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## **An Academic – Industry Partnership for Preparing the Next Generation of Ethical Engineers for Professional Practice**

DAYOUNG KIM  
BRENT K. JESIEK  
CARLA B. ZOLTOWSKI  
MICHAEL C. LOUI

AND

ANDREW O. BRIGHTMAN  
Purdue University  
West Lafayette, IN

### **ABSTRACT**

In light of both social and ABET expectations, engineering educators need to consider how to effectively infuse engineering ethics education into current engineering curricula. This article describes our initial efforts in that realm. We considered how to improve ethics education in engineering through establishing an academic-industry partnership, which facilitated conversation between engineering faculty members and practicing engineers in industry. We formed a College-level Ethics Advisory Council with representation from industry partners across all 13 engineering departments in Purdue's College of Engineering. As the first official activity, we held an Ethics Advisory Council Workshop to define common goals and share mutual expectations for long-term relationships. This article shares some basic information about the academic-industry partnership and outputs from the Ethics Advisory Council Workshop. We also discuss lessons we learned from the initial work on the partnership, including limitations and other considerations important for potential adopters of such a strategy at their institution. This article can provide insights to engineering educators who are interested in adopting the academic-industry partnership approach to facilitate direct conversations between academia and industry, especially for better engineering ethics education.

**Key words:** ethics, industry involvement, engineering curriculum



## INTRODUCTION

In light of continual, high profile ethical failures, such as the Volkswagen emissions scandal (Valentini & Kruckeberg 2018), we cannot emphasize enough the importance of engineering ethics education throughout college and into workplaces to shape a foundation for further ethical development among engineers. For this reason, accreditation standards have emphasized ethical and professional responsibilities as a required student outcome (ABET, 1997). However, we do not clearly know how to effectively infuse ethics into engineering curricula to prepare students for the everyday ethical situations that engineers encounter in their workplaces.

Moreover, pressures in the workplace frequently challenge the engineer to maintain high standards of practice. According to the National Business Ethics Survey (Ethics Resource Center, 2011), five of the top eight factors that pressure people to compromise ethical standards are related to corporate culture and values. The top factor (reported in 70% of cases) was the pressure to meet unrealistic business goals. Such pressure is faced by engineers not only in industry by engineers in industry. It has long been recognized that engineers in other workplaces such as government also face pressures that affect ethical conduct (Kornhauser, 1962). How then do we identify the kinds of everyday workplace challenges faced by engineers and prepare future engineers to effectively and ethically respond in such situations?

We think that improving ethics education requires more direct conversations between industry and academia. As an initial step, we created an academic-industry partnership in the form of an Ethics Advisory Council for the College of Engineering at our university. With funding support from the Dean of Engineering, we invited industry partners to discuss how we might prioritize attention to ethics and compliance in engineering curricula, and to develop engineering ethics education that is better aligned with practitioners' real-world experiences.

This article describes our initial efforts to better understand how to improve ethics education in engineering through establishing an academic-industry partnership that facilitates conversation between engineering faculty members and practicing engineers in industry. After reviewing the literature related to academic-industry partnerships, we will present the specific goals that guided the early development of our initiative. We also include the goals and outcomes of the first annual meeting of the Ethics Advisory Council, a workshop held in April 2018. We expect that this paper could benefit engineering educators and practitioners who are interested in improving engineering ethics education and ethical conduct in workplaces.

## LITERATURE REVIEW

As engineers navigate ethical problems in their workplaces, they face complex considerations which they might not have imagined as they prepared for their careers, including as related



to corporate cultures, laws and regulations, and wider societal norms and values. Indeed, the multifaceted, “wicked” problems that engineers face as practitioners are often beyond the scope of the typical formal education most students receive (Lynch & Kline, 2000), despite institutional efforts to prepare engineering graduates to have “an understanding of professional and ethical responsibility” (ABET, 1997).

Since ethics permeates the daily practice of engineers, beyond dramatic events such as whistleblowing (Lynch & Kline, 2000), we believe that understanding “everyday ethics” (Erlen, 1997) must become a central component of ethics education. Therefore, our approach to better align ethics education with professional practice embraces both micro and macro elements of professional ethics (Herkert, 2005) to promote a culture of ethical engineering practice.

