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Industry Perspectives on Professional and Design Skills of Bioengineering Senior Students

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Born and raised in Germany, Isgard Hueck studied Biology at the Wilhelms- University in Munster and received her license as Cyto-Pathologist in Cologne, Germany, in 1987. After years of clinical work in hematology, cancer diagnosis and therapy, Isgard Hueck received a Master of Science degree in Bio-Medical Engineering in 1998 from the University of Applied Sciences in Aachen, Germany. In conjunction with the University California in San Diego, Dr. Hueck conducted biomedical research focussing on long-term medical implants, angiogenesis in diabetes, and stem cell research. She has published in scientific journals like Microcirculation and the American Journal of Physiology. She contributed two chapters to the Springer Verlag Books 'Applications in Stem Cell Engineering' and 'Biological, Physical, and Technical Basics of Cell Engineering.' In 2012, Dr. Hueck was recruited as the Program Assessment Specialist for the Dept of Bioeng., UCSD, leading continuous improvement processes in engineering education and for the Accreditation Board of Engineering and Technology. In 2022, Isgard Hueck completed her Ph.D. in leadership in higher education with a focus on engineering education. Dr. Isgard Hueck founded the Office of Industrial Relations (IRO) in the Department of Bioengineering at UCSD to provide engineering students better opportunities to build close industry relationships within the academic education. In addition, Dr. Hueck engages in enrichment programs for "learning beyond the classroom". She is actively assessing and researching opportunities to improve eduction for the modern and holistic engineer of tomorrow.

Industry Perspectives on Professional and Design Skills of Bioengineering Senior Students

Abstract

Professional and design skill development is an essential part of engineering education [1], yet, according to industry feedback, many students struggle to satisfactorily develop these skills during their time as undergraduates [2], [3]. Despite numerous approaches to improve students' preparedness for the work environment through academia-industry collaborations (see [4]), the perceptions of industry experts on strengths and weaknesses of current senior engineering students remain widely unspecified in the literature. In this work, we are using a systematic approach and framework to examine the research question, "What are the industry perspectives on assessed strengths and challenges related to professional and engineering design skills of bioengineering seniors?"

Building on prior coursework, the senior design capstone experience provides students with the opportunity to apply concepts and develop important skills necessary for transition to their professional careers. In the bioengineering undergraduate programs at the University of California San Diego, the senior design experience culminates with an event called Bioengineering Day (BE-Day), in which senior students present posters on their design project. Students have the unique opportunity to interact one-on-one with industrial professionals to discuss their projects. After visiting with students at their posters, industry judges are asked to provide feedback on specific performance indicators, such as visual and oral communication, engineering design, and self-management skills. In this study, we investigated which skills were cited as a strength of senior bioengineering students and which skills need improvement. Coupling hierarchical clustering with industry reviews from two consecutive years, we analyzed industry feedback on aspects of student performance in senior design projects, extracting distinct skill subsets. By applying the Euclidean distance metric and average linkage method, we produced visualizations – a heatmap and dendrogram – for categorizing students' skills based on industry-specific criteria.

Results indicated that the highest-scoring performance indicators included the overall quality of the posters and oral presentations. Furthermore, students excelled at verbal communication and professional behavior. Students also demonstrated excellence in describing the background and needs of their project. Areas for improvement were consistent between years and included students' abilities to describe the "limitations of their work". Industry professionals also rated students' "ability to implement their work as proposed" as relatively lower than other performance indicators. Here, we gain an understanding of industry perspectives on senior design skill development that will help inform curricular improvements to close the gap between industry expectations and academic preparation of engineering graduates.

Keywords: industry feedback, professional skills, engineering design skills, visual communication, oral communication, senior design, capstone

Introduction

Globalization and interdisciplinary design preferences have shifted expectations on the modern engineer [5]-[7]. To be successful in engineering industries, technical knowledge and design skills need to be accompanied by professional skills to fulfill the multiple roles of early-career engineers [8]. Successful communication with others across multidisciplinary contexts has become an important part of the engineering profession [9]. Therefore, the development of professional and social-emotional skills along with design skills are essential parts of engineering education [1], [10]. Yet, students struggle to satisfactorily develop these skills during their time as undergraduates, as stated in recent feedback from over 500 employers who hired entry-level engineers [2].

