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Gaining Industry Experience Exposure During a Pandemic

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Gaining Industry Experience Exposure During a Pandemic
Introducing Engineering Students to Industry

Introduction

There is a growing need for engineering talent by both industry and government entities. The work of talented inventors, engineers and scientists of the past have permitted the United States to be the first country to have a piloted, powered, heavier-than-air machine to achieve controlled, sustained flight; break the sound barrier with an aircraft; land rovers on Mars; and land a man on the moon [1]. As we move into the third decade of the 21st century, we approach a time where there will be a shortfall of engineering talent in industry due in part to the large number of pending retirements by those in the Baby Boom generation [2].

To address this issue, there have been efforts to recruit students into the engineering profession and increase the talent pool [3] and provide students industry exposure while in school. One such effort is the Penn State University and Lockheed Martin Master Research contract. This contract is an agreement that includes research collaboration, an enhanced recruiting relationship and increased engagement in Penn State programs [4]. Programs like this have allowed students to gain industry exposure and work on industry projects. Traditionally, co-op and internship experiences have been a main way to provide students experience that can help in the transition from student to professional while in school. But what of those without the means to acquire such experience? What can be done to help those individuals gain some industry exposure in addition to benefiting those who possess the ability to co-op or intern? The pandemic of 2020 exacerbated the issue as companies and universities were challenged to provide students such experiences in a time of social distancing and limited contact between people [5]. This paper explores a new course that has recently been developed and run before and during the COVID epidemic at Virginia Polytechnic Institute and State University (aka Virginia Tech) that in part, addresses the needs for industry ready engineering graduates.

Need for a transition course

Engineering programs accredited through ABET [6] must show evidence that their graduates achieve a set of specific student outcomes that support a program's educational objectives. Some of these outcomes are a seemingly natural fit for engineering, such as Criterion 3, number 1: *an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics* [6]. Most if not all engineering courses and

programs focus on student outcomes which focus on complex engineering problems. Programs may struggle to incorporate other outcomes defined by ABET, including:

- *Criterion 3, number 2:* an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors [6]

- *Criterion 3, number* 3: an ability to communicate effectively with a range of audiences [6]

- *Criterion 3, number 5*: an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives [6]

Programs necessarily define points within the curriculum where these outcomes are included in coursework. In some cases, these are included in coursework in ways where there may not be a natural fit in a typical lecture or lecture/laboratory course, or that appear to be contrived. Teamwork may consist of students put into groups based on proximity, with minimal instruction in how to effectively operate as a team; while this is indeed working within a group, it is arguably not effective teamwork [7]-[9]. Effective communication often consists of in-class presentations and/or laboratory reports, emphasizing 'communications' but not 'effectiveness'. Indeed, engineers in the workforce easily recognize that teamwork and effective communication in practice are very different than that typically encountered in academia [10], [11]. Academic situations may lead to contrived assessment of teaming, communication, and to design with considerations beyond engineering. Projects within engineering courses are bounded by the end of the semester, lack of a realistic budget for projects leading to fabrication, and prescribed means of communication. Katz [11] describes interviews with engineers in industry who work with recent graduates. Among her findings:

> *The person coming out of school—unless he's had either a co-op program or fairly extensive internships in the summer—doesn't know what industry is all about.*
>
> *The undergraduates are not well prepared for a job market. They may understand some of the general principles in engineering, but they have difficulty in applying them from a practical standpoint.* [11]

Anecdotally, similar concepts have been echoed in conversations by the authors with various members of industry. A conversation with a recruiter for a major employer answered "What are we missing? What can we do to prepare better graduates?" with "I know anyone I hire with a degree from (institution) can do the technical things we'll ask – I know they know their stuff. But I need people who can work with a team of people scattered across the globe. I need someone who can present their designs with confidence. I need people who can communicate."

Intentionally integrating students into industrial projects with authentic customers allows for a more realistic experience with teaming, communication, and design, and offers a more realistic simulation of the job market to come. Few such courses exist in academia [12], and many that do are limited in participation [13]. This project-based, industry-focused course in which students

work on authentic projects and meet industry-defined criteria allows students to have direct experience with engineering design and an authentic need for effective written and verbal communication – even if students don't work on designs of technical significance. An earlier integration with industry will help students identify the importance of these skills they would otherwise see only in lecture or lab.

