Board 50: Unlock the Potential of Industry Partners for Engineering Education

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Unlock the Potential of Industry Partners for Engineering Education

Abstract

Most high-performing industrial advisory boards (IABs) in the U.S. provide engineering programs with future-looking advice that energizes faculty toward improved instruction. We envision IABs that go further than the norm, engaging as active partners to implement change in engineering programs that better prepare students for a dynamic industry. With the support of the Kern Entrepreneurial Engineering Network (KEEN, https://engineeringunleashed.com/), our team of university faculty from seven institutions (University of Wisconsin-Platteville, Clarkson University, Rowan University, Drexel University, Boston College, University of St. Thomas, and the University of North Alabama) have implemented a new program titled "Project Unlock: Accessing the power of your advisory board." This program aims to equip industry and academia advisory board members with a framework and accompanying playbook to "unlock" such a collaborative journey. In this presentation, we report the results of a "Lightning Poll" survey of Department Heads/Chairs and Deans from numerous engineering programs of various size, focus, and research activity across the U.S. about the types of engagements that happen between engineering programs and their advisory boards. The results provide a more detailed view of the landscape and context of current advisory boards and engineering program interactions and inform the framework and playbook development. We discuss further how programs can transform their IABs into Industrial Partnership Boards (IPBs) that are co-creators of the curricular and/or co-curricular student experience. It is our belief that these deeper interactions will drive transformational change at adopting institutions towards production of students with an entrepreneurial mindset that embraces the volatile, uncertain, complex, and ambiguous nature of future engineering practice.

Introduction & Background

Industrial advisory boards (IABs) are an accepted way to gather stakeholder input for an academic program [1]. In an academic setting, an advisory board can provide feedback on your curriculum, how well you are preparing your students for the workforce, and much needed fiduciary support [2]. Resource Dependence Theory suggests that advisory boards will increase access to resources, provide avenue for the exchange of information, establish the legitimacy of an academic program, provide managerial oversite, and garner support for the academic program [2], [3]. However, anecdotes from deans and chairs of institutions with exceptional advisory board participation suggest that the current model may underutilize the full potential of advisory boards to transform the undergraduate experience. For example, some programs engage advisory board members directly into their undergraduate curricular experiences. This can benefit the development of an entrepreneurial mindset in students by sparking their curiosity and helping them to make connections between their coursework and professional future.

In 2009 Genheimer and Shelab, surveyed academic programs and their boards to explore how they perceived the overall effectiveness of the board in several categories, including preparedness for ABET, fundraising, forms of student engagement, promoting research opportunities, and advising programs on curriculum content to meet industry needs [4]. Based on their findings, they recommended clear communication of the mission of the institutions and

expectations of the board, formal procedures for the board's involvement in the ABET process, and deliberate engagement of the board members in student activities.

Our ongoing effort, titled "Project Unlock", will provide academic institution engineering advisory boards with the toolset needed to effectively meet those recommendations. Interested programs will be invited to a year-long professional development program. The toolset includes a streamlined application of Strategic Doing tailored to the needs of this project, orientation guides for academia and industry members, and a self-assessment guide for IABs. The intent is for each participating IAB's members (academic and industrial) to co-create and co-implement "Partnership Projects" that meaningfully integrate industry partners into the education of students.

The first step in the development of the toolkit was to update Genheimer and Shelab's 2009 survey. Our aim was to obtain the current status of advisory board interactions as reported by deans and chairs to better understand the national landscape of how advisory boards are functioning within engineering programs. We wanted to address questions like:

- who has advisory boards?
- how those advisory boards were being used?
- were programs satisfied with the work product of their advisory boards?
- were the boards members active in undergraduate education?
- what other roles were the board members fulfilling in their programs?

We also wanted to know if there was interest in participating in a project to re-energize their advisory board toward our future program development. This paper outlines the results from this survey.