However, we lack a comprehensive yet engineering-specific understanding of ethical practice, and this has led to a “try and fail” approach to ethics education that is typically neither well-integrated nor context-specific. The most common approach of using scenarios and cases in engineering ethics education has been criticized for its lack of attention to the complexities of practice (Bucciarelli, 2008). In other words, curricular approaches may be misaligned with the real-world experiences of practicing engineers (McGinn, 2018). In fact, a broad survey study showed that most practicing engineers encountered ethical issues throughout their careers, since nearly every decision they made had an ethical component, but they had had little opportunity to learn about dealing with such issues (McGinn, 2003).

The misalignment of current academic curricula for engineering ethics and the actual practice of engineers might be rectified through academic-industry partnerships. For universities, academic-industry partnerships can provide access to ‘real world’ experience and opportunities for curriculum enhancement (Prigge, 2005). For engineering schools, the role of industrial advisory boards can extend beyond fundraising to include an educational reform agenda (Prados, 1998).

There is a long history of active engagement of industry partners in engineering education. Since the mid-1980s, for instance, ABET has maintained an Industry Advisory Council to engage industry leaders (Splitt, 2002). Currently, engineering education programs involve voluntary advisory boards comprised of industry practitioners for curriculum input, ABET accreditation, program assistance, and fundraising. Participants are generally satisfied with the effectiveness of such advisory boards (Genheimer & Shehab, 2009).

As this overview suggests, academic-industry partnerships can improve the quality of educational programs. Such partnerships can enable more effective communication with employers, who are one of the important “customers” of universities (Tener, 1996), while influencing the development of engineering curricula in which students can develop skills essential for successful practice in industry (Arlett et al., 2010). We think that innovations in ethics education might similarly be identified



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and achieved through academic-industry partnerships. For example, one study investigated best practices in ethics education and training through a forum with representatives from a number of companies. Despite the small number of companies included (8 total) the findings revealed specific trends that might “inform, guide, and improve practitioners’ efforts” (Sekerka, 2009, p. 77).

Partnerships with firms that employ engineers can help lend credibility, urgency, and relevance to infusing ethics education into the curriculum. Reforming how engineering programs implement ethics education will likely benefit from awareness and application of proven change management strategies developed collaboratively between academic and industry representatives. In the sections that follow we introduce key contents and outputs associated with the initial efforts of our own academic-industry partnership approach.

### **ESTABLISHING THE ACADEMIC-INDUSTRY PARTNERSHIP**

#### **Ethics Advisory Council, Goals and First Actions**

As a first step toward establishing an academic-industry partnership, we sought to form a College-level Ethics Advisory Council with representation from industry partners across all 13 engineering departments in Purdue’s College of Engineering. The primary goal of the Ethics Advisory Council was, through engagement with industry partners, to identify and prioritize ethics and compliance issues viewed as important by both industry and university stakeholders, and to begin to identify and evaluate potential best-practice instructional interventions. In the initial meeting we invited discussion of both compliance, which refers to specific rules and regulations, and ethics, often used as a broader term. We took this approach to avoid limiting the scope of discussion, as industry stakeholders usually consider ethics and compliance together. However, there was not much conversation about compliance in general or the link between ethics and compliance during this initial meeting. We think this is a reflection of the participants’ desire to discuss issues beyond compliance with regulations and the limited time available for these discussions. We anticipate future meetings to address both aspects and their interrelationships in more detail.

We anticipated that industry partners and engineering faculty members could work together to identify realistic ethical scenarios, which would better reflect engineers’ day-to-day practices. These efforts might be translated into effective case studies. As well, industry partners could be invited to engineering classrooms to directly discuss their experiences. Moreover, we intended to establish long-term relationships that would motivate and support engineering faculty to think and act strategically toward infusing the important ethical issues and concerns identified into their engineering courses. Industry partners with extensive experiences also might advocate for more ethics coverage in engineering curricula.