Despite the implementation of project-based educational learning models, the skill gap between work expectations of employers and the performance of engineering graduates persists in subsets of professional skills, such as contextual application of engineering design solutions, communication, motivation, and self-management [2], [3], [5]. A focus on collaboration with industry in the education of engineers has been shown to boost, not only design thinking with real-world complexity [1], but also to increase contextual understanding of design solutions, career motivation, personal life attributes (e.g. persistence, adaptability), ethics, and professional behavior [3], [11]-[15].

Particularly in engineering capstone senior design projects, activities with industry feedback have been identified as effective mechanisms to stimulate students' motivation, improve professional skills, and to reflect on realistic contexts or limitations of proposed design solutions [16], [17]. Shah and Gillen [4] provided a systematic overview of university-industry partnerships in capstone projects across engineering education and suggested identifying skills with low performance indicators and improving those with additional focus in the curriculum. Although various ways of soliciting industry feedback on senior design projects showed potential to improve students' preparedness for the work environment in general [4], [18], the perception of industry experts on details of strengths and weaknesses of current engineering senior students remains widely unspecified in the literature. Applying the framework of student learning outcomes according to the Accreditation Board for Engineering and Technology (ABET) [19], this study used a one-on-one approach to solicit industry feedback on senior design capstone presentations to answer the research question: "What are industry perspectives on the assessed strengths and challenges related to professional and engineering design skills of bioengineering seniors?"

In the bioengineering program of the University of California San Diego, senior undergraduates work in teams to design engineering solutions for human health. In this year-long experience, students build upon their prior curriculum and engage in real-world open-ended projects to develop important engineering skills. This experience culminates with an annual in-person event called Bioengineering Day (BE-Day), in which senior students present posters on their design work. Students have the unique opportunity to interact one-on-one with multiple industrial professionals, discussing their senior design at BE-Day. Industrial representatives also provide feedback on students' professional and design skills for formative assessment of the degree to which the students developed these competencies. In this work, we analyzed the industry feedback provided on a wide range of performance indicators, utilizing the framework of ABET-defined student learning outcomes [19], over two consecutive years of senior design projects. According to their specific expertise in the field, industry judges are assigned teams each year and are prompted to discuss and review a set of performance indicators, including visual and oral communication, engineering design, and self-management skills. After rotating through multiple teams at BE-Day presentations, the industry representatives complete a short survey with numeric and open-ended feedback questions for each team that they interacted with (see Appendix A). Some criteria are used for a competitive award component at the conclusion of the BE-Day to optimize student motivation and performances while talking to industry experts.

With the analysis of industry perspectives on specified performance indicators, we intend to provide valuable insights into the strengths and weaknesses in design and professional skill subsets of graduating bioengineering senior students. Our findings will serve to inform curricular improvements to the senior design experience to better prepare students for their transition into the workplace.

Methods

Description of Bioengineering Day Event

Bioengineering Day is an annual event that serves to celebrate the bioengineering department at the University of California San Diego, the current research and design by bioengineering seniors, and the overall field of bioengineering. Attended by over 400 people each year, this day-long event features keynote speakers, senior and Master's design project poster presentations, research seminars, and networking sessions. Members from the undergraduate, graduate, faculty, industry, and local research communities are active participants in this event, which is primarily student-led, via the local Biomedical Engineering Society student chapter. A large portion of the BE-Day is focused on the presentation and discussion sessions of the capstone senior design projects with peers, faculty, and industry judges. Besides networking opportunities, senior students and industry representatives have one-on-one time to discuss the development, obstacles, and limitations of their design regarding industry criteria.

