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Closing the Gap between Industry and Academia via Student Teams Support

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Abstract

A well-known challenge in engineering education is the attempt to balance the demands of industry recruitment with the core needs of an already packed engineering curriculum. Due to time constraints, real-world examples and other learning opportunities that aim to develop and consolidate the industry-desirable skills can be difficult to include in the curriculum. One way to address this challenge is to collaborate with industry (for example, on capstone projects, student team challenges, *etc*.) while the students are still studying. A place for these collaborations, which can provide benefit for both parties, is through student competitions. Student competitions in engineering can be taken on as an extra-curricular activity or included in the curriculum in the form of a group or senior project. Students work in a collaborative environment, often in groups involving students from different disciplines, to design and build a specific product within a narrow timeframe and budget that will satisfy certain criteria and perform competitively to complete specific objectives. These projects allow students to get hands-on experience in solving a range of engineering problems like those they will face in their careers, while also gaining professional skills that enable them to work with others as a team. It is this real-world problem solving and teamwork that makes student competitions an excellent place for developing these industry-academia collaborations to supplement the curriculum.

In this paper, we will highlight how Ansys supports the activities of student competitions through free software access, training, and other means as part of a larger academic support and workforce development strategies. The benefits for both company and academia, as well as the challenges, will also be discussed. Our goal in sharing these efforts is to continue to learn from the community on how to best bridge this gap.

Motivation

The need for industry-academia collaborations, like the ones described in this paper, come from the existence of a skill gap in engineering. For this paper, we will refer to a skill gap as a lack of skills or abilities found in a potential employee, leading to challenges in gaining employment post-graduation[1]. This is frustrating for all parties involved: employers, institutions, and graduates. Employers are forced to either spend resources (*i.e.* time and money) to upskill new hires[1] or time searching through a wider pool of candidates to fit the position. Higher Education Institutions (HEIs), particularly engineering programs, face a balancing act of covering the ever-expanding amount of technical knowledge needed in a specific field with the professional skills required to be successful as a practicing engineer today in a four-year degree[2]. And finally, we have the students or recent graduates. They are expected to be completely prepared for the workforce when they leave school. However, two or three extra years of practice may be needed to truly “master” their profession[3]. This leads to graduates feeling inadequate and unsupported and puts the burden of learning these missing skills on them[4] as they enter the workforce.

Before talking about possible solutions to closing this skill gap, we need to identify which skills industry views recent graduates are missing when entering the workforce. Many investigations have occurred to try and identify the missing skills. One such survey found that “a candidate’s demonstrated capacity to think critically, communicate clearly, and solve complex problems is more important than their undergraduate major”[5]. Problem solving, particularly applying knowledge in real-world settings, is frequently highlighted. Young professionals find work projects to be challenging due to the lack of boundaries compared to the ones they experience in school[6], [7]. Other professional skills, like teamwork, project management, and business management skills [2], [7], [8] have also been identified as crucial for new graduates.

Not all skills in this gap are professional; some fall under what many would consider the technical category. For example, the ability to make use of various software tools relevant to specific industries is seen as highly attractive in young employees[1]. Another technical area that is discussed is the need for a comprehensive understanding of how mathematics is applied in the real world[1], [3], [7]. Many papers suggest that the way math is taught to engineers should differ greatly from how it is taught to mathematics majors. Others highlight the fact that today's engineers need to learn how to effectively apply digital (virtual) modeling and simulation technologies within the context of their core engineering courses, in hands-on applied research projects and co-operative education programs [9]. The skills mentioned here are just a sampling and by no means an exhaustive list.

Now that we have identified some key missing skills, we can ask the question - why is this gap occurring? A key issue that has been highlighted during investigations of this issue is the lack of a feedback loop between industry and academia[3]. Given how universities operate, there is a clear connection between universities and research. But despite many graduates going into industry, the connection between university and industry in terms of graduate expectations remains unclear. Even with skills identified, there are some significant hurdles to changing an engineering curriculum. As technologies, businesses, and economic cultures change, so too should the skills engineers be taught. However, these cultural shifts can be rapid and are often too fast to be reflected in curriculum updates[1]. There is also the concept of balance in the curriculum; students do require some amount of fundamental technical knowledge to apply to real world problems. In the example of running simulation software, to truly be able to setup, run, interpret, and validate results, one must have knowledge of the equations being used by said software to complete the calculations and practical elements like best practices around simulation setup, mesh quality, mesh refinements, model selection, boundary conditions, and more. Software is only as smart as the people who run it. How do HEIs strike this balance in providing technical knowledge while still preparing students for the working world?

So, what can be done to close this gap? There does not seem to be one solution. A key element discussed in literature is the need for experiential learning. By allowing students to engage in critical thinking, problem solving, and decision making in contexts that are relevant to their personal interests as well as academic learning objectives[2], [10], educators are increasing student engagement, an essential element in learning[11]. Real-world examples are often used in active or experiential learning strategies[12]–[15], which could aid increasing students skills

highlighted as part of the gap. Real world case examples that include elements of professional practice could be particularly beneficial, as students with increased interest in professional practice have been shown to have more cognitive engagement[7]. But opportunities for students to engage in this type of learning can be found outside of the classroom as well. The focus of this paper will be on one specific form of extracurricular activity: student team competitions.

Background: Student Teams

It's important to define the term 'student team' as used in the context of this paper. Here, we are referring to student-led engineering design teams, formed for the purpose of competing in events external to the university. The teams are usually focused on designing and building a product and testing its performance against teams from other universities. These activities allow students to transfer what is taught in the classroom into real-world problem solving[16]. It also exposes gaps in their knowledge and provides the impetus to fill them.

Teams can range in size from less than 10 members to over 100. Student teams regularly comprise of sub teams, each focused on a particular aspect of the design and management. Teams also have roles that mimic companies as they have leadership roles such as engineering director, president, *etc*. and larger teams include business operations positions like marketing, treasurer and recruiting.

Competitions have been typically linked to specific engineering departments/disciplines and most team members are drawn from there. Some examples can be found in the table below.

Table 1: Engineering Departments and their Relevant Student Team Competitions

Department	Notable competitions
Civil Engineering	Steel Bridge Concrete Canoe Solar Decathlon
Mechanical Engineering	Formula SAE, Formula Student, BAJA SAE Hyperloop Solar Car Eco Marathon Solar Boat
Aerospace Engineering	Unmanned Aerial Vehicle/Systems Rocketry CubeSat

However, with competitions having increasingly complex requirements, design teams can be made up from a mixture of disciplines. For instance, in competitions like Formula Student Driverless, Formula SAE Electric, Robosub, and robotics, these require the development of systems that need multidisciplinary collaboration between students in mechanical engineering, computer science, and electrical engineering, among others.

As mentioned, these activities are usually extra-curricular. Students need to invest their own time into the process. They also need to recruit team members, manage budgets and work to fixed

deadlines. With the possibility of real jeopardy, such as failure at the competition or failing to compete if deadlines are not met, students are thrust into the sort of situations that might be faced in the workplace. Therefore, in addition to the improved design and engineering skills, students learn to be resilient in the face of challenges, make decisions that have clear consequences and critically analyze their own work to make progress.

While these competitions can be a challenge to be involved in, both from a technical and time perspective, they can have a huge benefit for students upon graduation. Student competition teams encompass many of the elements highlighted as part of the industry-academic gap and therefore employers specifically seek out students with this experience. Many companies ask for student team experience in their job postings and pay sponsorship fees to recruit at competitions (sometimes giving job offers while at competition). Ansys is one such organization.

Background: Industry Perspective from Ansys

Ansys is an engineering simulation software company that has been in the business for over 50 years. Currently, we are ranked #1 in simulation in terms of having the broadest, deepest, and most accurate engineering simulation product portfolio, outlined in Figure 1.

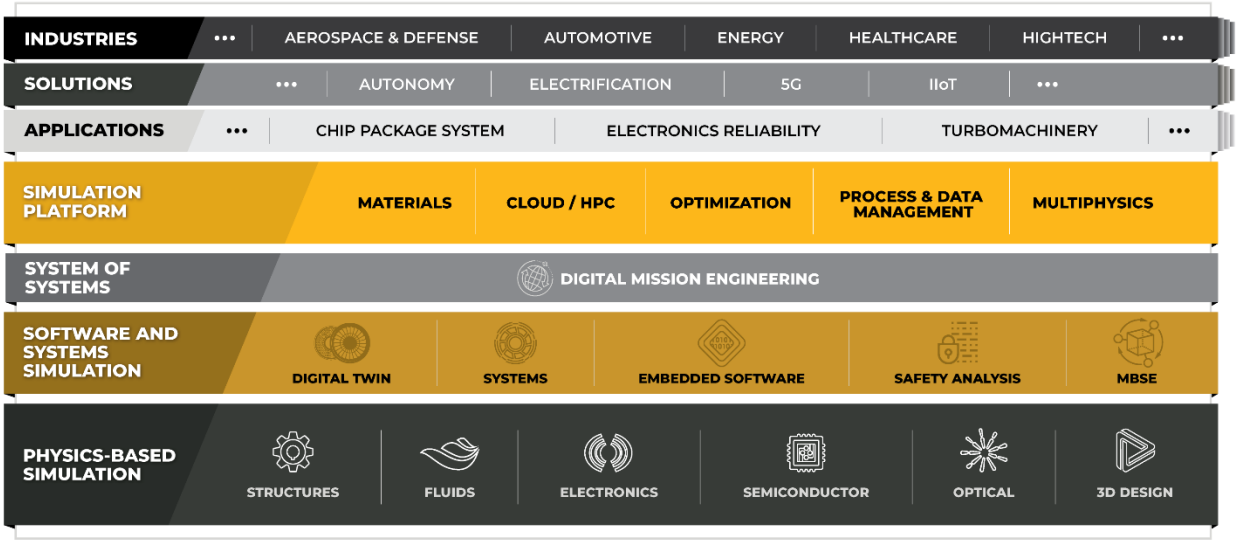

Figure 1: An overview of the various industries, platforms, and simulation areas Ansys provides solutions for via their portfolio

With this broad portfolio, we have firsthand awareness of how simulation and other software tools are influencing the engineering workplace globally. We have also seen the increased impact simulation software skills have on new graduates' career prospects. But, as engineers who once went through these programs at HEIs, we also have an appreciation of how fundamentals taught in engineering curriculum allow for students to understand and properly utilize the results from simulation and materials selection software. The question we at Ansys ask when thinking about this gap, is how can we close the feedback loop to better prepare engineers for the workforce. To do this, we can refer to the literature for learning. As mentioned previously, student engagement is essential to learning. There are five influential factors that contribute to overall engagement:

intellectual, student to staff, peer-to-peer, online, and outside of the classroom[17]. Industry-academia collaborations can exist in many of these areas, depending on the nature of the company. In our case, Ansys is a software company, specifically focused on simulation software. So our engagement efforts revolve around that. Other work is being done at Ansys to support intellectual engagement through in-class educator support, such as our Ansys Education Resources [18] and our Funded Curriculum Program. We also support intellectual and student-to-staff engagement through research efforts. For this paper, however, we want to highlight the work being done to increase this industry-academia collaboration through engagement outside the classroom via support of student team competitions.

Ansys Support for Student Teams

There are two main avenues through which Ansys supports student teams in their design process, namely free access to industry level software and training. The thinking behind this strategy is to make sure that the teams have the tools that would help them optimize their design choices and that they are fully equipped to use these tools to maximize the impact of using simulation.

Ansys Student Team Software Support

As a first step, each team is encouraged to enter a partnership with Ansys in which we provide them with a bundle of software products, relevant to their competition. This typically includes tools that would enable teams to conduct material selection and simulate fluids, structural, thermal, and motion analysis. However, if the competition requires it, the bundle can also include other specialized software such as ones that can support teams in simulation of autonomous vehicles or additively manufactured components. This access is provided completely free of charge and in return, we encourage teams to provide information on how these tools affected their design process and if they had encountered challenges that further development of these software can resolve.

This is complemented by providing the teams with access to a range of self-learning platforms where they can familiarize themselves with how to use these tools and the fundamental engineering concepts behind each type of simulation. There are also avenues through which teams can interact with Ansys experts, as well as other students, academics and engineers to resolve any potential challenges they are facing when using these tools in their design. Below, we will explore each of these platforms and how they support teams in their learning journey.

Ansys Innovation Courses

These are a set of publicly accessible, award-winning, free, online physics and engineering courses designed for educators, students and engineers to enhance simulation and physics learning (available here). They include lecture videos, hand-outs, exercises, and quizzes. At the moment, there are more than 200 self-paced courses available on our website, covering a wide range of design-relevant topics, including fluids, structures, 3D design, materials, electronics, optics, Python, and orbital missions. There is a dedicated set of courses, specifically designed to target student team-related challenges such as Baja and FSAE chassis design, aerodynamics of a solar car and battery pack thermal analysis. We also collaborate with student teams to identify

applications where the use of software can add value and then develop training material with those teams so that we can address their challenges and needs.

Ansys Learning Hub

The mission of the Ansys Learning Hub is to maximize the productivity of every user. It offers in-depth learning tracks, for every tool Ansys provides, ranging from Getting Started courses to deep dive training topics. The curricula is designed to shorten the learning curve, sharpen skills and keep users up-to-date with the latest technology. The available courses are typically on-demand and self-paced, however, on a regular basis, Ansys experts run live classes as well, where attendees can interact with the educator and resolve any questions they may have. This platform is what we retail to our industry customers; however, upon request, student teams can get access free of charge. Furthermore, there is a dedicated learning track with student team-relevant courses organized to maximize their learning efficiency.

Ansys Learning Forum

Ansys Learning Forum is the go-to place to engage with 1.6+ million peers and Ansys experts on topics like simulation, physics concepts, Ansys products, and more (available here). This is where all users, including student teams can post their questions, get answers, help a peer, or search thousands of discussions based on topics of interest in the forum. So, regardless of whether teams have encountered installation issues or are facing challenges in setting up or interpreting their simulation, they can use the large body of information stored in the forum or actively post questions and discuss with their peers and our engineers to find a resolution.

Additional Support

There are other ways through which we try to support student teams in their design process. Some of our regional partners organize and deliver day-long in-person training workshops for attending student teams, where they create a friendly (pizza and barbecue served) but competitive (awarding small prizes to winners of small competitions on the day) environment to incentivize teams to improve their simulation capabilities. And, finally, on a case-by-case basis, Ansys application engineers can also be available to provide technical guidance to individual teams.

Future Support Plans

As with all programs, we are continually looking for ways to expand our student team support. One such example of our support is the ongoing efforts to develop training material that helps students make the best use of simulation in their short design cycles. Ansys regularly connects with student teams to identify high impact simulations to make training content on.

Collaborations naturally develop from these interactions, whereby student teams maximize the impact of the training by giving input on what training content would be most useful and sharing data (CAD, boundary conditions, etc.) that can be used to match the content to what teams are actually doing.

Furthermore, there is now a preliminary exploration process underway in order to streamline our engagement with student teams through aligning different stakeholders at Ansys. The vision is that developing a central strategy will facilitate and optimize how we provide support to teams and competitions across the world and help more students to take full advantage of the resources Ansys provides in this area.

Limitations

In the Motivation segment of this paper, details of the industry-academia gap were explained in detail. But one element that was missed is the challenge of quantifying the impact that industrial support, such as the student-team initiatives explained above, can have on the skill development of students. While some Ansys employees have adjunct faculty positions, on average, we have no academic presence at the HEIs we support. That means our ability to assess things like improvement of conceptual understanding or increased simulation skills of student team members compared to their peers, especially in a quantitative way, is near impossible without a strong collaboration with key faculty at the institution. In future, we hope to develop these types of collaborations in order to have this type of result to share with the wider community. For now, we rely on our own experience and qualitative student and faculty feedback to guide our initiatives.

Conclusion

It's clear from both the literature and our own experience in industry at Ansys that the industry-academia gap is an ongoing issue for new graduates. Extracurricular activities, such as involvement in student team competitions, have been highlighted as a way to reduce this gap and help students gain the skills they need to start their careers. At Ansys, we look to support academia in a wide variety of ways, including student teams. This paper highlights our current support strategy, including free software and training as well as increasing our event support, as well as our plans for the future. We hope this paper helps continue this discussion of the best ways to support new engineers early in their careers.

References

[1] D. I. Spang, "Curriculum design and assessment to address the industry skills gap," in *2014 ASEE Annual Conference & Exposition*, 2014, pp. 24–345.

[2] E. F. Crawley, D. R. Brodeur, and D. H. Soderholm, "The education of future aeronautical engineers: conceiving, designing, implementing and operating," *J Sci Educ Technol*, vol. 17, no. 2, pp. 138–151, 2008.

[3] K. Alboaouh, "The gap between engineering schools and industry: A strategic initiative," in *2018 IEEE Frontiers in Education Conference (FIE)*, 2018, pp. 1–6.

[4] J. D. Bransford, A. L. Brown, and R. R. Cocking, *How people learn*, vol. 11. Washington, DC: National academy press, 2000.

[5] Hart Research Associates, “It takes more than a major: Employer priorities for college learning and student success,” 2013.

[6] R. Korte, S. Sheppard, and W. Jordan, “A Qualitative Study Of The Early Work Experiences Of Recent Graduates In Engineering.,” in *2008 Annual Conference & Exposition*, 2008, pp. 13–94.

[7] E. Goold, “Engineering students’ perceptions of their preparation for engineering practice,” in *The 6th Research in Engineering Education Symposium*, 2015.

[8] D. Heaslip, “Bridging The Gap Between Post Graduate Engineering Education And Industry Needs,” in *2004 Annual Conference*, 2004, pp. 9–264.

[9] “Need for a 21st Century Engineering Curriculum,” *CIMdata*, 2019.

[10] A. F. Warsame, “The Gap Between Engineering Education and Postgraduate Preparedness,” Walden University, 2017.

[11] NSEE Annual Report, “Engagement Insights: Survey Findings on the Quality of Undergraduate Education,” 2019.

[12] M. Prince, “Does active learning work? A review of the research,” *Journal of Engineering Education*, vol. 93, no. July, pp. 223–231, 2004, doi: 10.1038/nature02568.

[13] C. J. Finelli *et al.*, “A classroom observation instrument to assess student response to active learning,” in *Proceedings - Frontiers in Education Conference, FIE*, 2015, vol. 2015-February, no. February. doi: 10.1109/FIE.2014.7044084.

[14] S. Freeman *et al.*, “Active learning increases student performance in science, engineering, and mathematics,” *Proceedings of the National Academy of Sciences*, vol. 111, no. 23, pp. 8410 LP – 8415, Jun. 2014, doi: 10.1073/pnas.1319030111.

[15] M. T. H. Chi, “Active-constructive-interactive: A conceptual framework for differentiating learning activities,” *Top Cogn Sci*, vol. 1, no. 1, pp. 73–105, 2009.

[16] M. C. Hatfield and D. Lewandoski, “Student-Led Aerospace Design Team Experiences,” in *2019 ASEE Annual Conference & Exposition*, 2019.

[17] K. Krause and H. Coates, “Students’ engagement in first-year university,” *Assess Eval High Educ*, vol. 33, no. 5, pp. 493–505, 2008.

[18] K. Tyler, N. Stefani, and L. Mohee, “Teaching Engineering Design with Materials Selection and Simulation through Case Studies: A Work in Progress,” in *2022 ASEE Annual Conference & Exposition*, 2022.