To form the Ethics Advisory Council, we worked with the heads of the engineering departments to identify faculty members who teach capstone design and who lead curricular development and implementation of ethics instruction in their departments. We then asked them to identify a representative or two from their industrial partners who met most of the following criteria: an interest in and exposure to ethical issues in engineering practice; experience in training and evaluating new engineering hires; and willingness and capacity to continue in an advisory capacity for multiple years. The resulting Council comprised 12 representatives from various industrial sectors including automotive, semiconductor, electric power, and pharmaceutical industries. Their job roles broadly covered ethics and compliance as well as product design, risk management, marketing and sales, and other functions. Participants had from 6 to more than 30 years of work experience.

The first activity of the academic-industry partnership was an Ethics Advisory Council Workshop, with an aim to define common goals and share mutual expectations. Although the organizing team had some preconceived goals already, we thought clear goal setting with all members of the Advisory Council in the early stage of the partnership would help sustain a long-term relationship (Beckman, 1997). The Council would subsequently meet once or twice per year to progress toward these common goals.

### **ETHICS ADVISORY COUNCIL WORKSHOP**

In this section, we describe the first Ethics Advisory Council Workshop held on April 3, 2018. The one-day workshop involved the 12 industry representatives, as well as faculty members responsible for ethics education in 12 engineering degree programs. During the workshop, a leadership team facilitated sessions that encouraged exchange of experiences, goal setting, and identification of best practices among the workshop participants. Notes from the facilitators and participants taken during the workshop activities were collected and used for analysis. These notes are being used to inform future phases of the partnership.

#### **Workshop Sessions**

The workshop started with an overview session, in which participants first had time to reflect on and share their goals and objectives for participating in the workshop. Then one of the workshop facilitators provided a brief overview of the historical development of professional ethics and ethics education in engineering.

After the overview session, there were three activity sessions: 1) telling our ethics stories, 2) SWOT (Strength, Weaknesses, Opportunities, and Threats) analysis (Helms & Nixon, 2010), and 3) strategic planning. During the storytelling session, workshop participants shared experiences about ethically



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challenging situations that they had encountered (or been aware of) during their careers. During the SWOT analysis session, participants formed groups (academic and industry) to identify and evaluate competencies and training efforts related to ethics in their organizations, as described in more detail below. Finally, in the strategic planning session, participants were asked to identify at least one individual goal or action item and one collaborative (academic-industry partnership) goal or action item for each department.

In next section, we first analyze the goals and objectives that the participants identified during the overview session. We anticipate that by illustrating the motivations of our workshop participants we can contribute to shaping other academic-industry partnerships with similar purposes. We also include the results of the SWOT analysis to share our participants' general perspectives on current ethics education and ethical issues in workplaces.

### RESULTS

#### **Participants' Goals and Objectives**

During the workshop overview session, participants answered the question, "What do you hope to gain, contribute, and/or achieve through this workshop?" The responses were classified into the following four broad themes, in roughly descending order of frequency:

#### ***To Explore Educational Implications***

The most common answers centered on educational implications. As examples, participants wished to "gain understanding of ethical issues seen in industry in order to guide topical selection in my ethics course" and "find new ways to give students practical ethics training." Participants wanted to hear about experiences in industry and discuss ways to apply them in the classroom. Specifically, some mentioned wanting to develop relevant new ethics case studies. These types of responses were more prevalent among the academics, whereas responses from industry participants tended to cluster around the other three themes.

#### ***To Learn From Other Companies***

Some participants from industry sought to learn from other industry participants during the workshop. For example, participants hoped "to learn from other industries, specifically how they navigate conflict of interest issues and honestly representing yourself to clients," "to gain understanding of practical challenges confronted in other industries," etc. Some participants also expressed a desire to learn best practices in ethics and compliance processes, including ways to more effectively educate corporate audiences.

***To Make An Action Plan***

Some participants wanted to make an action plan related to improving ethics education or ethical conduct in general. For example, some participants mentioned “aligning on 2-3 key problems/questions we are trying to solve,” “action plan, timeline. How I can help bring ideas to life,” and “learn from others and back our ideas to action to help strengthen our society and make our ideas real.” As these excerpts suggest, many participants expected to take action and work toward implementation of specific ideas and plans that were informed by the workshop discussions.