Participants and Data Collection

The demographic location of the University of California San Diego in a rising Biotech hub area allows many smaller and start-up companies to join the BE-Day in person. Many industry experts are already engaged with other academia-industry partnerships to support the educational mission of the institution and to screen rising talent. Therefore, industry judges can be recruited from a variety of types of industry, including small and large biotech and medical device companies, as well as local start-ups. Companies represented included Philips Healthcare Corp., Xosomix, LLC, NuVasive Inc., SeaSpine Inc., Dimension Genomics Inc., and Illumina Inc., among others. Judges were prompted to engage with assigned senior design groups in poster presentation sessions. Each judge rotated to spend time with multiple individual senior design groups to discuss not only the poster presentation, but also the development of their projects. Judges were given a rubric of performance indicators based on the ABET framework [19]. They were also prompted to guide the discussions with seniors to talk about personal experiences during their year-long design development, such as overcoming obstacles, persistence, self-initiative, and thoughts on design limitations or iterations. In the way the discussions were guided to include individual experiences, learning outcomes that are not obvious in technical poster presentations alone, can be captured. After one-on-one time with each senior design group, judges provided feedback via a google form with numerical assessment of each performance indicator and open-ended comments (see Appendix A), before moving on to the next group. In Spring 2022, 19 industry responses were completed and submitted; in Spring 2023, 41 industry responses were submitted. Performance indicators with distinct skill subsets for engineering design, presentation skills, professional and self-management skills, such as persistence, motivation, and innovative thinking were assessed (18 total performance indicators for each year, see Fig. 1 and Fig. 2).

Data Analysis

We utilized the results from judges' assessments on various aspects of the senior design poster presentation and discussion session on BE-Day. The data was arranged in a matrix format with each row representing a specific evaluation criterion and each column representing the performance indicator level ranging from Novice, Intermediate, Very Good, and Outstanding. Each data set included 18 criteria categorized into the overall quality of the 1) Senior Design Project execution (Project), 2) Applying Engineering Principles (Engineering), 3) Presentation of the research project (Presentation), and 4) Quality of poster presentation (Poster). To understand patterns of high and low performance indicators in senior design projects from an industry perspective, we employed hierarchical clustering and a visualization tool called clustergram in MATLAB. This approach enabled us to identify and cluster criteria that were consistently rated high or low by industry judges. By applying the Euclidean distance metric and the average linkage method, we generated visualizations, including a heatmap and dendrogram. These visual tools categorize students' skills and performance based on industry judges specific criteria, effectively providing insights into which aspects of senior design projects are consistently rated high or low from an industry perspective.

Results

Quantitative Evaluation from Industry Judges

Results indicated that consistently, in both 2022 and 2023, the highest-scoring performance indicators included respectful and professional behavior and presentation skills, such as fluid speech and body language. Figure 1 and Figure 2 indicate that many industry judges scored these performance indicators as outstanding (see yellow color in the heatmap) in both years. Other aspects of project presentation, such as describing the background and needs of the project, increased in scoring from 2022 and 2023. More industry judges also rated entrepreneurial thinking higher in 2023 than in 2022. The program emphasized innovative ideas in the capstone projects.

Identified areas for improvement were also consistent between the two years and included students' abilities to describe the limitations of their work and aspects of implementing the work as proposed, considering how to overcome obstacles and setbacks. Motivation and self-initiative, however, were scored similarly in mid-range in both years (see Fig. 1 and Fig. 2).

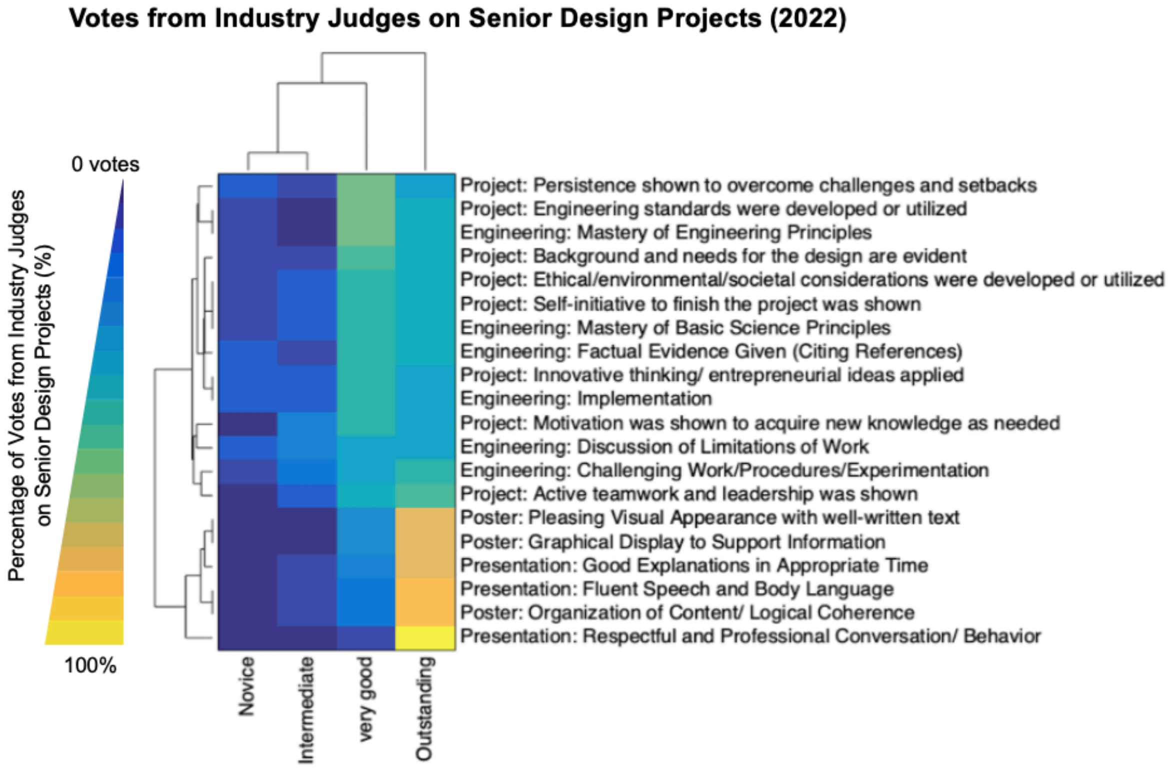

Figure 1: Senior Design Project Evaluation from Industry Judges in 2022. Heatmap and dendrogram generated using hierarchical clustering. The rows represent 18 evaluation criteria grouped into four main categories: Project execution, Application of engineering principles, Research Presentation, and Poster Quality. The columns denote performance levels: Novice, Intermediate, Very Good, and Outstanding. The color intensity in the heatmap indicates the frequency of each performance level for a given criterion, as rated by industry judges' votes. The dendrogram illustrates the clustering of criteria based on similarities in judges' ratings. Consistently high performance criteria are listed at the bottom of the rows (yellow) and low performance at the criteria at the top of the rows.

