# THE ASCE CONCRETE CANOE COMPETITION
# CONCRETE CANOE'S POTENTIAL TO ENHANCE ENGINEERING EDUCATION

A Thesis Prospectus
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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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## Introduction

Engineering, as a whole, exists in a very unique space in education, as it's meant to teach the application of scientific principles not the principles themselves. However, the principles can often become the major focus of engineering education, which forms a gap between a student's knowledge of the principles and their application. This gap is where design competitions and clubs can provide engineers-in-training with a more engaging educational experience. It's critical to recognize the faults of engineering education as the information age will ask new engineers to adapt to a world where technology progresses at an incredible rate. Researchers such as Charles Vest have pointed out "The twenty-first century will be very different from the twentieth. As we think about the challenges ahead, it is important to remember that students are driven by passion, curiosity, engagement, and dreams" (Adams & Felder, 2008 pp. 237). There has been extensive research done by professionals such as Cindy Rottman that non-formal learning spaces such as extracurricular clubs play an important role in developing engineering skills, leadership skills, and a love of lifelong learning (Rottmann et al., 2016). There will be a need for engineering education to change to meet these new challenges and provide these opportunities and I feel design competitions can help guide these changes.

Today I want to highlight one such opportunity, the Concrete Canoe Competition which asks a team of engineering students to design and construct a working canoe made entirely out of concrete (Bix, 2019). They are tasked with developing a work plan, executing the construction of the canoe, racing their canoe for competition, submitting a complete technical report, and an oral presentation of their team's construction process. These engineers are asked to consider: How long does it need to be? How wide can it be? How complex does the concrete need to be? How much money can I spend? This opportunity to apply engineering concepts and practical skills to

a very concrete problem is a key step in engineering education. The project management, design analysis, and collaboration skills that are taught in this competition have been praised by professional engineers as it prepares students for their future career (Sulzbach, 2007).

**Building The Canoe**

Students are asked to engage with a lot of technical aspects when designing their canoe which can be broken down in to 3 major sections reflecting the 3 largest challenges. The first is the mix design of the concrete itself and characterizing the affect additives, aggregate, and differing amounts of cementitious material have on concrete (Leczovics, 2013). This includes researching new concrete mixes made out of recycled materials, conducting tension and compression tests, and sourcing unique materials that can provide advantages during construction. Next is the hull design which asks students to think critically about what forces will affect the canoe and how best to manage these forces with creative designs. This also encompasses using modeling software (Paradis, 2007) to test the buoyant and hydrodynamic forces acting on the canoe while it moves to ensure a stable yet sleek hull for competition. Finally, construction engineering goes into the design of a mold that can properly support the weight of the concrete as it cures and delivers on the design while keeping the project on-time and on-budget. This includes utilizing scheduling software, price tracking, and detailed design documentation to allow for a more thought-out building plan. This culminates in a complete technical report and oral presentation that explains the process of building the canoe and the technical skills these students learned along the way. Of course, the project is capped off with a float test and race which is the final event for the canoe and proves that, in fact, it floats.

**Concrete Effects on Engineering Education**

The independence that these students have cannot be understated as they are expected to execute each of these tasks with only minimal help from an advisor. A key concept in the spirit of concrete-canoe is the importance of creativity, education, and teamwork. While many of the students who are asked to do these things have little to no experience, the time spent as a team researching, learning, testing, and failing cannot be replaced with a lecture. They aren't just tasked with building the canoe but learning to work with teammates, consultants, and professional companies when sourcing materials. These are important steps in engineering education and allow these students to challenge their ideas of what engineering looks like in the real world.

When trying to establish a connection between the technology and human aspects, one approach is the Actor Network Theory (ANT) which seeks to understand the complex interplay between human and non-human entities in shaping social realities (Latour, 1992). In ANT an "actor" can be any entity that has the capacity to influence the actions or behavior of other actors, whether human or non-human. In the context of the concrete canoe, we can see the how the competition modern iteration is shaped by the current organization participating in it. One organization is the American Society of Civil Engineers which adjudicates and controls the concrete canoe competition and its participants through regulations. While ANT views the social world as a network of interconnected actors and these networks are not predefined or stable but are constantly in the process of formation and transformation. If we consider the competition as a network, we see that several actors play a role in its development and over time the focus and goals of the competition have reflected those actors.

Originally concrete canoes revolved around Clyde Kesler, a professor at the University of Illinois, publishing the results of his concrete canoe experiment and encouraging other programs

to build their own. The intent of the project was to provide young engineers with a unique design challenge and to provide a more engaging educational experience. One year later Perdue decided to join in and soon the two schools would race their canoes, shifting the focus of the project to not only constructing a canoe that could float but one that could compete. Soon professional engineering firms and engineering organizations began finically supporting and promoting the competition. We can see that a network begins to grow from the competition and the actors in that network begin shaping the ideas and values of the technology.

A good way to observe the shaping ideas around the technology is by observing what factors in the design were values over others over time. As the competition expanded formal engineering organizations began setting standards and requirements for the competition in the late 1980's. These standards would formalize what materials were allowed and at what quantities, they regulated sizes, and finally required both a technical and oral report for each team in the competition. From here students were given a more concrete base to begin with and creativity, ingenuity, and communication skills began to be the key ingredients to a successful canoe. This is reflective of the educational values that young engineers needed to learn in the 1900's. As the competition continued to grow and the engineering challenges of the early 2000's began to shift, the competition soon followed. Soon computer-generated models and optimized design analysis became a large factor in the competitions and students were encouraged to learn and adapt this new technology into their construction process. Currently there are sections of the regulation that asks students to focus on sustainable construction with concrete mixes that used recycled and reuseable materials becoming more prevalent. Each iteration of the competition changes to reflect the current day engineering challenges that these students will face as they enter the profession.

**Research Question and Methods**

The value of the design competition and key skills gained from participating in them seem to point out the flaws and gaps in engineering education. This leads me to ask a logical question: What can we learn from design competitions to improve engineering education as a whole?

To investigate this question, I will be conducting a bibliometric search for review articles describing engineering education and reviewing how design competitions contribute to that education. I would like to focus primarily on using literature search databases which are web-based archive systems that store and categorize scientific and scholarly articles. Using these databases, I plan to conduct both forward and backward citation searches that involve engineering education and how evolving challenges faced by professional engineers have influenced the development of design competitions. My intent is to try and investigate how design competitions have fit into the network of engineering education and how they have helped reframe engineering education.

Additionally, I would like to conduct several interviews with specific actors in this particular network. I would like to interview the advising staff of these design competitions, graduates who participated, university administrators which encourage them, and the organizations that host and organize these competitions. I would like to ask participants what kind of skills they developed by participating and how those skills translated into their professional engineering careers. I would like to ask advisors of these competitions what makes these kinds activities stand out as a part of engineering education. I would like to ask university administrators what they see as the value of these design competitions and how they would see some of the skills gained from these competitions translated into course work. Finally, I would

be really interested in asking the organizations that host these design competitions how they have changed over time and what they see as the future of engineering education.

**Conclusion**

The concrete canoe competition presents engineering students with an intensive independent research and design experience that will improve their skills as engineers and provide them with unique leadership opportunities. It will do this by challenging students to conceptualize, plan, and execute complex design requirements with non-standard design materials for competition. The goal of the project is to learn to be adaptive, resourceful, independent, and work as a member of a team.

The goal of the STS deliverables outlined above is to better understand how the key aspects of the concrete canoe competition can be translated into engineering education. The rapidly developing technology and globalization that new engineering will be asked to tackle in the near future will present a unique set of challenges. I feel these design competitions can provide a guide for how engineering students can be better prepared to handle these new challenges. Using these unique learning opportunities can develop a concrete foundation for the next generation of engineers to build on.

**Resources**


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