Research Approach

In order to replicate and update the work of Genheimer and Shelab, we chose to use a simplified questionnaire-based survey (which we termed a "lightening poll") with Likert scale style questions targeted at a convenience sample of deans and chairs of engineering programs based upon our professional associations and mailing lists. These included a list of contacts for civil, environmental, mechanical, aeronautical, aerospace, materials, and related engineering programs in the United States. The survey was designed for several purposes:

1. Serve as a first marketing for the project, alerting engineering department chairs of Project Unlock;
2. Collect information that will further gauge interest in participating in the project;
3. Inform the content of program materials (i.e., the "Industrial Participatory Board (IPB) Playbook" modules) being developed in later stages of the project; and
4. Ensure a breadth of perspectives gleaned from our respondents' answers of engineering related advisory boards, further informing Project Unlock's materials, so as not to be just the team's perspectives (noting that IABs differ widely).

Survey content focused on the broader information gaps that needed to be filled in order to understand what people at other institutions thought about the purpose and goals of their IABs. This included the extent (percentage) of institutions engaging advisory boards, how they were

being used, whether programs were satisfied with the work product of their advisory boards, whether the board members were active in undergraduate education and how, and what other roles the board members were fulfilling in their academic programs. Once initial questions were developed, they underwent review by the larger project group for quality control and completeness before finalizing the survey. The survey was designed in a manner such that clarifying questions would appear to selected responses provided a "yes" answer, and to provide the opportunity for text-based responses / clarification should the respondent choose. All terms in the survey were operationalized so that respondents had a shared understanding of what was being asked. The online survey and Institutional Review Board-approved protocols for issuing the survey were designed to preserve anonymity so that respondents could answer more candidly. While termed a "Lightning Poll" to reflect a practicable survey design for busy deans and department chairs, the survey was more robust than that title indicates. The survey, conducted in Qualtrics XM (Qualtrics, Seattle, Washington), was issued in September 2022 and concluded in October 2022. The survey and a de-identified data sample are available upon request to the corresponding author.

Survey Results

Response Demographics

Of the deans and chairs that responded to the survey, 73 of 78 (93.5%) provided complete responses. Of these, 69 (94.5%) had advisory boards. For questions regarding advisory boards, percentages reported are based upon 69 responses. The only exception was question 7 of the survey regarding advisory board activity; two respondents left the question blank, thus n= 67 for this question. Ninety percent of the respondents followed a semester schedule (66); the remaining 10% (7) followed a quarterly schedule. Greater than 90% of respondents (69) represented either a department (74%) or a college/school/ or equivalent (21%), with only 4% and 1% representing a program or an institute/center, respectively.

For those respondents for which we could obtain university enrollment data (n=71 universities offering graduate programs and n=72 universities offering undergraduate programs), we classified their institution by size relying upon the frameworks of the (CCIHE) and the (NSCRC). However, these categorizations were applied to undergraduate and graduate student enrollments separately to represent within the data set student demographics (undergraduate vs. graduate). We used the five categories including "very small" (<1,000), "small" (1,000 – 2,999), "medium" (3,000 – 9,999), "large" (10,000 – 21,999), and "very large" (≥22,000) [5]. These sizes were applied to undergraduate student enrollments directly. Although the NSCRC reported there were less than a quarter as many graduate students as undergraduates in the springs of 2020, 2021, and 2022[6], we classified institutional scale based upon graduate student enrollments by halving the bin values owing that quartering them resulted in nearly double the number of very large institutions based upon graduate student enrollments versus undergraduate student enrollments (see Table 1). Using these classifications, over half of applicable respondents were categorized as medium or large for undergraduate enrollment (70.83%) and graduate enrollment (59.15%).

Table 1: Breakdown of the Respondents by Size Categories

Category	Undergraduate Students		Graduate Students (Half)		Graduate Students (Quarter)	
	# Students	Relative %	# Students	Relative %	# Students	Relative %
Very Small	<1000	0.00	<500	8.45	<250	5.63
Small	1000-2999	15.28	500-1,499	16.90	250-749	9.86
Medium	3000-9,999	34.72	1,500-4,999	32.39	750-2,499	19.72
Large	10,000-21,999	36.11	5,000-10,999	26.76	2,500-5,499	28.17
Very Large*	≥22,000	13.89	≥11,000	15.49	≥5,500	36.62

* Not defined by the CCIHE. CCIHE uses only size categories Very Small, Small, Medium, and Large. We have further broken "Large" into "Large" and "Very Large" as described in the preceding.