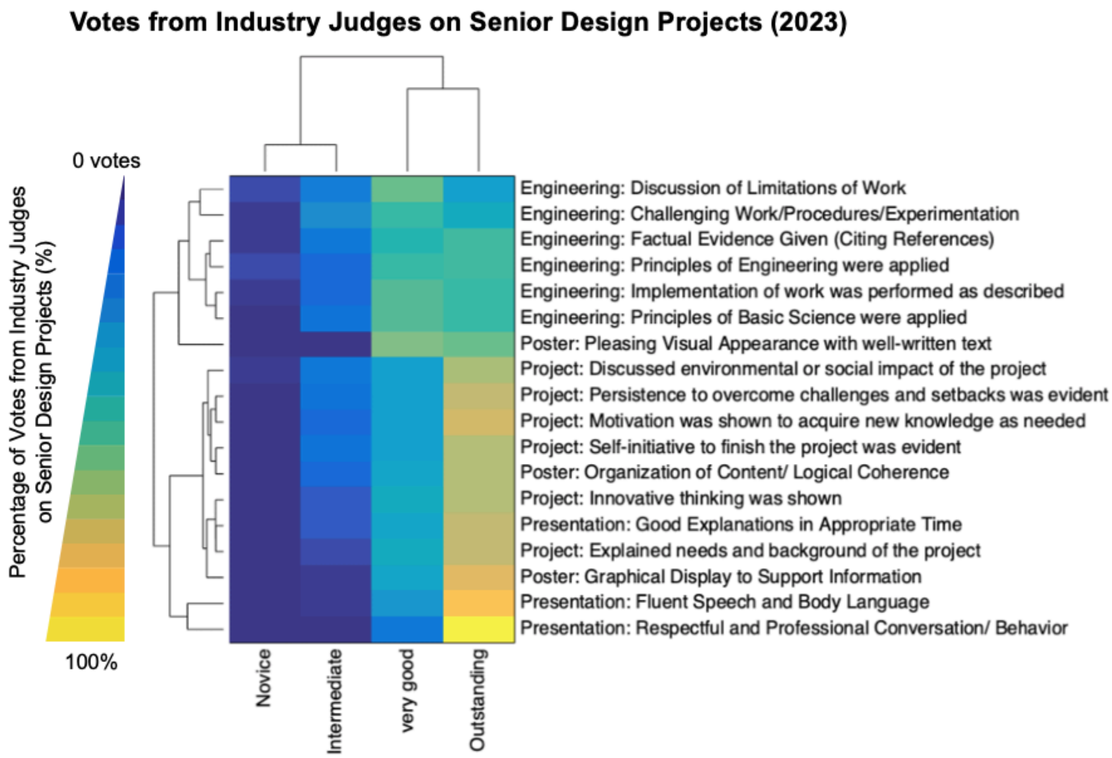

Figure 2: Senior Design Project Evaluation from Industry Judges in 2023. Heatmap and dendrogram generated using hierarchical clustering. The rows represent 18 evaluation criteria grouped into four main categories: Project execution, Application of engineering principles, Research Presentation, and Poster Quality. The columns denote performance levels: Novice, Intermediate, Very Good, and Outstanding. The color intensity in the heatmap indicates the frequency of each performance level for a given criterion, as rated by industry judges' votes. The dendrogram illustrates the clustering of criteria based on similarities in judges' ratings. Consistently high performance criteria are listed at the bottom of the rows (yellow) and low performance at the criteria at the top of the rows.

Open-Ended Comments from Industry Judges

In addition to quantitative rubrics, industry judges were also given the opportunity to provide open-ended comments regarding project development and representation of the project. Comments were provided in 32% of the 2023 industry responses and in 37% of 2022 industry responses. Industry judges elaborated on strengths and areas for improvement. These comments reflect the perspectives of the industry members and provide some insight into their quantitative evaluations (Fig. 1 and Fig. 2). Representative quotations included:

> "They did a good job in characterizing the bone surface via imaging. Their presentation was good and they successfully were able to accomplish the goal outlined. Overall it was a good effort and a good presentation by both students. One piece of advice I would convey is to more clearly define the end-goal and problem trying to be solved. It is

> important to understand why this is an issue and what problem would your solution solve."
>
> "Professional, passionate, seemed to enjoy their work, good communicators."
>
> "Not quite understanding the real world execution of the system."
>
> "Well spoken, professional, interested in material."
>
> "Most well rounded. Great energy and passion behind projects. Makes sense and incorporated a lot of engineering concepts and challenges."

In summary, industry feedback provided valuable information on strengths and challenges of engineering and professional skills as exhibited in senior design capstone projects of bioengineering students. Our findings serve as valuable insights into the strengths and weaknesses in design and professional skills of our graduating seniors, which will help inform curricular improvements to the senior design experience to better prepare students for their transition to the workplace.

Conclusions

Industry feedback provided valuable insights on the assessed strengths and challenges related to professional and engineering design skills of bioengineering seniors. The data suggested that the current curriculum prepares students well in oral presentation and poster design skills. However, in alignment with existing literature [20], students could improve on the understanding of the contextual complexity and limitations of their senior designs. These findings can be utilized to develop curricular improvements by adding exercises to outline limitations and societal impact to the senior design classes.

As a result of this feedback from industry evaluators, we plan to make improvements to the senior design curriculum. For example, industry professionals cited that students were not able to clearly explain the limitations of their work. To teach students that it is important to understand and be able to acknowledge the limitations of their work, we plan to ask the students to survey external industry professionals before BE-Day about their project to help them understand and appreciate aspects of limitations of their projects. We have also designed a new risk analysis lesson and assignment based on the Failure Mode and Effects Analysis technique, which will require students to think in depth about the potential failure modes in their system and their causes and effects, so they will have an increased understanding of limitations of their projects.

We will also highlight examples of how acknowledging limitations is critical and manifests in the real world, for example by showing them research articles which clearly acknowledge limitations, usually in their discussion sections. Also, at the time of this study, the final design report asked students to describe "the pros and cons of their solution relative to alternatives", but were not asked explicitly to elaborate on limitations of their design solution (e.g., limitations in application, adoption, function). In the future, we will modify the final report requirements to explicitly call for a discussion on the limitations of their design solution.

Although these data provide valuable insights into the perceptions of industry stakeholders regarding the skills of our students, one of the limitations of this study is that we are relying on two years of assessment. We plan to conduct an additional assessment in the next cycle, in order to investigate any impacts of our curriculum interventions. We also plan to engage with even more industry partners across company types, so that we can increase the number of reviews gathered at BE-Day. We also acknowledge that while the performance indicators we analyzed in this work are universally applicable across senior design programs, depending on the curriculum and emphasis of the senior design program, students may differ in the skills they develop and refine.

In conclusion, we hope that our approach of engaging industry partners in formative evaluation of senior design via one-on-one interactions serves as a useful model to other engineering educators. Based on the increase in the number of industry participants over the years at BE-Day, and the enthusiasm conveyed by both the industry professionals and the students, we are excited to continue to utilize this approach to gather formative feedback on professional and design skill development. We appreciate the participation of industry partners towards optimizing the educational experience, including professional preparedness of bioengineering undergraduate students and the engagement in continuous program improvement.

References

[1] Hadgraft, R.G., & A. Kolmos (2020). ”Emerging learning environments in engineering education”, *Australasian Journal of Engineering Education,* 25:1, 3-16, DOI: 10.1080/22054952.2020.1713522

[2] Hirudayaraj, M., Baker, R., Baker, F., & M. Eastman (2021). “Soft skills for entry-level engineers: What employers want”, *Education Sciences*, 11, 641-675. https://doi.org/10.3390/educsci11100641

[3] Kolmos, A., & J. E. Holgaard (2019). “Employability in Engineering Education: Are Engineering Students Ready for Work?” In The Engineering-Business Nexus: Symbiosis, Tension and Co-Evolution, edited by S. H. Christensen, B. Delahousse, C. Didier, M. Meganck, and M. Murphy, Philosophy of Engineering and Technology, Vol.32, 499–520. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-99636-3_22

[4] Shah, R., & A.L. Gillen (03 Sep 2023). “A systematic literature review of university-industry partnerships in engineering education”, *European Journal of Engineering Education,* https://doi.org/10.1080/03043797.2023.2253741

[5] Bae, H., Polmear, M., & D. R. Simmons (2022). “Bridging the gap between industry expectations and academic preparation: Civil engineering students’ employability”, *Journal of Civil Engineering Education,* 148(3). https://doi.org/10.1061/(asce)ei.2643-9115.0000062

[6] Gilar-Corbí, R., Pozo-Rico, T., Sánchez, B., & J.L. Castejón (2018). “Can emotional competence be taught in higher education? A randomized experimental study of an emotional intelligence training program using a multimethodological approach”, *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.01039

[7] Goldberg, D. E., Somerville, M., & Whitney, C. (2016). A whole new engineer: The coming revolution in engineering education. ThreeJoy Associates.

[8] Craps, S., Pinxten, M., Knipprath, H., & G. Langie (2020). “Exploring professional roles for early career engineers: A systematic literature review”, *European Journal of Engineering Education,* 46(2), 266–286. https://doi.org/10.1080/03043797.2020.1781062

[9] Winberg, C., M. Bramhall, D. Greenfield, P. Johnson, P. Rowlett, O. Lewis, J. Waldock, and K. Wolff (2020). “Developing Employability in Engineering Education: A Systematic Review of the Literature”, *European Journal of Engineering Education* 45: 165–180. doi:https://doi.org/10.1080/03043797.2018.1534086.

[10] Antoniadou, M., Crowder, M., & Andreakos, G. (2020). “Emotional intelligence in engineering management education: The missing priority”, In D. Ktoridou (Ed.), *In Cases on engineering management education in practice*. IGI Global. https://doi.org/10.4018/978-1-7998-4063-3.ch005

[11] LeFrancois, S., Centeno, G., & K.A. Reeves (2021). “Ethics training: Cultivating an ethical engineer identity”, *2021 IEEE International Symposium on Technology and Society (ISTAS)*. https://doi.org/10.1109/istas52410.2021.9629178

[12] Mikkonen, M., Tuulos, T., & T. Bjorklund (2018). “Perceived long term value of industry project-based design courses: Alumni reflections from two decades of the product development project”, In P. Ekstromer, S. Schutte, & T. Bjorklung (Eds.), *Proceedings of NordDesign 2018*. NordDesign. https://research.aalto.fi/en/publications/perceived-long-term-value-of-industry-project-based-design-course

[13] Myint, M. M., Kyaw, T., & Saw, Z. M. (2021). “An explorative study to build the work readiness for engineering students”, *2021 Annual International Conference on Industrial Engineering and Operations Management Proceedings.* http://ieomsociety.org/singapore2021/papers/536.pdf

[14] Ranabahu, N., Almeida, S., & E. Kyriazis (2020). “University-led internships for innovative thinking: A theoretical framework”, *Education and Training*, *62*(3), 235–254. https://doi.org/10.1108/et-02-2019-0031

[15] Wilson, S., & Kaufmann, R. (2020). “Communication expectations to industry realities”, *2020 ASEE Virtual Annual Conference Content Access Proceedings*. https://doi.org/10.18260/1-2--34305

[16] Trent Jr., J. L., & R. H. Todd (2014). “Bridging Capstone Design with Industry Needs Through Communication, Training and Involvement”, *International Journal of Engineering Education* 30 (1): 14–19. https://www.researchgate.net/publication/290577633_Bridging_Capstone_Design_with_Industry_Needs_through_Communication_Training_and_Involvement

[17] Zhu, Na (2018). “Effectiveness of Involving the Industrial and Business Professions. Into Mechanical Engineering Capstone Course”, *International Journal of Mechanical Engineering Education* 46 (1): 31–40. https://doi.org/10.1177/0306419017718920.

[18] Martínez León, H. C. (2019). “Bridging Theory and Practice with Lean Six Sigma Capstone Design Projects”, *Quality Assurance in Education: An International Perspective* 27 (1): 41–55. https://doi.org/10.1108/QAE-07-2018-0079.

[19] ABET. (2023). Criteria for accrediting engineering programs 2023-2024. https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2023-2024/

[20] Burkholder, E., Hwang, L., & C. Wieman (2021). “Evaluating the problem-solving skills of graduating chemical engineering students”, *Education for Chemical Engineers,* 34, 68–77. https://doi.org/10.1016/j.ece.2020.11.006

Appendix A

Bioengineering Day Poster Presentation
Questionnaire for Judges

Group # _______ **Name of presenting Senior Student:** ___________________ **Major:** □ BT □ BE □ BS □ BINF

Name of Judge ______________________ **Affiliation to UCSD:** □ Industry □ Faculty □ Alumni

or □ Junior (BENG 187A) □ Senior (BENG 187D) □ Graduate Student

Please assign scores to the students' performance based on the criteria listed with 1 being the lowest possible score and 4 the highest possible score. Please check one box per row. 1= less than what is expected for a college senior, 2= about what is expected, 3= very good, 4= outstanding/award quality

Overall Quality of Poster	1	2	3	4
Pleasing Visual Appearance with well-written text				
Graphical Display to Support Information				
Organization of Content/ Logical Coherence				

Quality of Oral Presentation	1	2	3	4
Good Explanations in Appropriate Time				
Fluent Speech and Body Language				
Respectful and Professional Conversation/ Behavior				

Overall Quality of Engineering Work	1	2	3	4
Challenging Work/ Procedures/ Experimentation				
Implementation				
Mastery of Basic Science Principle				
Mastery of Engineering Principles				
Factual Evidence Given (References etc.)				
Discussion of Limitations of Work				

Please, rate the student's approach to his/her project on a scale of 1-4, with 1 being the lowest possible score and 4 the highest possible score. 1= very little interested in the project: "It is just another assignment" attitude. 2= about what is expected for a senior student, 3= very good and engaged with the project. 4= outstanding/fully invested and enthusiastic

The presenting student...	1	2	3	4
1. explained needs and background of the project.				
2. discussed environmental or social impact of the project.				
3. showed motivation to acquire new knowledge as needed.				
4. showed evident self-initiative to finish the project.				
5. demonstrated persistence to overcome challenges and setbacks.				
6. showed innovative thinking.				

Which realistic constraints were considered in guiding the design? (mark all that were addressed)

□ Safety / Regulatory Affairs □ Risk Management □ Global / Cultural Impact

□ Manufacturability/ Economic Factors □ QC / Marketability / Translation or □ None of the above.

Please add comments concerning project development and representation of the project below or on the back: