Mechanical systems were ranked lowest. When compared with Figure 5 which shows students' ranking of their own *capacity* to investigate and resolve technical issues it is clear that the two are highly correlated. Students measure of how important a topic is maps almost perfectly onto how capable they feel to grapple with it (with the possible exception of sustainability where students are marginally less convinced of their own abilities than they are of the importance of the issue). This result demands further study. It seems a little too neat to imagine that students are perfectly as prepared to undertake a task as they feel they ought to be. A focus group of students might drill down on this observation fruitfully. Similarly, a study of program alumni might yield contradictory data regarding preparedness.

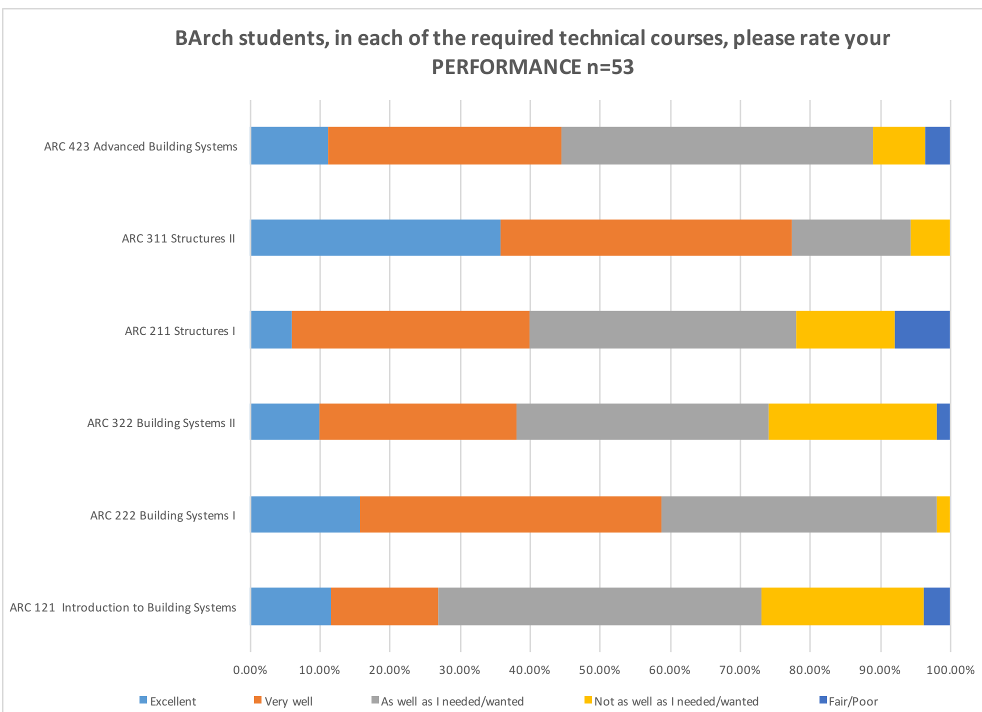


***Figure 1: Student self ranking of performance in each of their technical courses.***

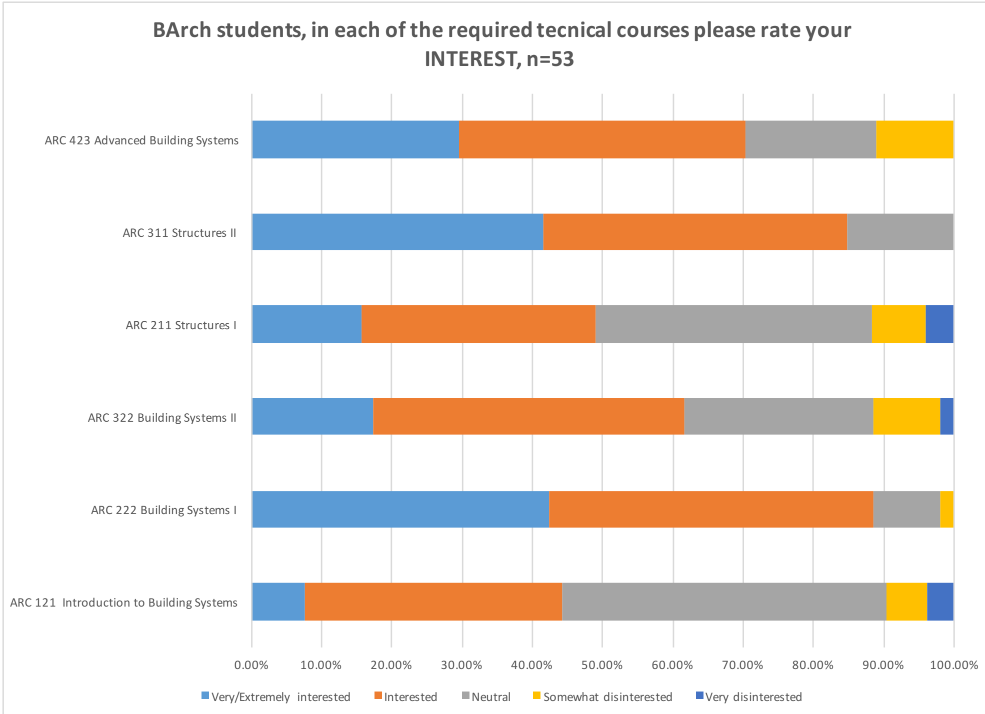


*Figure 2: Student rating of interest in each of their technical courses.*

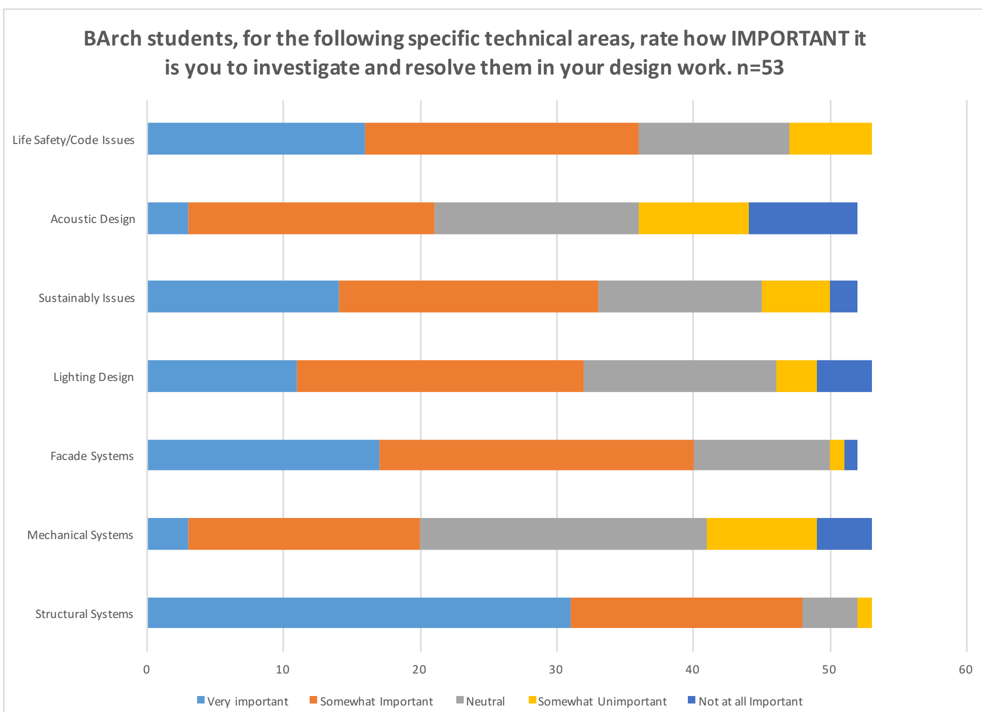


*Figure 3: Student rating of importance of technical topics.*

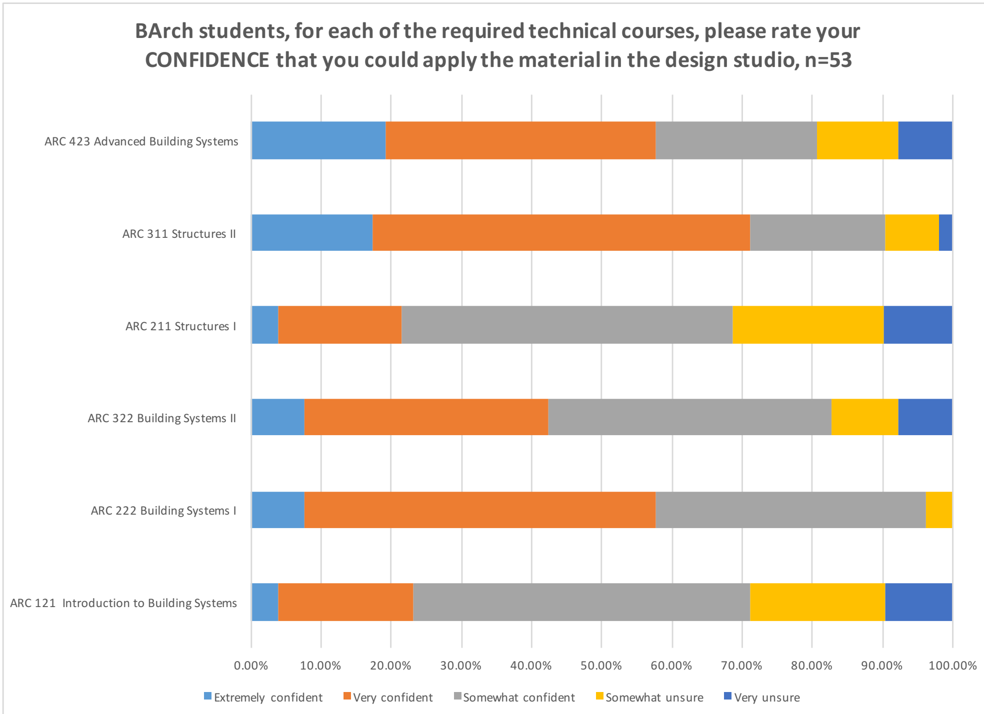


***Figure 4: Student rating of confidence that they could apply the material in a studio context, by course.***

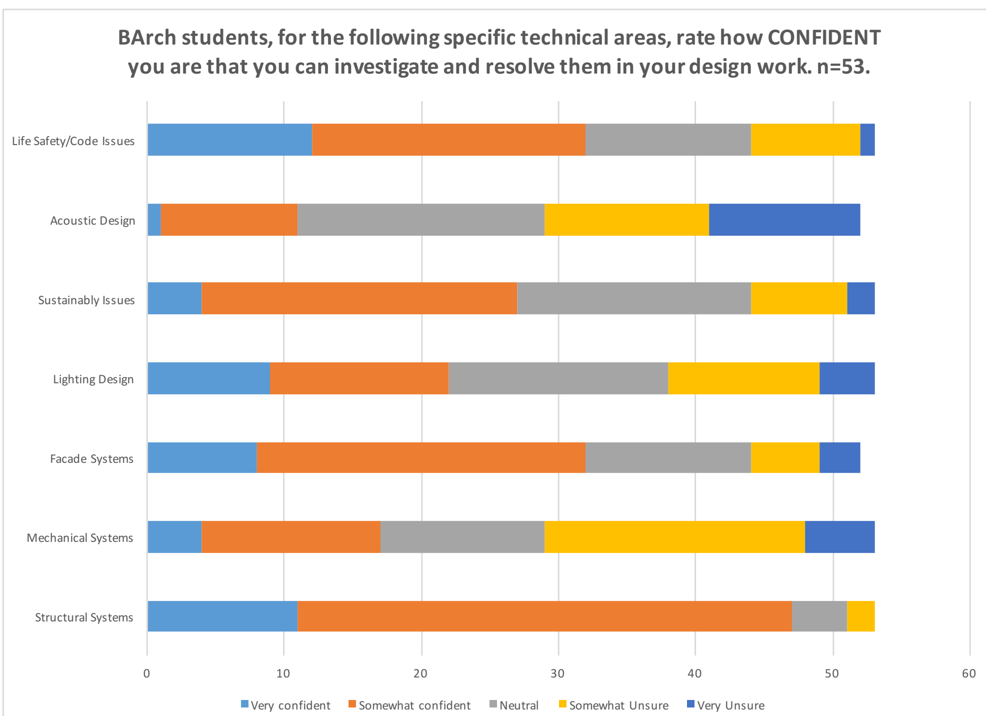


***Figure 5: Student rating of confidence that they could apply the material in a studio context, by topic.***

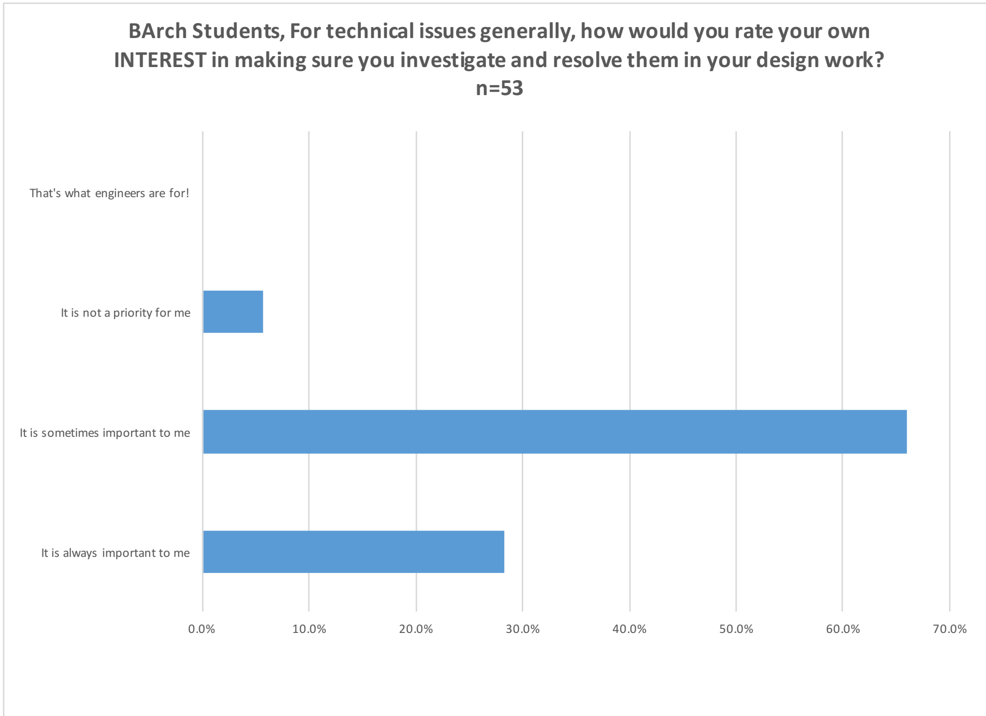


***Figure 6: Student self reported interest in resolving technical issues in the design studio.***

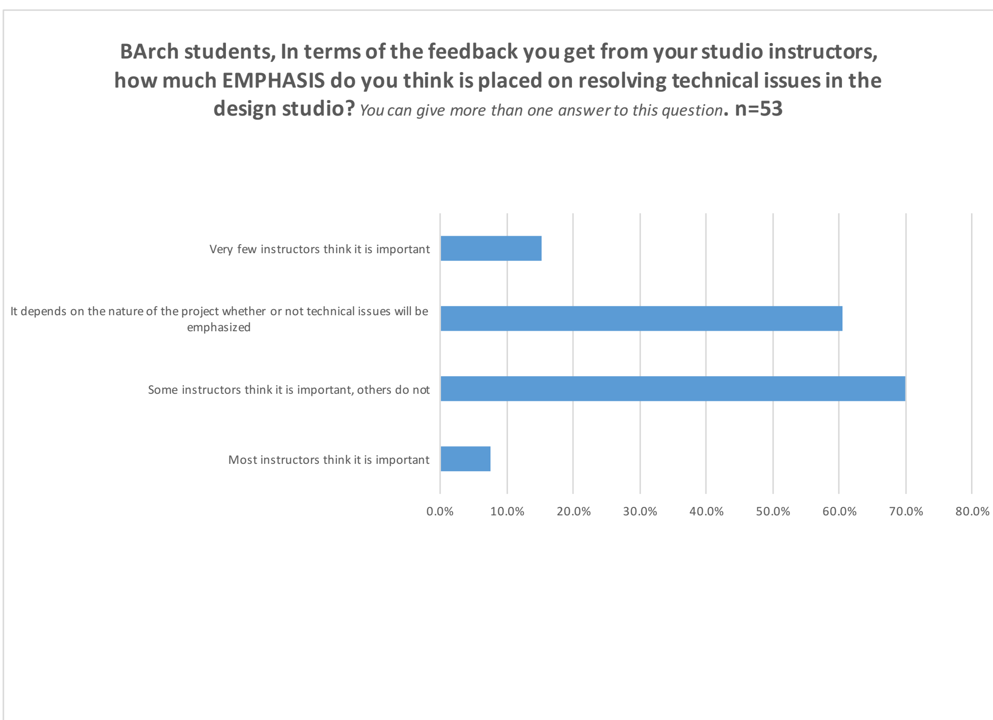


***Figure 7: Student evaluation of instructor emphasis on technical issues in the design studio.***

In addition to the closed-ended questions outlined in the graphs above, the students surveyed were give an open-ended opportunity to add any observations they might have about technical teaching in the curriculum. Of the 53 undergraduate students who responded to the survey, 20 gave answers to this question. The most dominant themes that emerged in these answers were desires for increased integration between the required technical courses and the design studio. A number of students placed the emphasis on the studio environment as a place to achieve this aim.

> *I'd appreciate a little more focus on gradually integrating all our systems knowledge before we get to comp. studio.*
>
> *They* [required technical courses and design studios] *relate and we've incorporated it, but it's hard for me to remember after these semesters everything for future studios. It's not consistently encouraged by every professor.*
>
> *I felt confident doing course work for structures but it is not reinforced in studio so it is difficult for me to know if I would remember how to design appropriately. I have some level of confidence with HVAC due to completing an ABS case study project with* [redacted]*. Otherwise I would have no clue.*
>
> *Studio professors must emphasize more the technical issues in student's studio project*
>
> *I think there should be more of a focus on basic technical concepts in studio rather than overly complex systems or not referencing technical stuff at all.*

However, other students noted that the technical lecture course instructors could do more to make manifest the design implications of their coursework and to explicitly engage the design studio in real time. It should be noted that this is potentially a more realistic goal than changing studio culture due to the respective number of faculty involved in both endeavors.

> *I feel some technical courses worked with studio, but I truly think all the technical courses should push us to engage our studio projects with the new material we are learning.*
>
> *I find that it is always almost the case that I don't understand what is happening in class until I have to apply it to my studio project.*
>
> *I wish studio professors worked more with the technical professors to integrate work. The project I've learned the most form was Professor* [redacted]*s assignment to draw a detail section of a studio project we were working on. More interaction would help.*
>
> *ARC222 gave me a better understanding of how different components of the building are put together, which helps me to understand how to design certain particular details in studio projects. ARC311 is extremely useful in terms of rules of thumb for structural systems.*

Another student had an interesting observation that indicated he or she saw the technical material being presented somewhat in competition with more "architectural goals." This is something we would hope to avoid.

> *I feel that a lot of what is emphasized regarding "technical systems" in class, whether technical courses or design studios, is rarely about the architecture. I feel that all the technical systems are valued equally with architectural design, rather than all of the technical systems being taught as supporters of the design, they hold equal parts. Also, I would enjoy a stronger emphasis of materiality and its architectonic language in response to the design project.*

In sum, the student narrative comments support the numerical data from the overall survey in that they argue for further integration of technical constraints in a design framework. They also reinforce the finding that they are getting inconsistent messages from their faculty regarding the role of technical resolution in architectural design.

## Conclusions and Further Work

This survey represents an initial inquiry in a years-long project. The results are interesting, but inconclusive, with the most significant observation being that students do not consistently get the message from studio faculty that material learned in technical courses is relevant to the studio environment. Further, there seems to be an appetite on the part of the students for more consistent integration between technical courses and contemporaneous studio courses. The results of this data will be compared to a post survey administered to students after they finish the integrated design semester, and to an alumni survey concerned with the same issues. The results of these surveys will be used to design pedagogical interventions in both required technical courses and the integrated studio course with the aim of better both integration and increased student perception of integration and cross relevance of the skills and topics addressed by both studio and required technical courses.

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