Response Analysis

With this survey, the fundamental interest was determining, to the degree possible, the differences between advisory boards (in layperson's parlance between "good" and "bad" advisory boards). To accomplish this goal, two metrics were used from our survey to gauge advisory board performance. The first metric came from question 7 of the questionnaire, which asked about the activity of the advisory board on a scale from 0 to 100. Respondents were split into two categories, those that rated their advisory board activity above 50 (22 [31.9%]) and those that rated it at 50 or below (47 [68.1%]).The mean response to question 7 was 44 and the median response was 49 (range = 12 – 90). Henceforth, this will be referred to as the "activity split". The second metric came from question 16, which asked about how well their advisory board was partnering with their academic unit to achieve their mission on a scale of 1-5 (1 being poor and 5 being well). Respondents were again split into two groups: those who responded with Likert values of 1, 2, or 3 and those who responded with Likert values of 4 or 5. Henceforth, this will be referred to as the "strength split". The remainder of survey responses were analyzed to compare along the lines of these splits.

When doing any kind of statistical analysis, one of the first considerations is whether one would like to perform univariate analysis, multivariate analysis, or some combination of the two. There is much speculation in the statistics community as to the correct way to perform multivariate analysis of multi-response questions [7]. When this is considered in combination with the goals of this research, a univariate analysis is preferred. When working with nominal data and trying to determine univariate dependence between variables, one should use Karl Pearson's Chi-Square test of independence [8]. This is because nominal data cannot be ordered in a meaningful way, thus parametric tests are not applicable.

As the analysis in this case is comprised only of univariate analysis, it should be noted that the results from each test can only be interpreted independently from each other. Thus, one is only ever considering one independent variable and how it correlates with the metric (in this case, activity or strength) we are treating as our dependent variable. In order to perform the Chi-Square test of independence on our multi-response questions, it was necessary to divide the responses of each question into mutually exclusive categories [9]. For a univariate analysis, this

means dividing the respondents into 2 groups for each response: they selected the response, or they did not. One can then build a contingency table based on the metric and the response and compare it to what would be expected if there were no relationship between the dependent and independent variables.

Figure 1 presents a comparison of reasons that engineering programs have elected to have an advisory board bifurcated based upon advisory board (a) activity and (b) strength. As can be seen in Figure 1, of the many reasons for having an advisory board, faculty / student engagement, academic support, and research support are important hallmarks of active advisory boards. Of these, research support is also a hallmark of strong advisory boards. While the data suggest that industry engagement may also be an important hallmark of active and strong advisory boards, this requires further investigation. Notably, these three motivations for an advisory board are those that are student-centric. A conclusion then is that active boards, and to some extent strong boards, are those that have a strong desire to support students, and are more likely to be student-centric than their less active counterparts.

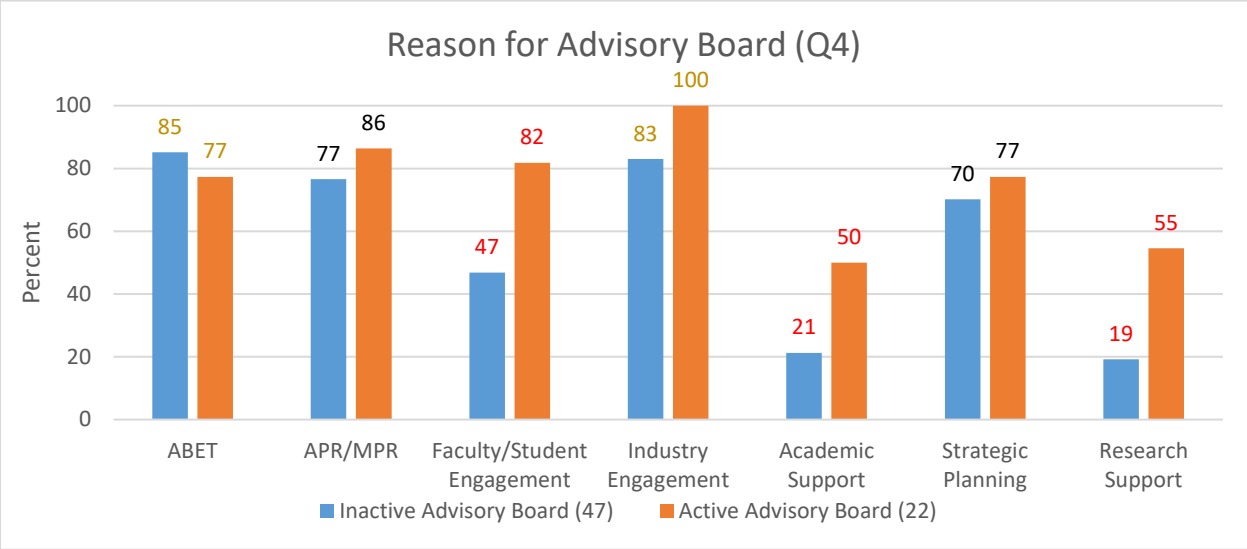

Figure 1a. Comparison of reasons for an advisory board (question 4) bifurcated between "active" and "inactive" advisory boards (ABET=ABET Accreditation | APR=Academic Program Review | MPR=Maintaining Program Relevancy).

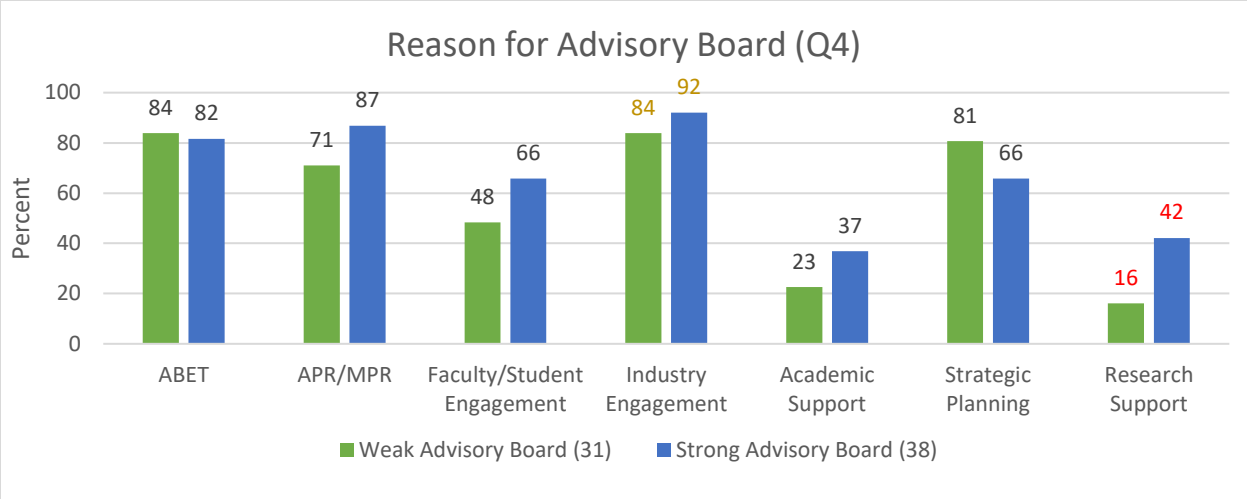

Figure 1b. Comparison of reasons for an advisory board bifurcated between "strong" and "weak" advisory boards (ABET=ABET Accreditation | APR=Academic Program Review | MPR=Maintaining Program Relevancy).

For Figures 1a and 1b, the values in red were determined to be statistically significant using the results of the Chi-Square tests of independence with $P = .05$. Values in yellow did not meet the assumptions of the Chi-Square test of independence and need to be further evaluated.

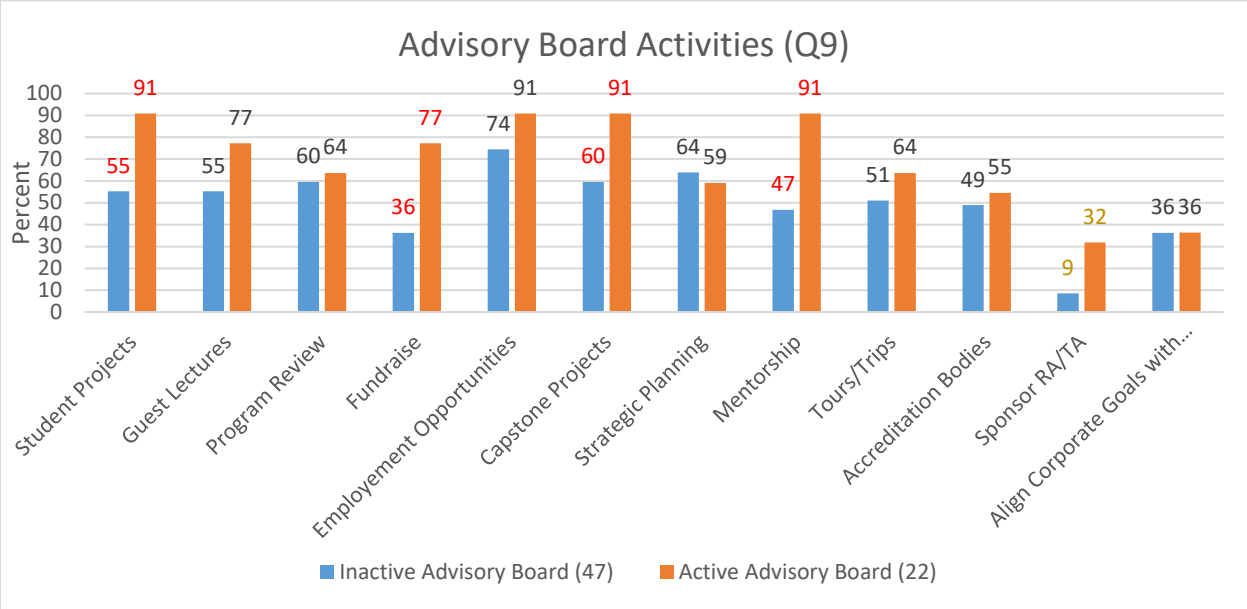

Figure 2a. Comparison of advisory board activity types (question 9) bifurcated between "active" and "inactive" advisory boards (Align Corporate … = Align Corporate Goals with University Foci).

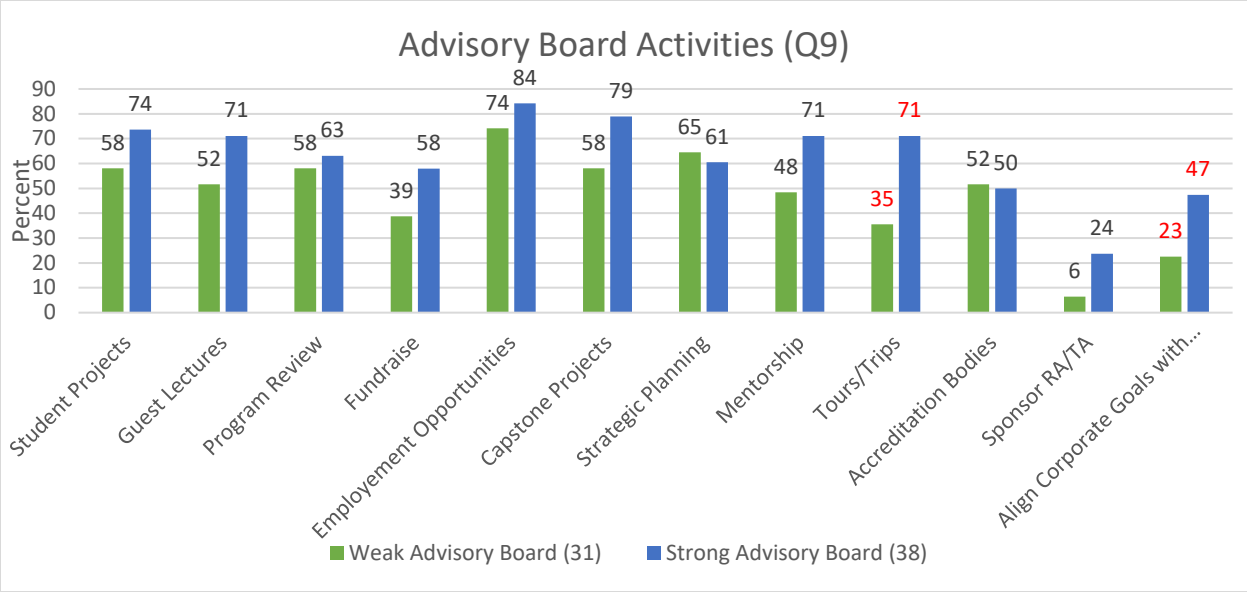

Figure 2b. Comparison of advisory board activity types (question 9) bifurcated between "strong" and "weak" advisory boards (Align Corporate … = Align Corporate Goals with University Foci).

For Figure 2a and 2b, values in red were determined to be statistically significant using the results of the Chi-Square tests of independence with $P = .05$. Values in yellow did not meet the assumptions of the Chi-Square test of independence and need to be further evaluated.

Figure 2 presents a comparison of advisory board activity types bifurcated based upon advisory board (a) activity and (b) strength. As can be seen in Figure 2a, of the many reasons, active advisory boards were more likely to have activities focusing on student projects, fundraising, capstone projects, and mentorship than their inactive counterparts. Outside of fundraising, which one might expect to see among active boards, the other three significant results all involve board members working directly with students. While the data also suggest that sponsorship of graduate research or teaching assistantships may be a hallmark of active advisory boards, this requires further evaluation. Regardless, these results lead us to posit that member engagement with students is vital for an active advisory board. Further, strong advisory boards were more likely to have activities involving tours/trips and aligning corporate goals with the universities' foci than their weaker counterparts (Figure 2b). Arguably, this also suggests that student engagement is vital for strong advisory boards. Additional responses in other questions not reported in Tables 1 and 2, such as those pertaining to having students being members of their advisory boards (both graduate and undergraduate) were also significantly more likely to have been chosen by active and strong advisory boards.

Planned Future Work

Beyond the analysis and insights above, the team is seeking to incorporate the Yate's correction for continuity to address the responses that failed to meet the assumptions of the Chi-Square test of independence. This will allow us to draw some results from this data that would not otherwise be possible [10]. Additionally, the team desires to perform additional analyses looking at how

the size of the university plays a role in advisory board success and whether there are any differences between universities with few vs. many engineering programs.

Beyond this dataset, the team is also seeking to apply its "Project Unlock" toolkit, including partnership projects, to a number of engineering programs across the U.S. An ongoing survey effort will be employed to determine if the Project Unlock effort is having the impact anticipated. Further, as more surveys are conducted to evaluate the effectiveness and impact of advisory boards, related to their level of activity and strength, the Project Unlock team seeks to document best practices and case studies that will serve as touchstones for improved student outcomes in engineering education.

Conclusions

As can be seen in this preliminary analysis, "active" and "strong" advisory boards for engineering education programs at institutions of higher learning across the U.S. have significant potential markers. Active advisory boards were significantly more likely to have listed faculty/student engagement, academic support, or research support as rationales for their board. Further, active advisory boards were more likely to have activities focusing on student projects, fundraising, capstone projects, and mentorship. Strong advisory boards, on the other hand, were significantly more likely to list research support as a reason for their board. Such advisory boards were more likely to have activities involving tours/trips and aligning corporate goals with the universities' foci. What this implies is that those boards that are both "active" and "strong", what we have termed "Industrial Partnership Boards", result in better outcomes that are educationally enhancing to students as well as provide financial, relational, and other benefits for all partners involved.

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