***To Provide/Share Experiences For Potential Use In Purdue Programs***

Two participants from industry wanted “to provide practical insights and perspectives on ethics in industry to help Purdue faculty craft educational experiences for their students and society’s future engineering professionals” and “share examples of ethical concerns from manufacturing, product design, and co-developments.”

As we analyzed these statements about the goals of participants we additionally realized that there was a complex set of objectives emerging that would require much more time than a single afternoon to fully explore. However, we also understood that this was a rich and potentially deep mine of insights and motivations that would have impact on ethics education initiatives. We were convinced by these findings that this first event should become an annual meeting and mechanisms for continuing the discussions and further exploring the goals should be implemented.

**SWOT Analysis Results**

We also analyzed and compared the perspectives of participants from academia and industry on the strengths, weaknesses, opportunities, and threats (SWOT) in their organizations or programs related to ethics education and addressing ethical conduct. Participants were asked to consider what their organization or programs both do well (strengths) and do poorly (weaknesses) in the ethics education arena. Then they identified gaps that could be addressed (opportunities) based on their analysis of strengths and weaknesses, and considered risks, dangers, or other obstacles important to consider and address (threats).

***Strengths***

The academic participants often highlighted students’ attitudes (motivation) and currently available sources for ethics education (i.e., courses, alumni and administrative investment and support) as strengths they had, while industry participants referred to practicing engineers’ attitudes, awareness, and practices related to ethics. Both groups identified existing norms and procedures related to ethics and compliance training as a strength, because those are already required: as examples,



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the academics most often referred to professional codes of ethics, while the industry participants referred to independent reviews and quality control processes. Also, both recognized the long-term effects of ethics education for engineering students as another strength, although perhaps more as a future benefit, rather than a current strength. For example, the academic group stressed that ethics education can provide an authentic engineering experience, and the industry group found that ethics education can be useful for developing non-technical skills.

### ***Weaknesses***

Both groups mentioned the complex nature of ethics education as a weakness. The academics highlighted the difficulty of assessing learning outcomes in ethics education. Also, they observed that making sound, rational professional judgments is a difficult problem for students, and that engineering faculty typically lack interest and expertise in ethics and thus often avoid such discussions. The industry participants distinctively mentioned the difficulty of ethical challenges that require participants to reach beyond their comfort zone. For example, some ethical responses require a personal sacrifice, and that is not easy to encourage and support. The industry group also identified ambiguity in ethics (i.e., what counts as ethics is not always clear) as a weakness. The industry group stressed the need of cultivating a safe environment for practicing engineers to raise ethical concerns.

### ***Opportunities***

The academic group focused on resources currently available for ethics education (e.g., a 2-week session in senior design courses, elective stand-alone ethics courses, first-year engineering program introducing ethics modules) and the possibility of faculty training in ethics education. In contrast, the industry group mentioned resources which can support ethical decision-making in the workplace (e.g., tools for instant communication and risk management). Industry participants also pointed out that education itself can be an opportunity, since we can influence students to embrace and cultivate cultures of open, data-driven decision-making.

### ***Threats***

For both academic and industry participants, the characteristics of the work environment (e.g., time pressure, cultures emphasizing winning and profit over ethics, etc.) were recognized as threats towards ethical conduct. Also, both groups mentioned shifting global norms and cultures as a special challenge to ethical conduct and training. Some viewed academic freedom as a possible threat to engineering ethics education, because this freedom can lead to inconsistencies across courses. The industry groups mentioned other potential threats to ethical practice, such as information overload and difficulty in dealing with complex and uncertain external changes in regulatory environments,





financial constraints, and societal expectations. For example, regulations are sometimes incomplete or ambiguous, and interpretations can vary. Engineers need to make judgments by considering multiple factors in such a fluid environment.

## **DISCUSSION**

### **Lessons Learned**

We have described our initial implementation of establishing an academic-industry partnership aimed at overcoming challenges of infusing ethics into the professional development of engineers. Our workshop was designed as the first official event for our continuing partnership. During the workshop, we learned several lessons. An important first lesson was the need to clarify language about what “ethics in engineering” means. Many from both academia and industry initially were thinking about avoiding disasters and scandals. As the dialogue continued, however, it became clear that nearly every engineering decision or project raises ethical issues and that engineering students need to understand this day-to-day aspect. Clarifying language about engineering ethics and ethical practice was an important early step in building an effective partnership. Because of time constraints, we could not delve deeply into individual participants’ daily experiences in connection to their roles in workplaces. However, each participant shared invaluable insights for us to capture a wide range of concerns they had, and we recognized the rich material that could be mined in future discussions.

The analysis of participants’ goals for the workshop identified their strong interest in developing or contributing to better ethics education. This interest was recognized as both promising for future efforts and confirming that ethics education had support from both industry and academia. Also noteworthy was that some participants from industry expressed their hope to learn from other industry representatives about dealing with ethical issues. This desire indicates a previously unidentified need and opportunity for collaboration. Although a primary purpose of this academic-industry partnership is obtaining insights to better align engineering ethics education with engineering practice, industry participants were interested also in learning from other industry representatives about promoting ethical engineering practice in their workplaces and forming better environments for ethical conduct. Since one of the common motivations for academic-industry partnership is its reciprocity between academia and industry (Ankrah & Tabbaa, 2015), the desire to learn from and connect with other industry participants is an important additional dynamic for further relationship and partnership growth.

Since all of the workshop participants already had interests related to teaching ethics or prior experiences dealing with ethical issues in engineering practice, the participants might not represent the general population of industry professionals and engineering faculty. Nevertheless, we were



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pleased that we could find participants from industry who were specifically passionate about improving ethics education and promoting ethical engineering practice across many industrial sectors. As Beckman et al. (1997) suggested, forming an industrial advisory board consisting of individuals who are passionate about supporting curriculum enhancement is an important first step toward successful academic-industry partnership. In our case, the lists of common goals and shared expectations will be an important starting point and guide for planning further activities. We will need to identify more common goals that are more clearly defined by each party and work together to advance ethics education in academia and ethical practice in industry.

During the SWOT analysis, we confirmed that participants considered the current practices of engineering profession itself as a strength. We learned that practicing engineers confront ethical issues in their daily activities, and that their experiences can inform and help to better align ethics education with practice. However, we found that there are still significant challenges in teaching ethics effectively. Two challenges are the limitations on the ethics education side: curricular constraints and faculty expertise. Another challenge is the difficulty of ethical conduct on the practice side, e.g., the complexity of ethical issues and the moral courage needed to respond effectively in difficult situations. These challenges will require ongoing collaboration by the partnership to find innovative and effective solutions. Therefore, we appreciate the fact that an ongoing relationship between academia and industry has been built as an important achievement through the workshop. We think the contents of the lessons we have learned up to now, as well as subsequent opportunities to understand each other's contexts and challenges deeply throughout the partnership, will be invaluable for improving engineering ethics education.

Based on the insights from the opportunities and threats analysis, we could suggest two innovations as part of the solution for nurturing students' aspirations toward being ethical: 1) creating space in current technical courses to discuss actual ethical issues and potential actions, and 2) connecting students directly with industry practitioners to encourage deeper exploration of a wide range of everyday ethics in engineering practice. Especially, we anticipate that more direct connections with practitioners will contribute to engineering students' "understanding of professional and ethical responsibility" (ABET, 1997) by providing them opportunities to listen to the voices from workplaces and broaden their horizons.

### **Limitations and Considerations for Potential Adaptors**

There are practical challenges in establishing an academic-industry partnership for engineering ethics education, such as participant recruitment and scheduling. For our Ethics Advisory Council, we first identified and engaged faculty members who were involved with ethics education and then asked them to identify a representative from their industrial partners who had experience in dealing with ethical issues in engineering practice. Many departments had previously established relationships with



industry partners, so it was relatively easy for them to identify appropriate representatives. Although the academic-industry partnership has become a more common practice in engineering education (Genheimer & Shehab, 2009), engaging busy professionals can be very challenging. We suggest allowing at least four months lead time for scheduling such a meeting. Once initial relationships have been established, future meetings can be conducted through web conferencing. Moreover, we found that for full and open participation, any concerns about confidentiality should be addressed as early as possible since sensitive issues will likely arise in the important and detailed conversations.

### **Future Directions**

This paper represents a step toward identifying specific best practices and action items based on a nascent academic-industry partnership and the first meeting of an Ethics Advisory Council. In the future, we aim to

- Develop new and relevant real-world industry case studies,
- Create instructional modules and assessment materials that are better aligned with engineering practice,
- Continue to engage our industry partners for both faculty support and student engagement in classroom ethics sessions and as content contributors for curriculum enhancement in ethics education, and
- Consider how to expand ethics instruction into experiential learning programs (e.g., service learning, study abroad, co-op assignments, industrial internships).

Our long-term goal is to continue to utilize annual workshops to strengthen the industry-academic relationships, which can foster deeper insights and practical applications for ethics education in engineering. We look forward to building on these initial successes and continuing to nurture the budding partnership.

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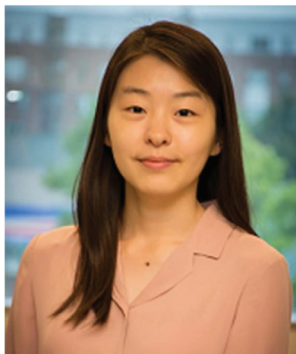
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### AUTHORS



**Dayoung Kim** is a Ph.D. student in the School of Engineering Education at Purdue University. Her current research interests include engineering ethics and practice, business ethics and entrepreneurship, and organizational culture. She earned her B.S. degree in Chemical Engineering at Yonsei University, South Korea in 2017.



**Brent K. Jesiek** is an associate professor in the Schools of Engineering Education and Electrical and Computer Engineering at Purdue University. He also leads the Global Engineering Education Collaboratory (GEEC) research group, and is the recipient of an NSF CAREER award to study boundary-spanning roles and competencies among early career engineers. He holds a B.S. in Electrical Engineering from Michigan Tech and M.S. and Ph.D. degrees in Science and Technology Studies (STS) from Virginia Tech. Dr. Jesiek draws on expertise from engineering, computing, and the social sciences to advance understanding of geographic, disciplinary, and historical variations in engineering education and practice.



**Dr. Carla B. Zoltowski** is an assistant professor of engineering practice in the Schools of Electrical and Computer Engineering and (by courtesy) Engineering Education and Director of the Vertically Integrated Projects (VIP) Program at Purdue University. She holds a B.S.E.E., M.S.E.E., and Ph.D. in Engineering Education, all from Purdue. Prior to this she was Co-Director of the EPICS Program at Purdue where she was responsible for developing curriculum and assessment tools and overseeing the research efforts within EPICS. Her research interests include the professional formation of engineers, diversity, inclusion, and equity in engineering, human-centered design, engineering ethics, and leadership.



Recently retired, **Michael C. Loui** was the Dale and Suzi Gallagher Professor of Engineering Education at Purdue University from 2014 to 2019. He was previously Professor of Electrical and Computer Engineering and University Distinguished Teacher-Scholar at the University of Illinois at Urbana-Champaign. He has published articles in computational complexity theory, in professional ethics, and in engineering education research. He currently serves on the Advisory Group for the Online Ethics Center at the National Academy of Engineering. He is a Carnegie Scholar, a Fellow of the IEEE, and a Fellow of the American Society for Engineering Education. Professor Loui was the editor of the *Journal of Engineering Education* from 2012 to 2017 and the executive editor of *College Teaching* from 2006 to 2012. He was Associate Dean of the Graduate College at Illinois from 1996 to 2000. He directed the theory of computing program at the National Science Foundation from 1990 to 1991. He earned the Ph.D. at the Massachusetts Institute of Technology in 1980.



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**Andrew O. Brightman** serves as Assistant Head for Academic Affairs and associate professor of engineering practice in the Weldon School of Biomedical Engineering. His research background is in cellular biochemistry, tissue engineering, and engineering ethics. He is committed to developing effective pedagogies for ethical reasoning and engineering design and for increasing the diversity and inclusion of engineering education programs.