# AC 2008-466: MODELS FOR DIRECT INDUSTRY SUPPORT OF US CIVIL ENGINEERING PROGRAMS

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# Models for Direct Industry Support of US Civil Engineering Programs

## Abstract

Of the approximately 250 accredited civil engineering programs in the US, the proportion that have direct and formal advisement from local industry is unknown. Where present, external, corporate-style advisory boards made up of practicing engineers and executives from local engineering and construction firms provide formal support in the form of curricular development advice, scholarships and operational funding, as well as co-op and internship programs. The presence and involvement of advisory bodies focused on the departmental rather than the college or university level is perceived as a distinct program advantage and has been recognized by ABET program evaluators. Still, the relative benefits of direct industry support and advisement have not previously been measured.

This paper will describe the various forms of informal and formal CE program support and present a survey methodology for evaluating whether these arrangements have a quantifiable effect on program success. A database of advisory boards from surveyed programs is presented and analyzed. The objectives of this work are to correlate the relative performance of CE programs' enrollment, research expenditures, and other factors with direct advisement and support by external boards; and to enumerate the co-incentives that advisory boards and CE-programs share. A case study is presented based on the Civil Engineering Institute (CEI), a nonprofit Virginia corporation and formal advisory board established in 1989 whose purpose is to assist with the Civil and Infrastructure Engineering program of GMU. The paper will finally present guidance and suggestions for implementing formal program support.

## Introduction

There are many benefits for University engineering programs to interface directly with industry through the use of industry advisory boards (IABs). IABs are typically formed to provide formal or ad-hoc support for education programs, capital improvements, scholarships, sponsorship of events and activities, internships and co-op programs, as well as mentoring and placement of graduates. They serve to advise with curriculum development, assess achievement of program outcomes, and aid with strategic planning. They include members from large engineering organizations, other academic institutions, local companies, alumni, prominent leaders, as well as entrepreneurs. The IAB interaction with engineering programs is usually a successful partnership based on these factors. The members and member organizations of IABs also benefit from this partnership. They typically are allowed to identify and recruit the top-graduating students, shape the future workforce to meet the needs of industry, and in some cases realize tax savings for their monetary and in-kind contributions to the University or engineering program.

IABs that operate at the Department level are less common than College-level boards, but provide many of the same functions. These boards tend to be proactive rather passive, and exhibit more specific interactions as enumerated recently[1]. For example, proactive IABs: (1) recruit members, especially Chairs, that will fit well with the goals and objectives of the program; (2) support student organizations for travel or educational activities; (3) screen potential faculty and support recruiting efforts; and (4) promote K-12 outreach through speaker bureaus and student recruiting events. Paramount to these interactions is the endowment of scholarship funds available at the Department level with discretion for their disbursal to talented students usually given to the Department Chair or a faculty scholarship committee.

The motivation for this paper was to determine the level of IAB involvement with US civil engineering programs and its resulting impact. With such clear and logical co-incentives, i.e. mutual incentives to both the programs and the boards, one would expect the involvement of IABs with a particular program to be positively correlated with its success. Although success in a particular program may be difficult to describe, highly regarded programs have positive industry perceptions of their graduates, productive faculty, and strength in one or more sub-discipline areas. There are, however, some objective factors that can be measured such as enrollment and degree production, research expenditures, and third party rankings that may contribute to a program's success.

The following section presents a brief review of past research in the role of IABs in supporting engineering education programs. Next, three models for direct industry support by IABs are developed with the relative advantages of each discussed. A survey of IABs is presented to assess their presence and involvement in civil engineering programs based on their model type. A case study of the Civil Engineering Institute, an IAB that interacts with the Civil and Infrastructure Engineering Program at George Mason University is then presented. Finally, a list of suggestions for establishing a new civil engineering program level IAB are given.

***Previous Research***

Several studies have been performed and papers written on the effectiveness of IABs. Most studies describe IABs that operate at the engineering or college level and either discuss the relative benefits of IABs, survey or model their interaction, or discuss their beneficial role in the accreditation process.

Tener[2] provides a detailed profile of an IAB operating at the program level, specifically the Construction Engineering and Management Program at Purdue University. He cites several expectations that programs and IABs should have of one another including shared accountability for program outcomes. Stuart[3] discusses the case for a single company IAB (Boeing) and its role in supporting Oregon Institute of Technology. Some may question the legitimacy of having a sole company in an advisory role, however the dominance of Boeing in the local economy is a good example where such an IAB relationship is both beneficial and appropriate.

There has been some previous survey work in the effectiveness of IABs to support engineering programs. Rooney and Puerzer[4] conducted a survey of small (non-PhD granting) institutions to determine the status of IAB interactions. Among their survey questions were: What is the size of the IAB?, What is the frequency of their meetings?, What are some of their typical activities?, and What fraction of their membership is composed of alumni? The discussion of the survey results suggests that the degree of IAB interaction, although beneficial, had not yet achieved its full potential of program support. Genheimer and Shahab[5] recently developed a model to assess the effectiveness of advisory boards. Their organizational effectiveness-based model considers human relations, internal processes, rational goals, and open systems to arrive at a score for overall IAB effectiveness.

The value of IABs is especially apparent for ABET accreditation requirements. When the EC2000[6] standards were phased-in, programs undergoing re-accreditation began the transition to direct assessment of outcomes. Program evaluators were encouraged to request *external* evidence of program outcome achievement. Sanoff describes the experience of George Mason University, which benefits from IABs that support and advise each engineering program[7]. Board members, who are drawn from local companies and knowledgeable about the skills and abilities of graduates, were able to provide evidence of outcome achievement and testimony to the program's meeting of industry needs. Kramer describes similar outcome achievement support from IABs through their involvement in the University of San Diego capstone design sequence[8,9].

## Models for Direct Industry Support

Having described the co-incentives that IABs share with institutions and programs, and the interactions cited in the literature, it is now useful to characterize the different types of IABs. IABs are formal entities with a clearly defined mission to support the educational, research, and outreach objectives of the institution or program. Three models are presented to classify the type of IAB organization and its impact specifically at the program level.

### *College or School Only IAB*

The College or School-only IAB is assembled for the benefit of the engineering school as a whole and is by far the most common. IABs of this type usually interface with the School administration or development office. These boards typically meet annually or semi-annually, provide advice on high-level initiatives, and contribute funds for specific events or needs[1]. College or School IABs typically do not interact with individual programs, although they do provide indirect support.

### *Multi-level IAB*

The Multi-level IAB is centralized at the College level, but maintains standing committees or councils to support the constituent programs. This model offers the advantage of providing direct industry support for each program, while coordinating efforts through a central body. The Industrial & Professional Advisory Council (IPAC) at The Pennsylvania State University is an example of this model[10]. The IPAC consists of alumni and individuals from industry and academia who advise the PSU College of Engineering on a range of issues. Each College program has a Department IPAC, which reports to a College-level Executive Committee. The Executive Committee is comprised of the Department IPAC Chairs. The Executive Committee meets annually while the Department IPACs may meet several times per annum.

### *Dedicated Department IAB*

The Dedicated Departmental Model is used to characterize IABs that are devoted only to the Department or program and remain independent from other boards. In some cases, these IABs are completely separate entities, independent from the University, and organized as non-profit corporations. Dedicated IABs have the potential to provide the greatest benefit to the Department or program because their organization and activities are focused only on the Department. This model has two sub-categories. The first is *simple organization* and the second is *committee organization.* Simple organization involves a board with fixed or rotating members that address all the needs, functions, and interactions with the program. Committee organization involves a group of committees assigned to activities such as membership, scholarships, or internships that report to the Board of Directors of the IAB. The Civil Engineering Institute (CEI)[11] at George Mason University is an example of the committee organized, dedicated department IAB. The CEI is profiled as a case study later in this paper.

## Survey of Advisory Boards for Accredited Programs

Given these models of direct industry support, a survey was performed to determine: (1) the occurrence of IAB involvement with US civil engineering programs; (2) if present, the model encountered; and (3) any quantifiable impact on program success. The survey was based on currently accredited US civil engineering and civil engineering technology programs. The survey questions to be answered included:

- Does the Department or program have a formal IAB?
- If so, which model most closely matches its structure?
- How large is the board and what is the nature of its membership? (Alumni, private companies, local firms, other academic institutions, etc.)
- Are there any notable achievements of the advisory board?

A web-based survey was performed and the results were compiled in a database.

### *Survey Methodology*

The list of currently accredited (as of October 1, 2007) civil engineering programs was obtained from the Accreditation Board of Engineering and Technology (ABET) website[12]. 251 accredited civil engineering and civil engineering technology programs were identified. An Internet search engine was used to identify the primary Departmental website for each program which was recorded in the database. Each Department website and any related websites (e.g., affiliated or interdisciplinary programs, research centers, etc.) were reviewed for mention of an IAB. If an IAB was identified and information available, the approximate size, member list, or presence of organizing documents (constitution, bylaws, minutes, annual reports) were noted.
A GMU undergraduate civil engineering student and co-author of this paper performed the web-based survey, which took approximately 20 hours to complete.

The approach for the survey relied on evidence of an IAB's existence to be available on the program website or affiliated websites. *It does not suggest definitively whether an IAB does or does not exist for each program.* An alternative survey methodology considered was the development and distribution of a voluntary online survey which would ask civil engineering programs to self-report the presence of and, if applicable, the degree of IAB interaction with their program. A survey approach similar to this one had previously been used to determine IAB interaction for smaller, non-PhD degree granting institutions[4]. This methodology was ruled out for two reasons. First, the relatively low rate of response from these types of surveys (less than 50% in the survey mentioned above) and long response periods would likely not provide a representative view of IAB-program interaction and would not address the present study objectives. Second, the involvement of an IAB, fitting the School, Department, or Multi-level model is believed to be so advantageous to the program, that its existence and a description of its activities can be expected to be touted through the Department's web presence. There would be no reason to list the presence of an IAB unless one actually existed (Type II error), except for the possibility of the IAB lapsing or disbanding. Similarly, if no evidence of an IAB could be found, it is improbable that one indeed exists (Type I error), as the benefits of IAB interaction would be a valuable student recruiting asset, beneficial in the eyes of ABET program evaluators, and well worth promoting. At the very least, the chosen methodology was judged to have a low rate of Type I and Type II errors as described above, and would compensate for the expected low response rate had a direct survey methodology been chosen.

Department websites were visited in sequential order based on the list of currently accredited civil and civil engineering technology programs[12]. A classification scheme was developed to describe the model of IAB encountered: "E" for College only IABs, "M" for Multi-level IABs, "D" for simple organization Department IABs and "DC" for committee organized IABs. For a program to have a designated "E" model, its website must have made mention of the College-level IAB and its relationship with it. In other words, the survey did not record if a College-level IAB was in place if the civil engineering program did not refer to it.

### *Survey Results*

Of the 251 accredited civil engineering and technology programs, 126 (50.2%) were found to have some evidence of an IAB as of December 2007. Most civil engineering programs with IABs had prominent links on their websites for their boards, often grouped with "industry partner" or "alumni relations" information. Separate sections or totally separate websites provided information ranging from a basic mission statement to detailed organizational information including items such as a constitution, by-laws, annual reports, meeting minutes, etc. It must be restated that the survey reflects only whether evidence of an IAB was present and, in the case of a College-level IAB, beneficial to the program, not whether one actually exists or not. The survey results are summarized in Figure 1.

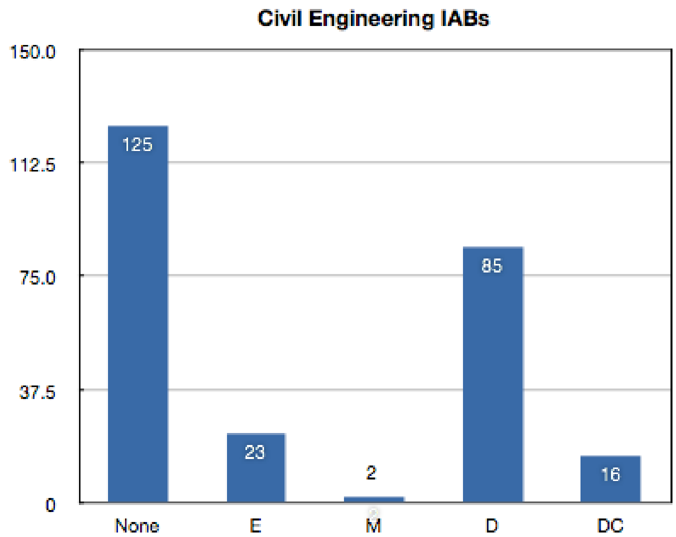


**Figure 1: Number of IABs identified for College-only (E), Multi-level (M), Department (D), or Department with committee organization (DC).**

Of the 126 IABs identified, 23 were classified as College-Level (E), but interacting with the program. 2 were of the multi-level (M) model, 85 were of the simplified organization, department (D) model, and 16 were of the committee organization, department (DC) model. The two multi-level model programs were the Civil Engineering IPAC at Penn State and the University of Alaska, Anchorage School of Engineering Advisory Board. The 16 DC IABs were found to have significant organizational materials, meeting minutes, committee reports, and other data suggesting a high level of activity and engagement. This group is listed in Table 1. In addition to the institution name, location, and Department website address, the size of the advisory board is listed if that information was available. The 85 D IABs had member rosters, mission statements, or other basic information describing their board and its relationship to the civil engineering program. A listing of these programs is provided in Table 5 in the Appendix.

**Table 1: Civil Engineering programs with committee organization, Department (DC) IABs.**

| INSTITUTION | LOCATION | DEPT. WEBSITE | MEMBERS |
|---|---|---|---|
| Arizona State University | Tempe, AZ | http://cee.fulton.asu.edu/ | 80 |
| University of Arizona | Tuscon, AZ | http://civil.web.arizona.edu/cms/ | 30 |
| Auburn University | Auburn, AL | http://eng.auburn.edu/programs/civil/ | |
| California State University, Sacramento | Sacramento, CA | http://www.ecs.csus.edu/ce/ | 20 |
| University of California, Los Angeles | Los Angeles, CA | http://cee.ucla.edu/cgi-bin/main.php | 10 |
| University of Delaware | Newark, DE | http://www.ce.udel.edu/ | 18 |
| George Mason University | Fairfax, VA | http://www.civil.gmu.edu/ | |
| Georgia Institute of Technology | Atlanta, GA | http://www.ce.gatech.edu/ | 42 |
| Illinois Institute of Technology | Chicago, IL | http://www.iit.edu/~ce/ | 18 |
| Iowa State University | Ames, IA | http://www.ccee.iastate.edu/ | 13 |
| University of Kentucky | Lexington, KY | http://www.engr.uky.edu/ce/ | |
| Lamar University | Beaumont, TX | http://ceserver.lamar.edu/ | 29 |
| University of Missouri-Rolla | Rolla, MO | http://civil.umr.edu/ | |
| New Jersey Institute of Technology | Newark, NJ | http://civil.njit.edu/ | 13 |
| New Mexico State University | Las Cruces, NM | http://cagesun.nmsu.edu/ | |
| University of Texas at Austin | Austin, TX | http://www.ce.utexas.edu/ | 30 |

***Survey Metrics***

In order to make assessments about the relative success of a particular program, additional data were obtained for the 16 programs in Table 1. The 2006 Engineering Profile Data and Statistics database[13] (the most recent available) was used to determine the undergraduate, i.e., B.S. enrollment, number of B.S. degrees awarded, and total program research expenditures for the DC-class IAB programs.

Two metrics were devised to represent the normalized characteristics of these programs. First, the *productivity* of the program is defined as the ratio of enrollment to degree production. Literally, programs with a lower productivity ratio gradate more of their students every year. Second, the *expenditures per student* of the program are the expenditures divided by the undergraduate enrollment of each program. Table 2 summarizes the Engineering Profile Data and the selected metrics.

Many other metrics are possible including expenditures by faculty member full-time equivalent, per graduate, etc.. These simple metrics are intended only as an initial investigation of the IAB-supported programs when compared to other groups. It also must be stated that this is a single year snapshot, which does not capture enrollment trends within a four-year cohort nor variations in research expenditures.

**Table 2: 2006 Engineering Profile Data and chosen metrics for DC IAB Programs.**

| SCHOOL | B.S. CIVIL ENROLLMENT | B.S. DEGREES | PRODUC-TIVITY | RESEARCH EXPENDITURES | EXP. PER STUDENT ENROLLED |
|---|---|---|---|---|---|
| Arizona State | 486 | 75 | 6.48 | $3,475,431 | $7,151 |
| U of Arizona | 200 | 38 | 5.26 | $649,311 | $3,247 |
| Auburn University | 417 | 91 | 4.58 | $6,694,000 | $16,053 |
| Cal State, Sacramento | 377 | 45 | 8.38 | NA | NA |
| UCLA | 255 | 51 | 5.00 | $2,918,334 | $11,444 |
| U of Delaware | 301 | 52 | 5.79 | $4,458,000 | $14,811 |
| George Mason U | 155 | 27 | 5.74 | $393,296 | $2,537 |
| Cal Tech | 632 | 156 | 4.05 | NA | NA |
| IL Inst Tech | 112 | 16 | 7.00 | NA | NA |
| Iowa State | 409 | 92 | 4.45 | $10,369,000 | $25,352 |
| U of Kentucky | 342 | 84 | 4.07 | NA | NA |
| Lamar University | 87 | 14 | 6.21 | $189,941 | $2,183 |
| U Missouri-Rolla | 338 | 78 | 4.33 | NA | NA |
| NJIT | 283 | 41 | 6.90 | $916,594 | $3,239 |
| NM State | 287 | 30 | 9.57 | $3,877,203 | $13,509 |
| UT Austin | 451 | 81 | 5.57 | $2,474,319 | $5,486 |

The median B.S. enrollment, number of B.S. degrees awarded, and research expenditures for programs advised by the highly engaged DC IABs were 319.5, 51.5, and $2,918,334, respectively. The median productivity and expenditure per student were 5.65 and $6,319, respectively. Comparable statistics for *all* civil engineering programs were not compiled for this survey. However, the number of B.S. civil degrees awarded by the top 50 degree-producing programs ranged from 203 down to 58 degrees, representing roughly one quarter of the programs surveyed[13]. Thus, the median of these programs is near the 75$^{th}$ percentile in degree production. This suggests that larger programs, as can be seen from Table 2, may be more likely to have a DC-type IAB.

***Comparing IAB programs with Third-Party Rankings***

A stated goal of this study was to determine whether the presence and level of involvement of a program-oriented IAB has an impact on the success of the program. As previously stated, success can be difficult to measure because of perceived reputation, asymmetric undergraduate/graduate programs, and other factors. As a cursory comparison, the productivity and research expenditures per B.S. student for the IAB DC programs (Table 1) were compared with schools in the US News and World Report 2008 America's Best Colleges, civil engineering specialty area[14]. The highest ranked undergraduate civil engineering programs were divided into two categories, non-PhD granting (12 programs ranked), and PhD-granting (21 programs ranked). For the purpose of this study, rankings were ignored and are not duplicated here.

The B.S. enrollment, number of B.S. degrees awarded, productivity, research expenditures, and per-student expenditures were compiled separately for both the non-PhD granting and PhD-granting programs, for comparison with the IAB programs. Table 3 and Table 4 summarize this data for each ranking type. The enrollment, degree production, and research expenditure data were also obtained from the ASEE 2006 College Profiles database. If data were not available for a particular program, "NA" is listed in the table.

**Table 3: US News and World Report 2008 Best Civil Engineering Non-PhD granting programs (unranked).**

| SCHOOL | B.S. CIVIL ENROLL. | B.S. DEGREES | PRODUC-TIVITY | RESEARCH EXPENDITURES | EXPEND. PER STUDENT |
|---|---|---|---|---|---|
| Bradley University | 119 | 29 | 4.10 | $28,624 | $241 |
| Bucknell University | 145 | 29 | 5.00 | NA | NA |
| Cal Poly, SLO | 732 | 176 | 4.16 | $832,224 | $1,137 |
| The Citadel | 194 | 38 | 5.11 | NA | NA |
| Cooper Union | 100 | 20 | 5.00 | NA | NA |
| Harvey Mudd | 214 | 62 | 3.45 | NA | NA |
| Lafayette | 94 | 26 | 3.62 | NA | NA |
| Rose-Hullman | 171 | 30 | 5.70 | $92,651 | $542 |
| Rowan | 120 | 23 | 5.22 | $388,358 | $3,236 |
| USAF | 152 | 33 | 4.61 | NA | NA |
| USMA | 112 | 47 | 2.38 | NA | NA |
| VMI | 156 | 23 | 6.78 | NA | NA |

**Table 4: US News and World Report 2008 Best Civil Engineering PhD-granting programs (unranked).**

| SCHOOL | B.S. CIVIL ENROLL. | B.S. DEGREES | PRODUC-TIVITY | RESEARCH EXPEND. | PER STUDENT EXP |
|---|---|---|---|---|---|
| California Institute of Technology | NA | NA | | NA | NA |
| Cornell University | 121 | 37 | 3.27 | $5,098,980 | $42,140 |
| Georgia Institute of Technology | 632 | 156 | 4.05 | NA | NA |
| Johns Hopkins University | 47 | 12 | 3.92 | $666,000 | $14,170 |
| Massachusetts Inst. of Technology | 45 | 13 | 3.46 | $12,494,000 | $277,644 |
| Northwestern University | 54 | 16 | 3.38 | NA | NA |
| Pennsylvania State U | 510 | 167 | 3.05 | $11,580,296 | $22,706 |
| Princeton University | 54 | 21 | 2.57 | $2,733,725 | $50,625 |
| Purdue Univ.-West Lafayette | 333 | 136 | 2.45 | $15,664,993 | $47,042 |
| Rensselaer Polytechnic Inst. | 197 | 38 | 5.18 | $3,602,099 | $18,285 |
| Stanford University | 50 | 33 | 1.52 | $10,833,522 | $216,670 |
| Texas A&M Univ | 846 | 203 | 4.17 | $64,668,000 | $76,440 |
| U. of Illinois-Urbana-Champaign | 523 | 113 | 4.63 | $15,742,000 | $30,099 |
| Univ. of California-San Diego | NA | NA | NA | $18,245,000 | NA |
| Univ. of Wisconsin-Madison | 228 | 102 | 2.24 | $9,560,000 | $41,930 |
| University of California-Berkeley | 199 | 102 | 1.95 | $19,929,000 | $100,146 |
| University of Florida | 661 | 124 | 5.33 | 18245000 | $27,602 |
| University of Michigan-Ann Arbor | 162 | 46 | 3.52 | $5,054,000 | $31,198 |
| University of Texas-Austin | 451 | 82 | 5.50 | $2,474,319 | $5,486 |
| University of Washington | 190 | 105 | 1.81 | $10,393,000 | $54,700 |
| Virginia Tech | 558 | 145 | 3.85 | $23,023,790 | $41,261 |

For top ranked non-PhD producing programs, the median civil enrollment is 148.5, B.S. production is 29.5, productivity is 4.80, research expenditures are $240,505, and per-B.S. student expenditures are $839.36. Based on median values, enrollment and degree production are roughly one half that of the IAB group. The productivity ratio is lower than the IAB group. Research expenditures and expenditures per student are only a small fraction of the IAB group, which is not surprising given the teaching focus of the non-PhD group.

For top ranked PhD producing programs, the median civil enrollment is 199, B.S. production is 102, productivity is 3.46, research expenditures are $11,206,909, and per B.S. student expenditure is $41,930. Based on median values, the enrollment is smaller, degree production is greater, and research is greater by a factor of more than three. The productivity ratio is smallest for this group.

The distributions of productivity and research expenditures per B.S. student were also considered and compared as shown in Figure 2 and Figure 3, respectively For productivity, the distributions show some skew towards low productivity ratios for PhD-granting programs. The distribution of the IAB productivity is actually skewed to the right. All three groups seem to exhibit a central tendency between 4 and 6 B.S. degrees awarded per student enrolled. For research expenditures per undergraduate student, the non-PhD degree-granting group has insufficient data for any comparison. The IAB group seems to be distributed similarly to the PhD-granting top ranked civil programs.

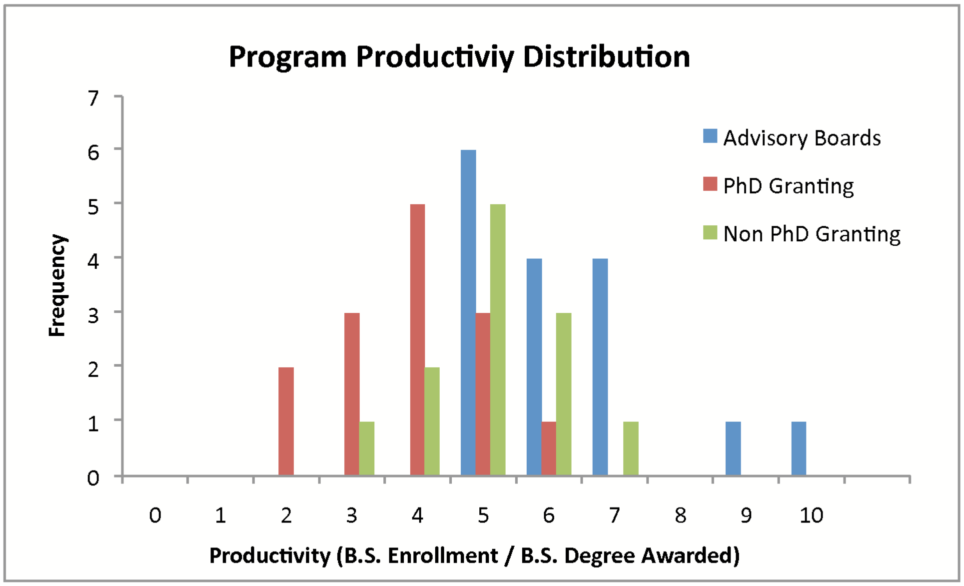


**Figure 2: Productivity distribution.**

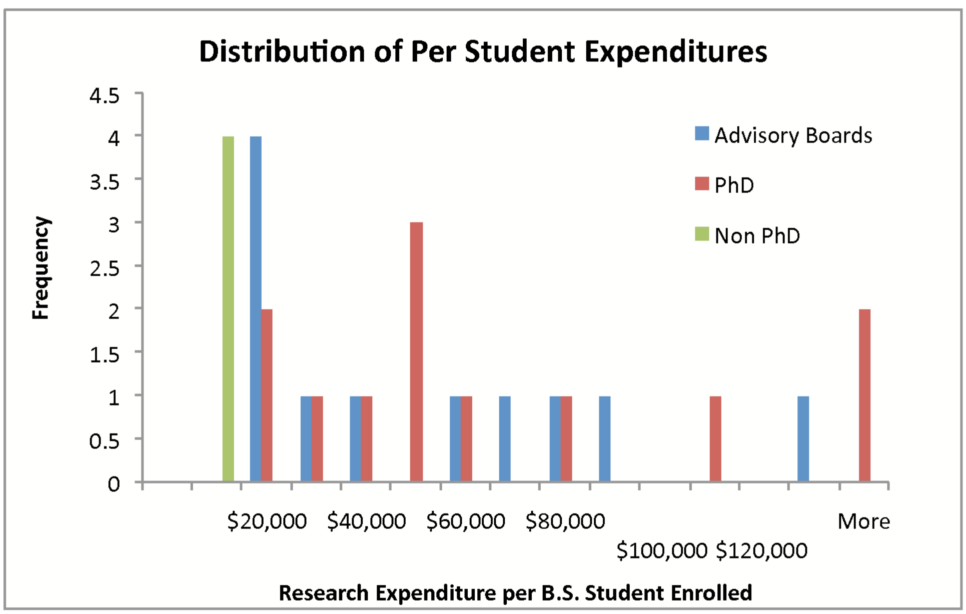


**Figure 3: Research expenditures per student distribution.**

## Discussion

The results of the IAB survey were very useful in identifying the presence and makeup of IABs that support accredited civil and civil engineering technology programs. The comparison between the study group of IAB-backed programs and the top non-PhD granting and top PhD-granting civil programs does not seem to produce a clear link between IAB existence and program success, unfortunately. Some insights from the survey analysis can be identified, however.

Only about one half of the accredited programs had IABs identified by this survey and many of the "best ranked" programs lacked one. The cohort of civil engineer programs matching the Departmental, committee organized IAB model, shared some success factors with best-ranked programs, especially in terms of enrollment trends. These IABs span the range of small to very large programs with the greatest number of boards near the mean enrollment of around 400 students.

None of the best-ranked non-PhD granting programs had highly active or beneficial IABs as identified by this survey, but two (Rose-Hullman and Lafayette College) did have simple organized advisory boards. By contrast, several of the large PhD-granting programs also had active (DC) IABs.

The distributions of the selected metrics (productivity and research expenditures per student) showed some mixed trends when compared to the top-ranked programs. Had the distributions of IAB programs closely matched those of the top ranked programs, a case for correlation between the presence of IABs and top-ranking might be made, but the results are inconclusive. At a minimum, IABs do not hinder membership in a top ranked group.

## Case Study: GMU Civil Engineering Institute (CEI)

The Civil Engineering Institute (CEI) is a nonprofit corporation registered in the State of Virginia since 1989 whose purpose is to assist with the Civil and Infrastructure Engineering program of George Mason University (GMU). The establishment of CEI actually predates the establishment of the program at GMU. While its original goal was the creation of the civil engineering program itself, it has evolved to become an integral component of the program's operations. CEI

CEI is governed by a Board of Directors, which for 2008, has 23 members composed of Alumni, senior engineers, and executives from local industry. Each board member has a three-year appointment. Faculty in the Civil, Environmental, and Infrastructure Engineering Department are members ex-officio and are not included in the count above. A Vice-Chair, Chair, and Executive Director are the officers of the Board and coordinate several standing committees including a scholarship and internship committee as well as a by-laws and nominating committee. To date, CEI has coordinated the establishment of an endowed professorship in the name of Sydney O. Dewberry, co-founder and Chairman, Board of Directors of the Dewberry Companies and founding Chair of CEI. It has provided significant scholarship, program and student activity support including major funding for 5 international engineering education trips for the GMU Chapter of ASCE. The CEI liaises with the Volgeau School of IT and Engineering Dean's Advisory Council and has provided significant interaction with ABET program evaluators during GMU's recent re-accreditation.

***Suggestions for Establishing a Formal Advisory Board***

The creation of an advisory board where one does not already exist presents a significant challenge in the beginning. Market research to establish trends and conditions from local and regional firms is needed to establish need. The tapping of an alumni network would be especially useful as graduates will be much more likely to support their own program. Coordinating with a School or University advisory board *may* present a challenge as some development staff prefer to elevate corporate interfaces at a higher level of administration. We advocate that despite these challenges, the establishment of the AB at the Department level has the greatest benefit. The following specific suggestions are presented for establishing an advisory board.

- *Identify a champion.* It only takes a single prominent individual from industry or an alumnus on which to focus support. The individual should be personally committed and have a vested interest in establishing the board for the mutual long-term benefit of both the program and industry. As the board is formed, the champion can become the logical founding Chairman.
- *Create an independent organizational structure.* Although informal bodies can contribute many of the IAB benefits discussed, a formal, corporate-style board is considered more desirable. A corporate board can operate independently from the program and the University and will be free to choose its on membership and to set its own agenda without undue influence from higher university officials. A non-profit corporate model is well suited to this purpose. This model may be easier to establish if a University Foundation holds the Board's finances. In this way, contributions to the board for scholarships or operational support as well as member dues may be considered charitable donations and result in tax savings for the member. Every Institution's structure is different, so implementation may vary.
- *Create a permanent tie to the program.* Successful IABs can prosper through their dual nature. On the one hand, they are ideally independent from the University or school with separate finances and governance. On the other hand, they may formalize an arrangement with the civil engineering program such that the Executive Director of the IAB is a senior professor or they may endow a Chair in the Department that is tied to the IAB formally. What ever the arrangement, the tie should be structural and formal.
- *Identify clear co-incentives and return on investment.* This paper has listed many clear benefits from the perspective of the program, but the benefits to potential board members may be less clear. One tangible benefit is the establishment of a formal internship program from which IAB members can select student for summer or part-time employment. It should be clear to potential members that first choice of students is available to participants in the IAB.
- *Engender a succession of engaged and well-connected Board members.* One widely accepted practice of successful IABs is the naming of officers to establish a succession for leadership of the board. Because of personal and professional commitments, it is unreasonable to expect that the original champion of the board can remain in a leadership role indefinitely.

## Conclusions

The goal of this paper was to profile the prevalence of Industry Advisory Boards (IABs) and their impact on civil engineering and engineering technology programs. Three models of direct industry support were developed and a survey of accredited programs showed that approximately one half show evidence of IAB interaction on their primary websites. A comparative analysis of programs with these boards was performed against top-ranked civil engineering programs which showed that large enrollment programs were more likely to have IAB interaction. Although some trends in these and other factors were visible, the study did not find clear correlation between program success and IAB involvement, although large programs were found to be members of both groups.


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## Appendix

**Table 5: Civil engineering programs found to have simple organized, Departmental IAB support.**

| INSTITUTE | LOCATION | DEPT. WEB |
|---|---|---|
| The University of Akron | Akron, OH | http://civil.uakron.edu/ |
| University of Alabama at Birmingham | Birmingham, AL | http://main.uab.edu/soeng/Templates/Inner.aspx?durki=49363&pid=49363 |
| Boise State University | Boise, ID | http://coen.boisestate.edu/ce/home.asp |
| Bradley University | Peoria, IL | http://www.bradley.edu/academics/eng/Civil/Html/index.htm |
| California Polytechnic State University, San Luis Obispo | San Luis Obispo, CA | http://ceenve.calpoly.edu/ |
| California State University, Fresno | Fresno, CA | http://www.csufresno.edu/engineering/departments_programs/civil_geomatic_const/programs/civil/index.shtml |
| California State University, Los Angeles | Los Angeles, CA | http://www.calstatela.edu/academic/ecst/civil/index.htm |
| University of California, Irvine | Irvine, CA | http://www.eng.uci.edu/dept/cee |
| Christian Brothers University | Memphis, TN | http://www.cbu.edu/Academics/civil.html |
| Clemson University | Clemson, SC | http://www.clemson.edu/ce/ |
| Cleveland State University | Cleveland, OH | http://www.csuohio.edu/engineering/ |
| University of Colorado at Boulder | Boulder, CO | http://ceae.colorado.edu/new/ |
| Columbia University | New York, NY | http://www.civil.columbia.edu/ |
| Cornell University | Ithaca, NY | http://www.cee.cornell.edu/ |
| University of Dayton | Dayton, OH | http://engineering.udayton.edu/programs/civil/default.asp |
| University of Detroit Mercy | Detroit, MI | http://eng-sci.udmercy.edu/civil/index.html |
| Duke University | Durham, NC | http://www.cee.duke.edu/ |
| Embry-Riddle Aeronautical University - Daytona Beach | Daytona Beach, FL | http://www.erau.edu/omni/db/academicorgs/dbced/ |
| University of Evansville | Evansville, IN | http://mece.evansville.edu/civil/index.asp |
| Florida A&M University/Florida State University(FAMU-FSU) | Tallahassee, FL | http://www.eng.fsu.edu/departments/civil/index.php |
| Florida Atlantic University | Boca Raton, FL | http://www.civil.fau.edu/ |
| Florida Institute of Technology | Melbourne, FL | http://coe.fit.edu/civil/ |
| Florida International University (University Park) | Miami, FL | http://www.eng.fiu.edu/cec/CEC_BS_Civil.htm |
| University of Florida | Gainesville, FL | http://www.ce.ufl.edu/ |
| Georgia Southern University | Statesboro, GA | http://cost.georgiasouthern.edu/cmcet/ |
| University of Hawaii at Manoa | Honolulu, HI | http://www.cee.hawaii.edu/ |
| University of Houston | Houston, TX | http://www.egr.uh.edu/CIVE/ |
| Indiana University-Purdue University Fort Wayne | Fort Wayne, IN | http://www.mcet.ipfw.edu/programs/CETprogram.html |
| Indiana University-Purdue University Indianapolis | Indianapolis, IN | http://www.engr.iupui.edu/cnt/index.shtml |
| University of Iowa | Iowa City, IA | http://www.cee.engineering.uiowa.edu/ |
| The Johns Hopkins University | Baltimore, MD | http://www.ce.jhu.edu/ |
| The University of Kansas | Lawence, KS | http://www.ceae.engr.ku.edu/ |
| Lakeland Community College | Mentor, OH | http://lakelandcc.edu/academic/engineer/civil/ |
| Lawrence Technological University | Southfield, MI | http://www.ltu.edu/engineering/civil/.asp |
| University of Louisiana at Lafayette | Lafayette, LA | http://civil.louisiana.edu/ |
| Louisiana Tech University | Ruston, LA | http://www.latech.edu/coes/civil-engineering/ |

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|---|---|---|
| University of Massachusetts Dartmouth | North Dartmouth, MA | http://www.umassd.edu/engineering/cen/ |
| University of Massachusetts Lowell | Lowell, MA | http://www.uml.edu/college/engineering/Civil/Default.html |
| The University of Memphis | Memphis, TN | http://www.ce.memphis.edu/ |
| Metropolitan State College of Denver | Denver, CO | http://www.mscd.edu/~cet/ |
| University of Miami | Coral Gables, FL | http://www6.miami.edu/UMH/CDA/UMH_Main/1,1770,51247-1;10683-3,00.html |
| Michigan State University | East Lansing, MI | http://www.egr.msu.edu/cee/ |
| Minnesota State University, Mankato | Mankato, MN | http://cset.mnsu.edu/mece/ce/ |
| University of Missouri-Kansas City | Kansas City, MO | http://www.sce.umkc.edu/cme/ |
| Montana State University-Bozeman | Bozeman, MT | http://www.coe.montana.edu/ce/ |
| University of Nebraska-Lincoln | Lincoln, NE | http://www.engineering.unl.edu/academicunits/civil/index.shtml |
| University of Nevada-Las Vegas | Las Vegas, NV | http://www.ce.egr.unlv.edu/ |
| University of New Hampshire | Durham, NH | http://www.unh.edu/civil-engineering/index.html |
| City University of New York, City College | New York, NY | http://www-ce.engr.ccny.cuny.edu/ |
| North Carolina Agricultural and Technical State University | Greensboro, NC | http://www.eng.ncat.edu/dept/caae/ |
| North Dakota State University | Fargo, ND | http://www.ce.ndsu.nodak.edu/ |
| Northern Arizona University | Flagstaff, AZ | http://www.cens.nau.edu/Academic/CENE/ |
| The Ohio State University | Columbus, OH | http://www-ceg.eng.ohio-state.edu/ |
| Ohio University | Athens, OH | http://www.ohio.edu/civil/index.cfm |
| Oklahoma State University | Stillwater, OK | http://cive.okstate.edu/ |
| Oregon State University | Corvallis, OR | http://cce.oregonstate.edu/ |
| Purdue University at West Lafayette | West Lafayette, IN | https://engineering.purdue.edu/CE/ |
| University of Rhode Island | Kingston, RI | http://www.uri.edu/cve/ |
| Rose-Hulman Institute of Technology | Terre Haute, IN | http://www.rose-hulman.edu/ce/ |
| Rutgers, The State University of New Jersey | New Brunswick, NJ | http://www.civeng.rutgers.edu/ |
| San Jose State University | San Jose, CA | http://www.engr.sjsu.edu/civil/ |
| Santa Clara University | Santa Clara, CA | http://www.scu.edu/engineering/ce/index.cfm |
| University of South Carolina | Columbia, SC | http://www.ce.sc.edu/default.asp |
| South Dakota State University | Brookings, SD | http://www3.sdstate.edu/Academics/CollegeOfEngineering/CivilandEnvironmentalEngineering/ |
| Southern Illinois University at Carbondale | Carbondale, IL | http://civil.engr.siu.edu/civil/home.asp |
| Southern Methodist University | Dallas, TX | http://engr.smu.edu/ence/index.html |
| Southern University and Agricultural & Mechanical College | Baton Rouge, LA | http://www.engr.subr.edu/CE/index.html |
| Syracuse University | Syracuse, NY | http://www.lcs.syr.edu/academic/civilenvironment_eng/index.aspx |
| University of Tennessee at Knoxville | Knoxville, TN | http://www.engr.utk.edu/civil/ |
| Tenessee Technological | Cookeville, TN | http://www.tntech.edu/cee/ |

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|---|---|---|
| University | | |
| University of Texas at Arlington | Arlington, TX | http://www-ce.uta.edu/ |
| The University of Texas at San Antonio | San Antonio, TX | http://engineering.utsa.edu/CEindex.html |
| Texas Tech University | Lubbock, TX | http://www.ce.ttu.edu/ |
| The University of Toledo | Toledo, OH | http://www.eng.utoledo.edu/civil/ |
| Vanderbilt University | Nashville, TN | http://www.cee.vanderbilt.edu/ |
| Villanova University | Villanova, PA | http://www.villanova.edu/engineering/departments/civil/ |
| Virginia Polytechnic Institute and State University | Blacksburg, VA | http://www.cee.vt.edu/ |
| University of Virginia | Charlottesville, VA | http://ce.virginia.edu/ |
| Washington State University | Pullman, WA | http://www.ce.wsu.edu/ |
| Wayne State University | Detroit, MI | http://www.eng.wayne.edu/page.php?id=59 |
| West Virginia University | Morgantown, WV | http://www.cee.cemr.wvu.edu/ |
| University of Wisconsin-Milwaukee | Milwaukee, WI | http://www4.uwm.edu/ceas/cem/ |
| Worcester Polytechnic Institute | Worcester, MA | http://www.wpi.edu/Academics/Depts/CEE/index.html |
| University of Wyoming | Laramie, WY | http://wwweng.uwyo.edu/civil/ |