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BOARD # 59: Work In Progress: Development of the Asphalt Road-eo Student Competition

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Abstract

A critical issue within the field of civil engineering is building a diverse workforce to serve as the next generation of civil engineers. Among the subfields of civil engineering, pavement engineering lags substantially behind in terms of diversity, equity, and inclusion. Furthermore, most civil engineering curricula do not cover pavement engineering extensively; often it is simply a week worth of classes during an introductory transportation course. Previous studies have demonstrated student competitions as an effective supplemental tool to also build interest and improve learning outcomes in a specific field of engineering. The target population for this project are undergraduate students, with a particular focus on undergraduate students from underrepresented groups. The desired outcome of this project is to generate interest among these undergraduate students to explore careers and graduate study in the field of pavement engineering. Another outcome is to expose students in general to the research process and how to get involved in undergraduate research and later apply to graduate school. In addition, we hope to provide a framework for a low barrier to entry competition which can be replicated in other regions of the country but does not require participating universities to have extensive laboratory or computational facilities. In fact, this framework may be replicable at the high school level in future competitions. This paper presents a literature review on the effectiveness and current gaps in terms of studies related to student competitions, and then presents the framework of the Asphalt Road-eo competition thus far, including obtaining sponsors and securing participation of student groups on our campuses and other campuses.

Introduction

One of the major challenges faced in the field of pavement engineering is recruiting the next generation of engineers and other employees and ensuring this group is representative of the United States population. Over the last few years, several studies have demonstrated this potential issue. For example, a recent survey by the National Asphalt Pavement Association (NAPA) indicated that only 20% of the general public and 23% of educators believe that road construction

"has a diverse, inclusive culture" [1]. Although critical in any field of engineering, it is of utmost importance that pavement engineers and decision makers come from diverse groups, considering the implications of their decisions. For example, a recent study of Massachusetts found that Environmental Justice (EJ) communities, defined in Massachusetts as communities with low income, high minority population levels, and/or lower levels of English speaking, were found to be more than twice as likely (21% compared to 10%) to live near roads rated to be in poor condition, compared to non-EJ communities [2]. Considering these factors, it is crucial to ensure that students from underrepresented groups have knowledge of the field of pavement engineering and are encouraged to pursue careers in this field. Most civil engineering curricula do not cover pavement engineering extensively; often it is simply a week worth of classes during an introductory transportation course, and several universities do not offer full pavement materials courses.

Considering the lack of exposure that students have, this study proposes the development of an asphalt pavement-related student competition, similar to previous competitions hosted by the American Society of Civil Engineers (ASCE), but with fewer barriers to entry. The competition is specifically modeled after the Asphalt Road-eo previously hosted by the University of Texas at Austin and the Texas Asphalt Pavement Association [3]. However, this study specifically focuses on two objectives through the establishment of this competition: (i) exposing students from diverse groups to career opportunities in pavement and asphalt materials engineering and (ii) exposing students from diverse groups to opportunities for graduate studies and research overall. This work-in-progress paper presents a brief literature review, which encouraged the further development of this competition, and a summary of the project's planning and structure. Future results of surveys and outcomes of the project will be presented in a future paper based on the findings presented herein and the results of the first competition held at the University of Illinois Urbana-Champaign.

Literature Review

Previous studies have demonstrated student competitions as an effective supplemental tool to also build interest and improve learning outcomes in a specific field of engineering. Often, this has been contextualized within the field of experiential learning. For example, Gadola and Chimdano developed a design competition focused on motorbike design which allowed students to perform the design as well as actually test their design by building and driving the motorbikes [4]. Their findings indicated that student competitions were an ideal way to implement the experiential learning concept. Other frameworks have integrated the concept into engineering curricula; for example, De-Juan et al. [5], who introduced a student design competition into a mechanical engineering course through involving design assignments in three courses across different semesters ranging from the first to the final one. Their findings included observation of improved links across courses and overall better achievement of learning outcomes. The methods of preparing students for participation are, however, very important to consider as student competitions are established [6].

Other benefits include improved leadership skills driven by technical competence, as identified by Wolfinbarger et al. [7]. Furthermore, some faculty have used competitions in the classroom to improve student interest for first-year students in their major in cases where there is no

introductory engineering course during the first year [8]. Student competitions have also been shown to help students grow and improve their identities as engineers [9]. Bordel et al. [10] indicated that a student competition helped improve autonomous, collaborative, and personalized learning based on surveys of students participating in a cybersecurity competition.

Considering the above examples, it should be noted that student competition teams can be described as either part of an engineering curriculum or as an extracurricular activity. Khorbatly and Al-Olimat [11] recommended choosing the latter over the former due to the voluntary nature of extracurriculars, but examined benefits of both. Existing competitions can also be integrated into engineering curricula as Senior capstone design projects [12, 13].

As observed by some previous researchers, student competitions can help drive interest in a specific engineering field. Schmelzle et al. used a student competition to excite students and attract them to the field of automotive engineering, leveraging successful industry partnerships to do this [14].

The institution and curriculum can also benefit greatly from the implementation of student competitions including both reputation and improved attraction of students to the program [15]. In addition to benefits for students, some studies have also showed benefits for faculty mentors involved in student competitions [16]. Student design competitions can also help improve diversity within a field, especially when involving K-12 students [17].

Finally, although most literature on student competitions is overwhelmingly positive, a few studies have proposed drawbacks and potential issues. Some of the barriers to competitions include financial costs, space needs, and computing resources (in the case of modeling projects) [18]. Schuster et al. identified several student-related challenges including:

1. Education challenges such as design changes without good reasons, constraints on incremental improvements, and building and testing rather than designing.
2. Student challenges including potential safety issues, negative effects on other academic performance, and feelings of failure or embarrassment among losing teams.
3. Technical challenges including incomplete projects, poor designs, poor building, and inadequate presentation of the project.

Other drawbacks could include that there are inherent biases in terms of which institutions have the best chance to win such competitions, which may increase some of the above-mentioned student-related issues. These include dedication of faculty advisors and availability of resources [19], which could result in inequitable competitions.

With respect to the skills developed, several studies have confirmed the improvement of both “soft” and “hard” skills through student design competitions [20, 21, 22]. However, to date, the literature still lacks investigations of the effectiveness of student competitions on generating interest in a specific field, or graduate study in general, among undergraduate students. There are some examples of evidence that student interest in a field can be improved and retained for graduate students [23]; however, this is a very different case as undergraduate students have much less a priori knowledge. Another drawback, identified by Barry et al. [24], within civil engineering competitions specifically is that most are heavily constrained and do not attempt to

solve more open-ended problems.

Initial Development of Asphalt Road-eo Competition

Given the above-mentioned benefits of using student design competitions for several stakeholders, the decision was made to carry out the Asphalt Road-Eo competition at the University of Illinois' Illinois Center for Transportation (ICT) during Spring 2025 or later. At the time of submission of this paper, the initial steps to develop this competition were taken and described in this section.

The survey instruments to be used for students before and after the competition are still under development. As a first step, the PI and research assistant working on this project completed Institutional Review Board (IRB) training to ensure compliance in all aspects. An IRB analysis was performed by the PI's home institution and the project was deemed exempt from IRB.

Several themes which will inform the survey questions were identified initially through gaps in the literature review, research interests of the team, and stakeholder interests, although these will continue to be revised. These themes include:

- Interest in graduate study and research opportunities
- Identity as an engineer
- Interest in the asphalt industry
- Knowledge about the civil engineering profession and asphalt materials

The next step was to identify potential partner institutions. Several partner institutions in our state and neighboring states were identified based on having existing engineering programs and diverse student populations. To date, four institutions have confirmed their participation including:

1. One R1 flagship state university (host institution).
2. One R1 minority-serving institution in the host's state
3. One R2 institution from a neighboring state
4. One non-research institution with an undergraduate program in civil engineering in the host's state

Planning has begun for the competition itself with an initial date selected and sponsorship verbally confirmed from both university and non-university sources. The non-university sources include one professional organization, one trade organization, and one local company. The competition will be held at the host institution with students coming the night before for an onsite dinner, and then beginning to compete in the morning. Each university will field at least one team, who will design an asphalt mix with several different design constraints, and construct a slab with conventional and novel materials. For universities that do not have a lab with these capabilities, the host institution will open to them early to help them make this. Each slab will be tested for three parameters, rutting (permanent deformation) resistance, cracking resistance, and surface friction. Prizes will be awarded to the top two teams in terms of these three plus a score for their

presentation to a panel of technical experts. Finally, the students participating will also gain knowledge about graduate study and research through an immersive tour of the lab at Illinois Center for Transportation and hands-on demonstrations of graduate student research in pavements and materials at UIUC.

Discussion

This paper conducted a literature review to better understand the current understanding of outcomes resulting from student design competitions. Based on this review, extensive review has been conducted to better understand how student competitions contribute to learning outcomes and "soft" skill development. However, there are relatively few studies assessing the impact of such competitions on student motivation to pursue a certain field of study within engineering, and relatively few which examine the impacts on student interest in research and graduate study. To this end, we have proposed and begun to develop an Asphalt Road-eo competition which allows undergraduate students to gain exposure to research and novel topics in the asphalt world. This competition framework was presented, and future work will include outcomes from surveys to assess if these objectives have been met.

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