Industry experience has been shown to lead to improvement in GPA and starting salaries for engineering students, with significant effect for students in Aerospace Engineering [14]. This need for authentic problem solving, teaming, and effective communication is especially important for students pursuing a degree in Aerospace Engineering [15], [16]. While this course is an interdisciplinary course, the application in the first-year course (the foundation for the industry experience course) was tied to Aerospace Engineering.

Course overview

A new course was conceived in the Engineering Education Department in the College of Engineering at Virginia Tech in 2018 to provide students insights into the ways of the working engineering professional with an emphasis on engineering design. This would all be achieved while in the confines of a university environment. The project-based learning course is called the Introductory Industry Design Experience and was designed to introduce engineering students to the industrial work environment through a series of concentrated engineering design project experiences similar to what one may see in an internship or co-op experience with both small and large engineering companies. Course learning objectives include:

- Practicing industry environment folkways and mores in academic and professional settings.
- Engaging with engineers and other professionals working in domestic industry sites.
- Demonstrating proficiency with implementing an engineering design process.
- Using various engineering skills and tools in designing a system, component or process to a meet a desired need.
- Demonstrating workplace competency by contributing effectively to an engineering team.
- Demonstrating workplace competency by using time management skills through the completion of project objectives within specified time constraints.
- Preparing and presenting technical information, including design recommendations and outcomes, in a professional working environment.

These objectives are achieved by the students only by actually working with both small and large regional and international engineering companies that are partners with the course. In this arrangement, the partner companies gain access to a wide range of new talent from the university while the students are able to gain experience, exposure, insight and a networking opportunity. The design projects of the course are created in partnership with the partner companies. They provide the context for the student and company interaction. This interaction allows the student to learn about a number of companies and see their cultures beyond the public literature within the timeframe of a semester. Projects are designed to last for at least a week and have a firm design deliverable which includes a presentation and potentially a physical product depending upon the scope of the project. The design experience culminates with an onsite plant visit and authentic design review with the partner company.

Throughout the course, students gain first-hand knowledge of what a partner company does, how it functions and what the company culture is like. This allows the students to gain an authentic understanding of an engineering workplace while developing the necessary workplace skills of teamwork, communication, time and project management and assorted contemporary workplace tools. For the companies, this experience provides the opportunity for students to view and work with potential new hires and do it without the same commitments associated with an internship or co-op hire. In many ways, the experience becomes an extended interview, from the company perspective, where they are able to gain more insight into a potential hire than can be gleaned from a resume or typical short on-campus interview. The approach also has the benefit of still allowing the partner company to potentially directly contact a student of interest for a formal interview that can lead to a full-time internship, co-op experience, or a full-time position upon degree completion.

The target audience for this course is primarily students in their sophomore year of engineering and beyond due to the baseline technical experience that the students have achieved at that point in their academic career having experienced at least one year of college and completing at least two foundational courses in engineering. These courses, Foundations of Engineering I and II, introduce students to the engineering profession, engineering thinking and the engineering design process [17]. The course targets both students who lack experience in the "real world" through the traditional internship or co-op experience with those who do possess co-op and internship experience. This interaction allows the less experienced students to gain insight into work life from a peer in addition to course instructors, guest speakers and the partner companies. For the experienced student, they gain the opportunity to interact with companies other than those they may have already worked with. We have found that the inexperienced students often have a desire to gain experience with and exposure to industry but often lack the financial means or ability in their program of study to take advantage of the co-op/internship program at the university. The course can be used as a preparatory experience for those who desire to pursue an internship or co-op experience before graduating. Though the course does contain elements that can be seen in some capstone design experiences, this course is designed to be a supplement to those experiences building upon a cornerstone design experience and preparing for and potentially working in conjunction with a capstone design experience [18]. Unlike those courses, the design process itself is not the main focus of the course; instead, the design process provides a framework for which to explore the industry experience in an attempt to provide the student a glimpse into their professional futures.

Course structure

The course structure is purposely arranged to be similar to an onboarding and work experience for a new hire to a mid-sized to large company. We intentionally hold the class in locations that can be manipulated to be similar to a design space or conference room one might find at various engineering companies and firms. The instructor assumes the role of a first level supervisor to the students in the class to help set the tone for the course and move the students into more of a corporate space mindset, something that would be automatic if the student were actually physically working in a company facility. With the onset of the pandemic, working in a single space with the students was prohibited and the interactions between students and in the instructor were all achieved through online means such as Zoom, email, chats etc. In this way, students experienced the same reality that many in industry experienced with stay at home orders that were in effect in 2020 [19].

There are three major components in the course: Onboarding and Training, Project Work and Site Visits. Onboarding and Training component occurs in the beginning of the course and is structured to provide some additional foundational training in various tools that may be used in design. Such training is often seen for new hires in a company. Pre-pandemic, students were given complete training on all of the equipment in the Frith First-Year Engineering Design Lab of the university which introduces them to 3D printing, laser engraving, soldering, and power tools. Experience with such equipment can be added to a student's resume to help increase their marketability. This is complemented with additional training in CAD beyond the introduction of the subject in the Foundations of Engineering courses. As most modern workplaces utilize the Microsoft Office Suite of software tools, students are also introduced to some advanced capabilities of programs in this suite that can be very useful in completing a variety of workplace tasks. The technical training is supplemented with open discussions on corporate culture and expectations. The importance of teamwork skills and communication are discussed and students are placed in situations requiring the practice of these skills. It is during this training period of the course that students are placed in teams and given their first project designed to have them demonstrate and practice newly acquired skills in preparation for the larger partner projects to come later in the course. All of these training experiences combine to help establish a common skill set among the cohort beyond what is brought to the course through prior experience.

In the course, students have a chance to interact with a variety of speakers with current and past industry experience. These speakers are purposely selected to have different levels of experience and come from different industries so that students see a variety of viewpoints and career paths. Such interactions allow students to potentially relate to a wide variety of speakers and see themselves in others. That knowledge can help them plan a possible career path to help them achieve their professional goals. These interactions are supplemented by meetings with representatives of the Career & Professional Development organization of the university. This organization provides a variety of services to students that range from insight into the latest expectations from recruiters to preparation for an interview and plant visit.

The Project Work component of the course runs throughout the semester and is designed to let students experience projects that are either developed in conjunction with a partner company or developed at the university, inspired by the partner company and its product lines. Working in small design teams that contain a variety of disciplines and skills, students tackle multiple projects during the semester usually numbering between three and four in total. The types of projects completed by the students during this portion of the course are more involved than those during the Onboarding and Training period of the course. To help mimic the expectations and realities of an industrial level work environment (noticeably different than a typical academic environment), strict deadlines are kept and requirements/expectations on the project can vary as the project progresses. Students provide periodic status reports to the instructor/supervisor. Formal internal reviews are also conducted where students are required to present and communicate with partner companies in addition to various industry or government experienced instructors in the Engineering Education Department in order to provide an authentic review experience. These interactions prepare the students for the final component of the course, the Site Visit with the partner company [20].

In a normal semester, the Site Visits allow the students to experience, briefly, life at an actual engineering company. The visits allow the students to see the actual facilities where they may

eventually work and learn about the various processes the companies utilize in producing their products. Students interact with actual supervisors, managers and engineers in addition to meeting with Human Resources personnel of the company. Starting with the projects themselves, students are introduced to the partner company's corporate brand. Site visits themselves become informal interviews of the students by the partner company. Students have the opportunity to practice skills such as business etiquette and professionalism gained in discussions with the Career & Professional Development organization at the university [20].

Table 1 contains a sample course schedule and outline for the 15-week semester version of the course. Each week of the course contains a theme relevant to the three major components of the course. Activities and assignments are scheduled to support these weekly themes and in turn address overall course learning objectives.

EngE 3604: Introduction to Industry Design Experience

Spring 20XX Basic Course Schedule

	Weekly Theme	Daily Schedule
Week 1	Introduction and Onboarding	Course Introduction and Expectations
		Industry culture & expectations - Unwritten Laws of Engineering
Week 2	Training	Design Lab Equipment Training
		Training (Further Lab Training, MS Office, CAD)/Discussion (Teaming and Work Structures)
Week 3	Training/Mini-Project #1	**Career Services visit - Backpack to briefcase**
		Mini Project #1 Time / Industry Project Case Study Discussion
Week 4	Mini-Project #1	Mini Project #1 Time /Ethics Case
		Mini Project #1 Presentation/ Review
Week 5	Major Company Project #1	Major Project #1 Introduction - Brainstorming
		Customer #1 Company Examination/Working in small companies
Week 6	Major Company Project #1	Project Work Time/Career Services Talk #1
		Project Work Time/Guest Speaker
Week 7	Site Visit / Presentation	Trip Preparation / Work time
		Company Visit #1
Week 8	Major Company Project #2	Major Project #2 Introduction - Brainstorming
		Customer #2 Company Examination/Working in mid-sized companies
Week 9	Major Company Project #2	Project Work Time/Career Services Talk #2
		Project Work Time/Guest Speaker
Week 10	Site Visit / Presentation	Trip Preparation / Work time
		Company Visit #2
Week 11	Major Company Project #3	Major Project #3 Introduction - Brainstorming
		Customer #3 Company Examination/Working in large-sized companies
Week 12	Major Company Project #3	Project Work Time/Career Services Talk #3
		Project Work Time/Guest Speaker
Week 13	Site Visit / Presentation	Trip Preparation / Work time
		Company Visit #3
Week 14	Reflection and Lessens Learned	Class Discussion(Topic - Performance Appraisals)
		Class Discussion (Flexible Topic)
Week 15	Course Wrap-up	Course wrap-up

Table 1. Sample Course Schedule and Outline

The weekly activities in the course cover the following major topics which are aligned to the learning objectives listed in the Course Overview section of this paper:

- Industry Culture & Expectations – *Students are introduced to industry culture and expectations – this is contrasted with the students' academic experience*
- Professional Life in Small, Medium and Large-sized Engineering Firms – *Students interact with professionals from engineering firms of various size in order to permit them to see similarities and differences between such organizations*
- Industry Workplace Work Structures and Performance Assessment – *Students are introduced to concepts such as matrix organizations and the yearly performance appraisal process*

- Job Search and Interview Practices – *Students gain practical skills necessary for a successful professional job search*
- Engineering Ethics in the Workplace – *Students are introduced to engineering ethics as it is practiced in the workplace along with receiving training typical of employees at companies such as Lockheed Martin*
- Industry Design Practices – *Approaches to solve design problems in the workplace are introduced*
- Team Management in Industry – *Course makes extensive use of teams to approach design problems*
- Project Management in Industry – *Students are introduced to tools such as MS Project and the basics of Project Management and Scheduling*
- Technical Communication in Industry – *Students participate in formal and informal industry communication practices in the course such as proper email etiquette, informal status reviews, and formal presentations and design reviews*
- Industry Software and Tools Training – *Students work with real industry tools such as CATIA, MS Office Suite programs, and Phoenix Integration's Model* [21]

With the onset of the pandemic, students were not able to visit partner companies due to restrictions in travel for the university and new visitor limitations for the partner companies. Though the site visits were not allowed, some partner companies did make themselves available for extended Zoom conversations with students thus still allowing the students to have a direct interaction with company representatives and keeping in line with the ideals of the course. After each Zoom meeting, students were required to provide a meeting debrief report to recount the visit and document the outcomes. In addition, the speaker provided the instructor feedback on the class and the interaction which contribute to the assessment of the students in the class.

Overall assessment in the course is also structured to be similar to a corporate work environment. Feedback from the corporate partners is used in assessing student performance in addition to grading students on the quality of the work they produce and the actual project product itself. In addition, students also receive a number of reflection assignments so that the instructor main gain insight into how the students are viewing the course and their performance (positives and areas for improvement) as students/employees [22]. In a corporate environment, such information can be gleaned by a supervisor with an employee during a yearly performance appraisal discussion. These items provide some insight into student readiness to work in industry through how the student discusses the experience and through the choice of subjects the student chooses to discuss in some assignments.

Pilot runs of the course

The course was piloted in 2018, 2019 and 2020. The 2018 and 2019 sessions of the course took place during six-week Summer Sessions. Partner companies were selected that were within a day's drive of the university so that students could take other courses in addition to the Introductory Industry Design Experience course without missing classes during plant visits. The companies that were visited included Volvo Trucks North America, Eastman Chemical, Moog Inc., and TMEIC. Student enrollment was small numbering less than ten students. With this said, the classes were diverse and ranged from sophomores to seniors; contained both men and women; and included recent transfer students. This provided us a look at the course through difference lenses

and allowed us to assess its impact on different candidate populations for future offerings of the course. Feedback on the experiences was positive in both course offerings and suggested that the course was having the desired impact on students.

The 2020 pandemic run of the course

The third run of the course occurred in Spring Semester 2020 and had 18 students, the largest cohort of the class to date at the time. This change to a non-summer offering was an attempt to increase student enrollment by providing the class at a time when more students would be available for the course and when the price per credit hour for the course would be less expensive than during a summer session (something we were told by students in the previous runs of the course was a challenge for summer students). As in the first run of the course, the class was varied in its composition contain both male and female students. However, for the first time the class contained a second semester first-year engineering student and a number of exchange students from Europe who in some cases had already completed one degree.

The start of the semester for this class followed a pattern similar to the other runs of the course with a completion of the Onboarding and Training period of the course and a start of the Project Work period of the course which included a visit by representatives of TMEIC to kick-off one of the long-term partner company projects. New partnerships were formed with the companies Kollmorgen and Novozymes with plant visits planned for later in the semester. Roughly half way into the semester and just prior to the start of the Site Visits portion of the course, formal in-person university activities ceased and stay at home orders for students and faculty went into effect. With this interruption in the plans for the balance of the course, plans were shifted to a fully online and distance mode of interaction and learning.

In an effort to still provide the students meaningful interactions with partner companies, extended Zoom meetings were held with the partner companies that were still able to work with us given their own unprecedented challenges in having to switch to a working from home mode in many cases. To supplement the partner company extended Zoom meetings, additional guest speakers were brought in for the virtual class. Students continued to work on the projects for the course, however, scope was scaled back on the larger projects due to the limited ability of the teams to work together remotely while also adjusting and working with an unplanned transition of all their courses to an online mode. This particular cohort contained students who were from two countries outside of the United States and this created unique challenges as those students were forced to tackle with returning to their home countries prior to the larger lock-down in the U.S. in addition to dealing with significant Time Zone differences with their teammates in the course once they arrived in their home countries. With this said, all students kept a highly positive attitude in the course and continued to stay highly engaged in the course activities in a way that did not drop off when compared to the in-person experience. At the time paper was written, academia was still in the midst of the pandemic, however, lower engagement and lower attendance were observed in most engineering (and other university) classes. Student attendance stayed at full capacity for all classes save a couple of instances where a student ran into troubles with their internet service going offline.

Student feedback on the course and the experience continued to be positive as in previous semesters and was encouraging for its continuation. The following are sample comments

expressed by three students in the course and are fairly representative of the overall sentiment expressed by the students regarding the course:

> *I have the tendency to work alone even when I am in a team and I learnt how essential teamwork is to the success of a project, especially in the field of engineering. I love the fact that my teams consisted of different types of engineers because I was able to see how differently everyone thinks about/approaches a problem. It was also easier and faster to come up with ideas in a team… After taking this course, my plan for jobs has definitely changed. At the beginning of the semester, I was strongly interested in the automotive industry and I hadn't considered anything else. After taking this course, I realized I wanted to do more beyond the automotive industry. This course made me start exploring more options because it opened my eyes to endless possibilities.*
>
> *Initially I valued this course because of the real-world experience that I would be able to witness firsthand. I envisioned myself going to companies, pitching projects, and gaining valuable out of class experience. However due to the COVID-19 pandemic, our course was cut short and so I found a new lens to view the course. The course was then redefined as an opportunity to almost interview interesting and insightful people working in the field. These individuals came from a broad range of different background and work environments. This course also inspired me to do more and search for more opportunities that are open to me as an engineer at Virginia Tech.*
>
> *Overall, I think this course is valuable for someone like me. Coming into this course I had little to no real experience in the field and talking to engineers and individuals that have gone through the education that I'm going through provided me a sense of perspective. Although we missed out on a number of different in person opportunities, I would still recommend this course to others for the opportunities alone. I found it really amazing that we were able to communicate with large companies like MOOG and TMEIC. Whenever I would talk about this course to family or friends they would always be surprised at the level of projects we were attempting. Although we never saw some of these projects to the end, I found the experience not only fun, but rewarding. Understanding how these companies work and their ideas for the future really had me excited.*
>
> *My future plans have definitely changed since the beginning of the semester. I was sitting at the crossroads between Aerospace, Mechanical and Industrial Systems Engineering. I think this course has really helped me decide that I really can't go wrong with either one because there is overlap in those fields and each job I have is likely to be vastly unique even if they have the same title or requirements.*

The only suggested modifications for the course by the students were the possibility of seeing some of the research labs on campus and expanding the number and types of companies the class visited and spoke with. Both suggestions are under full consideration for future iterations of the course and will depend upon the availability of the additional potential partners to participate in the course and the particular logistics involved in visiting facilities beyond a day trip away from the campus.

Conclusions and plan moving forward

Student feedback showed that this course addresses the intent of some of the necessary and useful ABET accreditation criteria by allowing students to experience *effective* teamwork and communication with an audience who has a vested interest in success. The course approach is applicable to multiple engineering disciplines.

Through the three trial runs of this course and based upon the feedback from both students, employers and colleagues, it is felt that the course is starting to have the desired impact on student preparedness for the transition from student to working professional. Since the time of the 2020 run of the course, the course has passed through governance and is now a permanent course offering in the Engineering Education Department at Virginia Tech. The course is being offered for the first time as a permanent course in Spring 2021, and lessons learned from the 2020 run are being used for this all virtual version of the course. Once in-person interaction is safely permissible, the course will resume plant visits and higher interaction between students and partner companies. Future plans include continuing contact with some of the course participants to see how they progress in their careers upon graduation and talking with employers to see how these graduates compare to others they employ. In addition, it is desired to grow the course to the level where we can create a series of tracks unique to different industries such as aerospace.

In the case of an aerospace track, students can gain an early introduction to major aerospace contractors such as Lockheed Martin and Boeing while also being introduced to the many smaller companies and organizations that support such large defense contractors in a subcontractor role. Design projects can range from the overall conceptual design of a vehicle, part or system to the development of a specific part that may assist the partner company in its pursuits. Such experiences and exposure will be valuable to aerospace engineering students in their future professional endeavors.

References

[1] National Air and Space Museum, "The Wright Brothers: The Invention of the Aerial Age," *Smithsonian National Air and Space Museum* [online], URL: https://airandspace.si.edu/exhibitions/wright-brothers/online/ [Accessed April 10, 2021].

[2] L. Levine, "CRS Report for Congress: Retiring Baby-Boomers = A Labor Shortage?" Congressional Research Service, Washington D.C., 2008.

[3] Aerospace Industries Association, "2016 National Aerospace & Defense Workforce Summit: Proceedings Report & Recommendations," [online report], Washington D.C., 7-9 Sept. 2016, URL: https://www.aia-aerospace.org/event/national-aerospace-defense-workforce-summit/ [Accessed November 21, 2018].

[4] A.E. Messer, "Penn State signs new Master Research contract with Lockheed Martin," *Penn State News* [online], 10 Nov. 2016, URL:

https://news.psu.edu/story/436953/2016/11/10/research/penn-state-signs-new-master-research-contract-lockheed-martin [Accessed November 21, 2020].

[5] M. Cometa, "Making co-ops count: Work experiences continue during pandemic," *Rochester Institute of Technology University News* [online], 6 Jan. 2021, URL: https://www.rit.edu/news/making-co-ops-count-work-experiences-continue-during-pandemic [Accessed January 28, 2021].

[6] ABET, "ABET Criteria for Accrediting Engineering Programs, 2019 – 2020," URL: https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2019-2020/ [Accessed August 8, 2019]

[7] B.A. Oakley, D.M. Hanna, Z. Kuzmyn, and R.M. Felder, "Best Practices Involving Teamwork in the Classroom: Results from a Survey of 6435 Engineering Student Respondents," *IEEE Transactions on Education,* Vol. 50, No. 3, 2007.

[8] R. Lingard and S. Barkataki, "Teaching Teamwork in Engineering and Computer Science," *IEEE Frontiers in Education Conference*, Rapid City, 2011.

[9] M.L. Loughry, M.W. Ohland, and D.J. Woehr, "Assessing Teamwork Skills for Assurance of Learning Using CATME Team Tools," *Journal of Marketing Education*, Vol. 36, No. 1, 2014, pp. 5–19.

[10] K.J. Reid and E. Cooney, "Implementing Rubrics as Part of an Assessment Plan," *International Journal of Engineering Education,* Vol. 24, No. 5, 2008.

[11] S. Katz, "The Entry-Level Engineer: Problems in Transition from Student to Professional," *Journal of Engineering Education,* Vol. 82, No. 3, 1993.

[12] G. Ricco, P. Talaga, J. Sanchez, D. Olawale and S. Spicklemire, "A Report on a New Design Spine Implementation," 2019 IEEE Frontiers in Education Conference (FIE), Covington, KY, USA, 2019, pp. 1-6, doi: 10.1109/FIE43999.2019.9028684.

[13] E. J. Coyle, L. H. Jamieson, W. C. Oakes, "EPICS: Engineering Projects in Community Service," International Journal of Engineering Education, Vol. 21, No. 1, 2005.

[14] M. K. Schuurman, R. N. Pangborn, R. D. McClintic, "Assessing the Impact of Engineering Undergraduate Work Experience: Factoring in Pre-work Academic Performance," *Journal of Engineering Education*, Volume 97, Issue 2, pp. 207-212, April 2008, doi: 10.1002/j.2168-9830.2008.tb00968.x.

[15] J. H. McMasters, "Influencing Engineering Education: One (Aerospace) Industry Perspective," International Journal of Engineering Education, Vol. 20, No. 3, 2004.

[16] D. R. Brodeur, P. W. Young, K. B. Blair, "Problem-Based Learning in Aerospace Engineering Education," Proceedings of the American Society for Engineering Education Annual Conference, 2002.

[17] Virginia Polytechnic Institute and State University: Department of Engineering Education, "General Engineering Experience: Courses," URL: https://enge.vt.edu/undergraduate/geexperience/courses.html [Accessed November 21, 2020].

[18] S.D. Sheppard, S. D., “Design as Cornerstone and Capstone,” *Mechanical Engineering-CIME*, vol. 121, no. 11, p. 44, Nov. 1999.

[19] A. Levy, “Working from home is here to stay, even when the economy reopens,” CNBC, May 11, 2020, URL: https://www.cnbc.com/2020/05/11/work-from-home-is-here-to-stay-after-coronavirus.html [Accessed January 30, 2021].

[20] W.M. Butler and K.J. Reid, “Introducing Engineering Students to Industry,” *AIAA SciTech Forum*, January 6-10, 2020, Orlando, Florida.

[21] Phoenix Integration, "ModelCenter Integrate," *Phoenix Integration* [online], URL: https://www.phoenix-int.com/product/modelcenter-integrate/ [Accessed April 10, 2021].

[22] J. Schindler, " Giving an Effective Performance Review," *Forbes* [online], 29 Oct. 2019, URL: https://www.forbes.com/sites/forbescoachescouncil/2019/10/29/giving-an-effective-performance-review/?sh=4e6ac82a3d8f [Accessed February 18, 2021].