P-12 Outreach - Exploring a School of Architecture's Efforts to Engage the Early Education Community

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STEVEN O'HARA, Professor of Architectural Engineering and Licensed Engineer Professor O'Hara received his Master of Architectural Engineering from Oklahoma State University (OSU), and has been a member of the teaching faculty at the School of Architecture since 1988. His primary areas of interest include the design and analysis of masonry, concrete and timber structures, with special interest in classical numerical structural analysis and the design of concrete structures. Professor O'Hara is one of four faculty members in the Architectural Engineering program at OSU, and as such teaches courses in the AE program at all levels; he enjoys his close mentoring relationship with the students in the AE program at OSU, as he also performs the role of their academic advisor. Outside the OSU classroom, Professor O'Hara is an Affiliate Professor of Civil Engineering and Architecture in "Project Lead the Way", and has authored the workbook for the curriculum. As a faculty member, Professor O'Hara has received numerous awards; in 2016 he was awarded the Outstanding Faculty award in the College of Engineering, Architecture and Technology (CEAT), in 2015 he was awarded the Outstanding Faculty Service award in CEAT and was part of the First Place team winning the Presidents Cup for Creative Interdisiplinarity at Oklahoma State University (OSU), in 2013 he was elected to the first class of Faculty Teaching Fellows at Oklahoma State University, elevated to Chapter Honor Member by Chi Epsilon and was part of the Second place team for the Presidents Cup at OSU, in 2001 he was the honored recipient of the first Melvin R. Lohmann Professorship, in 1999 he received the Chi Epsilon Excellence in Teaching Award, and in 1995 he was recognized as the Halliburton Excellent Young Teacher for the College of Engineering, Architecture and Technology at OSU.

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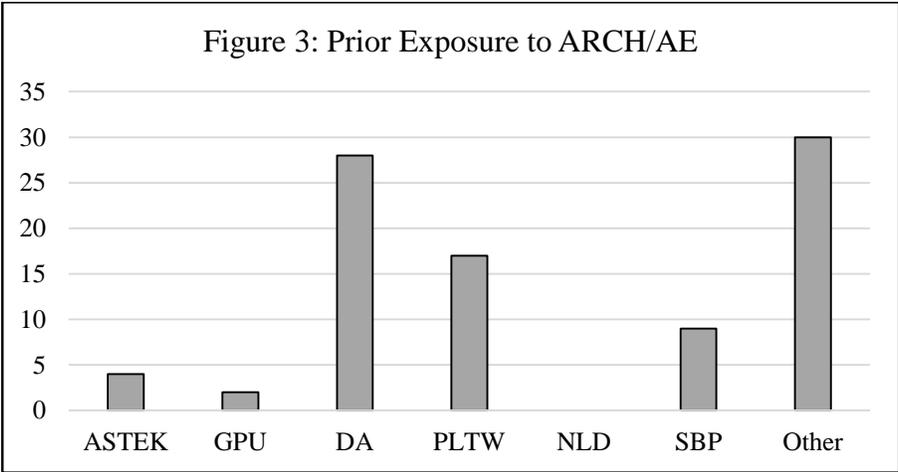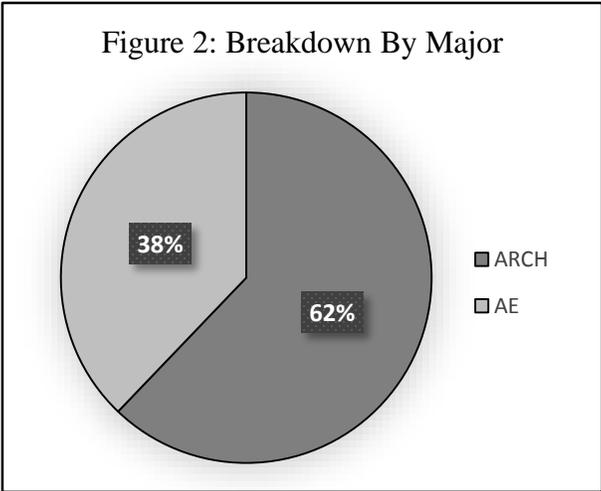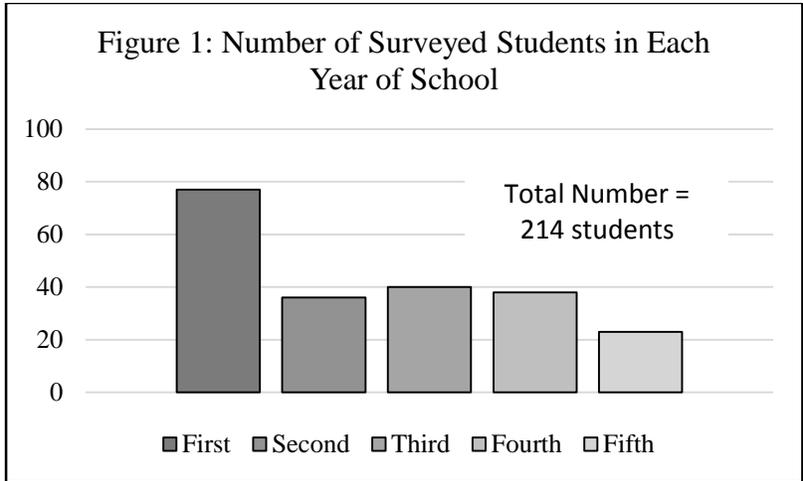
Abstract:

It all comes back to that age old question, "What do you want to be when you grow up?" The answers run the gamut but usually contain, "Architect!" However, architecture schools find themselves struggling with enrollment and retention as much as any other field. To combat this problem, the School of Architecture at Oklahoma State University developed a variety of outreach programs targeting elementary through high school age students and focused on a variety of architectural topics including: architecture, architectural engineering, landscape architecture, and construction management. These programs provide students practical application on various levels and spark interest in the profession.   The school participates in three outreach programs geared toward elementary and middle school students, and two programs offered to high school students interested in architecture or architectural engineering. These programs are ongoing in some capacity and have been offered for various amounts of time since the early 2000s.
This paper will be two-part. The first will highlight each community outreach program the school offers. The second will summarize a survey of the school's current students. The survey will cover students' exposure to the school's programs and any subsequent impact on their career choices. It will also poll the students on any P-12 exposure to architecture or architectural engineering they may have experienced.

Introduction:

Studies have shown that children consider careers much earlier than thought. By age 7, children have realistic career aspirations (Moulton, et al, 2014). During developmental stages, children will shape these aspirations based on social expectations (Gottfredson, 1981) and identity, which usually includes gender, class, and ethnic background (Archer, et al, 2010). At Oklahoma State University, the School of Architecture participates in and coordinates activities aimed at younger generations. To better understand these programs and other P-12 architecture and engineering exposures' effectiveness, the authors of this article conducted a survey of the current student population of the school. This is shown in the Appendix. Students of every level completed the survey. A breakdown of the 214 responses is shown in Figure 1. First year had 77 responses, second, third, and fourth year had an average of 38 and fifth year dropped to 23. The number of fifth year students is affected by the timing of the survey and the opportunity for internships and travel. Some students graduate in 4.5 years and some utilize their last semester for study abroad trips or internships. Administering the survey during the spring semester affects the number of fifth year students. Out of the responses, both architecture (ARCH) and architectural engineering (AE) students were represented – Figure 2.   This figure is a natural breakdown of the typical enrollment within the school. The survey not only questioned exposure to programs the school offers, but also any prior architecture or engineering influence from other sources. The following sections will outline each program the school is coordinating or with which it is affiliated. The programs associated with the school are Architecture Students Teaching Elementary Kids (ASTEK), Grandparent University (GPU), Discover Architecture (DA), National Lab Day (NLD), and Summer Bridge Program (SBP). The only other

program/academy specifically named but not directly affiliated with the university was the pre-engineering academy, Project Lead the Way (PLTW). The reported number of students exposed to each of these programs is shown in Figure 3. The "other" column reported the most responses at 30 students. This category contained other academies that were not directly named.

Figure 1: Number of Surveyed Students in Each Year of School

Total Number = 214 students

Legend: First, Second, Third, Fourth, Fifth

Figure 2: Breakdown By Major

- 38%
- 62%

Legend: ARCH, AE

Figure 3: Prior Exposure to ARCH/AE

Categories: ASTEK, GPU, DA, PLTW, NLD, SBP, Other

ASTEK (Architecture Students Teaching Elementary Kids):

The longest-running outreach program at the school was developed by the local chapter of the American Institute of Architecture Students (AIAS) in 1999. ASTEK began with donated materials and limited time outside of the classroom and studio. This program partners with the local public school district to engage fifth grade students in architecture, planning, and structures. The ten-week program has architecture students from the university visit the six local elementary schools to advocate for the profession and community. Weekly assignments and activities are: A Story and Visualization Exercise, Textures and Materials, Urban Planning, Scale Sketching, Geometry in Architecture, The Architect's Floor Plan, Structures in Architecture, Beginning Building, and Finish Building. It ends with a Gallery Show at the school. An ASTEK project is shown in Figure 4 and a sample lesson is shown in Figure 5. In 2000, the school's AIAS Chapter received AIAS's National Special Accomplishment Award to recognize this endeavor. Although this program is limited to those students who grew up in the community, 4 of the 214 university students reported having participated in ASTEK.
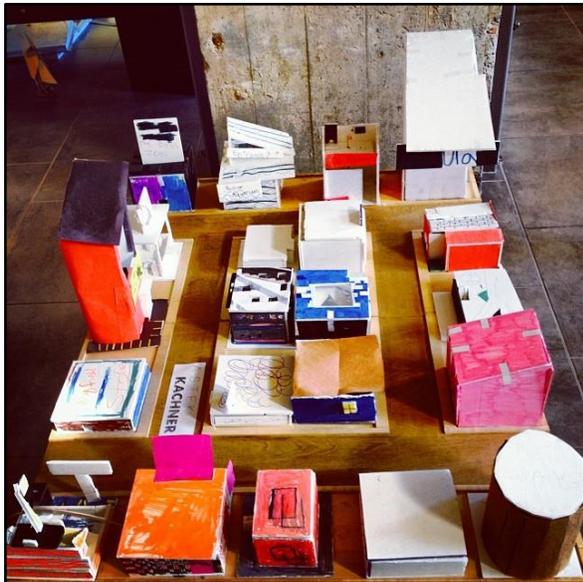

Figure 4: City planning/Building Design in ASTEK

Figure 5: Lesson 1 – Story and Visualization

Grandparent University:

The university's alumni association established this program in 2003 with the architecture school providing one of the inaugural "majors" - architecture. The three-day program is open to university legacies ages 7 to 13 and their grandparents with the goal of bridging the gap between generations. The program's emphasis is exposing children to various departments and majors across campus. Each grandchild/grandparent team selects a "major", stays in campus housing, and, at the end of the program, "graduates" with a certificate. In 2016, the architectural engineering program was introduced as an option in addition to architecture. The two programs offered by the school range from 25-30 people per session and per major, approximately 13-15 of those being grandchildren.

The architecture offering's description is as follows: "We experience the art of architecture every day, with buildings all around us affecting the ways we live, work and play. Learn some of the basic design principles and structural systems evident in great architecture, and the role and responsibility of the architect in contemporary society. The class will design and build a scale model of a city, appropriately named "Petesburgh!"."
Activities include: Visualization and drawing techniques, Structures in architecture, City planning, and Principles of building design.An example of the city planning exercise is shown in Figure 6.

Figure 6: Grandparent University City Planning/Building Design

The architectural engineering program's description is:
"Architectural Engineering is both a science and an art. The design of building systems requires knowledge in science, technology, engineering, mathematics (STEM) and architecture (STEAM). Learn about the various systems that make building stand up and provide comfort to the people inside them. Investigate the behavior of materials used in the construction of building structures. The class will design, build, and test their own structural members."
Activities include: Interactive Kid Structures, Secret Spaces Tour, Deconstructures (Boom!), Design, and Construct and Test Structures.

An example of the interactive kid structures is shown in Figure 7. The grandchildren become the structure while learning about arches, domes, buttresses, barrel vaults, trusses and cantilevers. The Secret Spaces Tour utilizes the building as a teaching tool. By touring the mechanical rooms, students can truly understand what makes a building work. And, "Deconstructures" involves breaking different materials in a stress analyzer to compare behavior.

Two current students reported having participated in Grandparent University, one in second year and one in third year. This low number could be due to the duration of program offering (since 2003) versus the age of students entering college, the program enrollment limitations, and only one "major" offering until 2016.
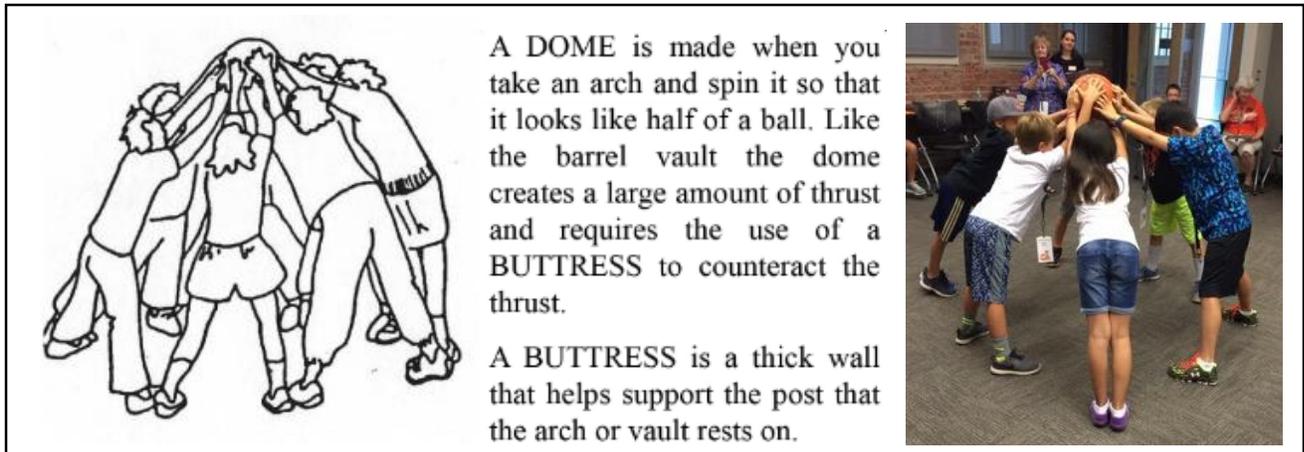
Figure 7: Grandparent University Kid Structures "Dome"and summer 2016 participants (shown right)

Discover Architecture:

Discover Architecture transpired in 2002 and was initially offered in two urban city centers each located approximately an hour away from the university. In 2006, the two offerings were combined and re-located to the university's campus, and Discover Architecture has remained there since. The program consists of a 5-day summer workshop introducing participants to architecture, architectural engineering, landscape architecture, and construction management. Some activities include sketching, computer presentation tools, materials, and hands-on projects (shown in Figure 8). The program is open to students 16 and older. Participants live on campus and are exposed to the university and school. Typically, the program consists of approximately 23 students from the university's state and surrounding states. Discover Architecture ranked second in the survey next to "other" as programs attended previously by current students with a response of 28 students. One student remarked in the comment section that this program was the sole deciding factor in their decision to not only major in architecture but to enroll at Oklahoma State University. The responses were somewhat consistent between years with an average of 5 students per year, except for the third-year students, of whom 9 reported attending Discover Architecture, Figure 9.

Figure 8: Discover Architecture, constructing concrete beams (left) and building trusses (right)

Figure 9: Number of Students in Each Year of School That Attended Discover Architecture

A bar chart titled "Figure 9: Number of Students in Each Year of School That Attended Discover Architecture" showing values: First = 6, Second = 5, Third = 9, Fourth = 5, Fifth = 3.
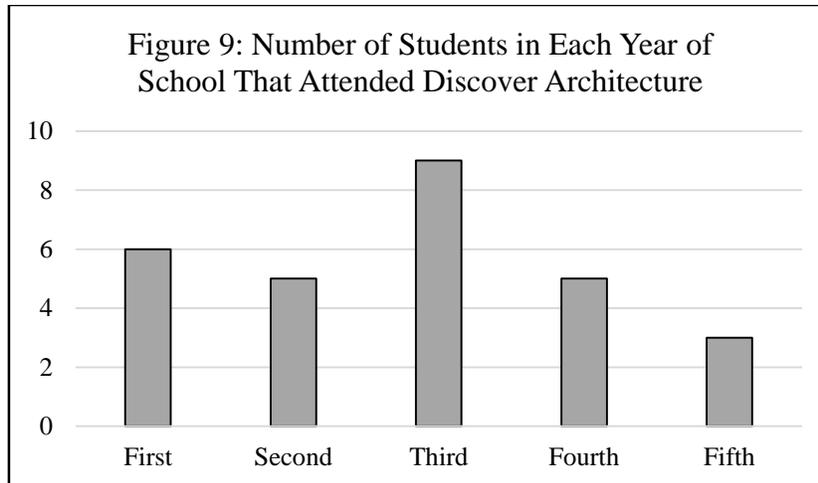
Summer Bridge Program:

The college created the Summer Bridge Program in 2007 as a program to "bridge" the gap between high school and college, and prepare students entering engineering, architecture or technology. It is an eighteen-day, on campus program that occurs immediately before the fall semester and offers prep coursework, mock exams, design projects, and campus orientation. It also offers an opportunity for students to bond with other incoming freshmen and faculty. It was included in the study as exposure to engineering before entering the curriculum, although the Summer Bridge Program is a post P-12 outreach program and comprised of students already interested in engineering or architecture. Currently, the school of architecture does not provide a specific design problem or "architecture focus" to the Summer Bridge Program. However, the possibility is being explored as another way to gain students interested in similar fields but who might not have been exposed to architecture or architectural engineering.

It is also worth noting that per the survey, nine students came into the School of Architecture after completing the Summer Bridge Program.

National Lab Day:

National Lab Day (NLD) began in 2010 as a response to President Obama's call to action made at the National Academy of Sciences in 2009 (www.nsf.gov/news/special_reports/natlabday/). The National Science Foundation defines National Lab Day as "a volunteer initiative to form local communities of support around science, technology, engineering and mathematics (STEM) teachers and to connect them with STEM professionals who will share their expertise as well as their excitement and passion for their disciplines." NLD is a one-day event during which science teachers pair with programs at the university to educate high school students about various departments, programs and majors using lab experiences. In 2013, the school of architecture realized the opportunity to reach students interested in STEM and began offering three lab activities each May. The first is similar in content to what is offered in other school of architecture programs, Deconstructures, where materials are broken to see behavioral response. They also complete a truss building exercise.   The second lab option offered through an interdisciplinary pairing with architecture is a tour of a space habitat that was developed as a

prototype for The National Aeronautics and Space Administration (NASA). And, the third offering highlights the lighting portion of architectural engineering with a tour and demonstration of the lighting dome – counting natural lumens.

Although participation in NLD is positive outreach for the STEM community, it has yet to produce a student at the school of architecture. However, the numbers are small and it is only offered for a few hours, once a year. Also, students are required to attend as a high school group so the interest is varied.

WONDERtorium:

The local children's' science museum, the WONDERtorium provided a natural opportunity for P-12 outreach in both architecture and architectural engineering. The pairing began in 2013 with two afternoon workshops geared toward students in the 8-12 age range. The first activity involved using plaster molds to form spaces. The second workshop was earthquake themed and students built structures to stand on gelatin molds and undergo shake table testing – Figure 10.

From these workshops, a summer camp was developed. This camp is a three-day event that is similar in nature to Grandparent University and ASTEK. Interactive Structures, Secret Spaces Tour, and Deconstructures make up the curriculum along with a tour of the building which leads to discussion on the building's history, structure, systems and design. Campers draw floor plans, practice sketching, investigate materials, and, on the final day, build a tree house model.

The WONDERtorium activities were not included in the survey due to the short time offered. Participants are too young to be college freshmen and included in the data.

Conclusion:

"A world which sees art and engineering as divided is not seeing the world as a whole." – Professor Sir Edmund Happold

With children having realistic career aspirations as early as age 7, it is imperative that exposure to Science, Technology, Engineering, Architecture and Mathematics

Figure 10: Shake table demonstration at the WONDERtorium

(STEAM) happens simultaneously. The School of Architecture at Oklahoma State University realizes this need and provides various programs to engage various age levels in architecture and architectural engineering. However, the effectiveness of these efforts had not been tracked full

scale. The authors surveyed current students during the spring semester about exposure to architecture and engineering programs and academies. The second portion of the survey questioned prior interest in those fields. The choices were always interested (Always), pre-engineering academy or architecture influences sparked interest (Academy), family influence (Family), interest in a related area (Related) and other (Other). The results are shown in Figure 11. The main question that arises from this data is what convinces a student that is interested in a related field to architecture and architectural engineering (the most common response) to major in architecture or architectural engineering? If similar students are intercepted on a larger scale, what affect does this have?

Figure 11: Influence on Major

A bar chart with the y-axis ranging from 0 to 200 in increments of 50, and the x-axis showing categories: Always, Academy, Family, Related, Other. Approximate values: Always ≈ 108, Academy ≈ 42, Family ≈ 75, Related ≈ 155, Other ≈ 22.
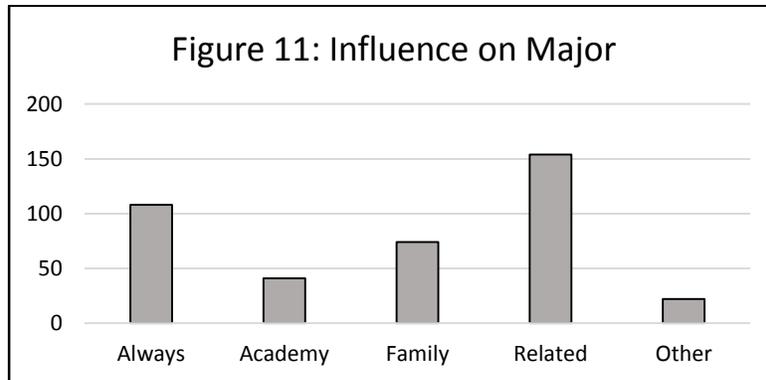
After noticing the drop from first year enrollment to second year enrollment and seeing the numbers remain relatively constant after that point, thought was given to the cause for such sharp decrease. If those students who leave the program have a better understanding of the majors and what they entail before enrollment, they would be less likely to major in architecture or architectural engineering, therefore decreasing the enrollment in first year and improving retention. However, instead of anticipating a drop in first year to match the averages of the follow-on years, one might consider the idea that if students have a better understanding of the majors prior to enrollment, those interested in related fields who may not have had the knowledge to make a more informed decision might major in architecture or architectural engineering. This theory would predict a raise in enrollment numbers across the board.

Lastly, the survey opened up for comments. One point in particular that was raised that was not previously considered when thinking of outreach and recruitment was the impact of student tours. One student commented that a tour of the school and a conversation with a faculty member influenced their decision when choosing a major. Student tours are given daily on campus and when a student is interested in architecture or architectural engineering, they visit the school for a personalized tour. Each faculty member at the school is assigned a week during the semester to meet with interested students.

Other comments noted other outside influences: growing up around construction, placement tests, visiting siblings in college, legos and other building toys, and, surprisingly, pop culture in the form of a television character who is an architect.

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Appendix:

School of Architecture Survey – Spring 17

Major (Please Circle One):   Architecture   Architectural Engineering

What exposure did you have to architecture or engineering prior to enrolling? Please check all that apply

        □   ASTEK

        □   Grandparent University

        □   Discover Architecture

        □   Project Lead the Way or other pre-engineering academy:

                Please list: _____ .

        □   National Lab Day

        □   Summer Bridge Program

        □   Other architecture or engineering academy: Please list: _____

Please check what may have influenced your interest in majoring in architecture or architectural engineering:

        □   Always interested

        □   Pre-engineering or architecture influences (from list above)

        □   Family influence

        □   Interest in a related area (art, design, math, etc.)

        □   Other. Please list: _____ .

Additional Comments: