The Future of Engineering Education
2024 Annual Conference & Exposition
Oregon Convention Center
Portland, OR . June 23 - 26, 2024
ASEE
Paper ID #43414

Work in Progress: A Novel Two-Semester Course Sequence that Integrates Engineering Design, Sociotechnical Skills, Career Development, and Academic Advising

Dr. Benjamin J. Laugelli, University of Virginia

Dr. Laugelli is an Assistant Professor of Engineering and Society at the University of Virginia. He teaches courses that examine social and ethical aspects of technology and engineering practice.

Dr. Keith Andrew Williams, University of Virginia

Born in Georgia, USA; moved shortly thereafter to Jordan and then to southern Africa, including Rhodesia (Zimbabwe), Botswana, and South Africa, attending local/native schools throughout. Completed middle school education via correspondence with The Calvert School in Baltimore, Maryland. Returned to the US for three years of high school. Completed MS degree in physics at the University of Kentucky in 1999, including stipendium at the Ruprecht-Karls University in Heidelberg, Germany. Graduate work included two research appointments in Japan. Completed a Ph.D. in materials physics at Penn State University in 2001. Completed postdoctoral research in the Molecular Biophysics Group at the Delft University of Technology in the Netherlands; thereafter established a nanophysics laboratory in the Physics Department at the University of Virginia (UVa). Appointed Program Manager and division CTO for the Materials, Corrosion, and Environmental Technologies Department of Leidos (f/k/a SAIC), based at the Naval Research Laboratory in Washington DC, while on leave from UVa. Presently Associate Professor in the Department of Electrical & Computer Engineering at UVa, and also Director of the ENGR (introductory engineering) program.

Dr. Esther Tian, University of Virginia

Esther Tian is an Associate Professor of Engineering in the School of Engineering and Applied Science at University of Virginia. She received her Ph.D. in Mechanical Engineering from the University of Virginia. Her research interests include bio-inspired robotics and engineering design education.

Julia Lapan, University of Virginia
Shaylin Williams, University of Virginia

Shaylin Williams is invested in identifying ways to improve the engineering education experience for future generations of engineers. As a McNair Scholar, Shaylin worked on chemical engineering projects creating thermal barriers for food packaging and studying soil remediation. Additionally, she completed an REU project in healthcare engineering at the University of Wisconsin- Madison. She earned a master's degree in industrial and systems Engineering with a Management Systems Concentration in December 2022. Shaylin recently completed her Ph.D. in Engineering Education at Mississippi State University, using Self Determination Theory to analyze freshmen and continuing Summer Bridge students' experiences and senior engineering students' graduation plans. She previously worked on a longitudinal study researching how varying first-year experience structures affect students' engineering identities and involvement in communities of practice. Shaylin now serves as an Assistant Professor for the University of Virginia's First Year Engineering Center and is interested in learning more about what contributes to engineering students' success, how they can get the most out of their undergraduate programs, and how programs can be better designed to cater to students' needs.

Dr. Deepyaman Maiti, University of Virginia

Deepyaman Maiti is currently an Assistant Professor in the Department of Engineering and Society in the School of Engineering and Applied Science at the University of Virginia. He teaches Introduction to Engineering and Applied Mathematics classes, and se

Ms. Anne Marguerite McAlister, University of Virginia

Anne M. McAlister is a PhD student and graduate research assistant in the Department of Curriculum and Instruction and Special Education at the School of Education and Human Development at the University of Virginia. Her research focuses on identity devel

Benjamin Goldschneider, University of Virginia

Benjamin Goldschneider is an Assistant Professor of Engineering Foundations at the University of Virginia. He holds a PhD in Engineering Education from Virginia Tech, as well as a BS in Industrial Engineering from Purdue University. His research interests include students' sense of belonging, socialization, program development, and pre-college introductions to STEM material.

Nicole Dufalla, University of Virginia
Anna Leyf Peirce Starling, University of Virginia
Dr. William H. Guilford, University of Virginia

Will Guilford is an Associate Professor of Biomedical Engineering at the University of Virginia, and he serves as the Associate Dean for Undergraduate Affairs in the School of Engineering, and as Director of the First Year Engineering Center. He received his B.S. from St. Francis College, and his Ph.D. from the University of Arizona. He completed a postdoctoral fellowship in Biophysics at the University of Vermont before joining UVA in 1997.

Work in Progress: A novel two-semester course sequence that integrates engineering design, sociotechnical skills, career development, and academic advising.

Abstract

We present our work in progress of the design and implementation of a new first-year introductory design course sequence in the School of Engineering at the University of Virginia, replacing two long-standing required courses for first-year students – one that introduced the field of engineering, and another that focused on sociotechnical principles and communication. In developing this new course sequence, a task force first generated a set of guiding principles to drive the curriculum redesign, gathered feedback on needed technical and professional proficiencies from alumni, faculty, and employers, and sought information about what engineering looked like at peer institutions before defining a vision the curriculum. Among the recommendations was the creation of a new two course "Engineering Foundations" sequence to integrate engineering design, communication, ethical reasoning, sociotechnical thinking, develop students' professional competence, and embed academic advising and career development. The sequence has since been deployed and is taught by purpose-hired faculty who serve a dual role as the student's professor and academic advisor, meaning that every student has regular, face-to-face interaction with their advisor. This increased contact promotes a supportive environment for students as they navigate the beginnings of their college careers. Learning objectives are consistent across sections of the courses taught by the different faculty, and evidence-based pedagogies are consistently employed. Importantly, the interwoven technical and sociotechnical approach to engineering is supported by guidance, materials, and guest lectures from faculty with specialization in Science, Technology, and Society (STS) and directly applied by students within the context of their design projects. The expertise of career development professionals supports the program's objective to develop students' professional competence alongside their engineering knowledge. By leveraging an integrated and well-supported curriculum, the new Engineering Foundations courses provide a holistic approach to educating first-year engineers. While constructing an engineering course sequence is not a novel process, our integration of technical and sociotechnical content is unusual. We report on our process and the resulting course sequence so that other institutions might benefit from the insights we gained.

Background

A persistent challenge in postsecondary engineering education is keeping the curriculum current with industry needs to ensure that students develop the skills necessary to succeed in their careers. In 2019, our Engineering program underwent a rigorous self-evaluation of the core course sequence (the collection of courses required of every student, regardless of engineering major) and decided to make major changes based on input from key stakeholders. A Core Curriculum Task Force, comprised of chair-appointed faculty representatives from each degree-granting department in the school, examined the entirety of the core curriculum in engineering at the University of Virginia (UVA) with the charge of recommending changes that would maximize outcomes for 21st century students. Among its recommendations, the Task Force generated a set of guiding principles to drive the design of a new curriculum, gathered information on the core curriculum model at the time from relevant stakeholders, including alumni, faculty, and employers; considered models for delivering needed learning outcomes used by peer institutions; and made recommendations to the faculty of the school for how to update the core curriculum for courses that span the duration of our degree programs, and especially for those in the first year.

Existing Core Curriculum

Our core curriculum in 2019 included a common first year. First-time first-year students entered the school as undeclared majors in engineering. That is, students would take a set of general education requirements prior to entering their majors. Within this core, we had a single-semester introduction to engineering course, ENGR 1624 "Introduction to Engineering" (4 credits) that was required of all students, the content of which varied by instructor.

Of note, the instructors of the first-year engineering course sections served as the academic advisors to new students in an embedded advisor model. Students in this embedded model saw their academic advisor two or more times a week, a large increase from traditional models of seeing academic advisors only occasionally. This model was associated with a number of positive outcomes, including a large gain in students reporting that their academic advisor played an active role in their success [1], [2].

Students were also required to take an introductory course in Science, Technology, and Society (STS), STS 1500 "Science, Technology, and Contemporary Issues" (3 credits), that introduced STS theory, the history of invention, communication, and intellectual property. The field of STS seeks to understand how scientific knowledge, technological innovations, and their development are shaped by, and in turn, influence social, cultural, economic, political, and ethical aspects of human life. It includes theories of science and technology including actor-network theory, the history of science and technology, the social construction of knowledge, the ethical and moral implications of scientific and technological developments, the formulation and implementation of policy, public engagement, and communication. In 2020, students were required to take four STS courses in total that culminated in the writing of a senior thesis. The later courses delved more deeply into STS theory and engineering ethics and supported the writing of a senior thesis.

Guiding Principles

The task force defined a set of guiding principles for the core curriculum at UVA that would govern the structure of the core curriculum and guide the pedagogical approach and delivery of individual courses that comprise it. These principles were supported by a supermajority of the faculty. Five of these principles are relevant to a cohesive first-year experience:

1. A shared, major-agnostic first year curriculum is important for students, giving them time to grow, develop, and make informed decisions on their own academic path.
2. Students will develop an understanding of ethics, the habits of career management, an appreciation of social context and communications skills since these are vital to their progression as professionals.
3. Students will be presented with authentic, open-ended, value-driven, and consequential problems.

4. Students will develop individual mastery of core skills, while also learning to work collaboratively to solve problems.
5. Classroom environments will be equitable, affirming, and inclusive, and will imbue students with the knowledge of support systems that are available to them.

A cohesive first-year experience, as described in the first guiding principle, was especially important to our curricular redesign. First-year experiences [4], [5], usually in the form of courses which bring students together with faculty or staff on a regular and recurring basis, are high impact practices – that is, practices that "educational research suggests increased rates of student retention and student engagement" [3]. The best of these first-year experiences focus on developing habits of critical inquiry, writing, information literacy, and team-based learning [5].

Surveying faculty, alumni, and employers

The Task Force surveyed and received responses from 133 faculty, 516 recent alumni, and 46 employers to determine what technical proficiencies and professional proficiencies they believed were most important for contemporary engineering graduates. While a detailed accounting of the survey results is beyond the scope of this paper, the three groups of stakeholders agreed (>70% in each group) that a range of technical subject matter is important for all engineers, regardless of field. These included single variable calculus, differential equations, probability and statistics, general purpose computing and programming, the engineering design process, modeling (including prototyping), and project management. The three stakeholder groups also agreed that a number of professional proficiencies are important for all engineers, including communication (oral, written, graphical), codes of ethics and identification, working with people of diverse and different backgrounds, reflection, feedback, and career skills, among others. These proficiencies were used to guide the structure of a new general education curriculum.

Benchmarking

The Task Force undertook a brief benchmarking against 42 near-peer schools which were determined to be peer schools by similar Carnegie Classifications – very high research activity, full-time, four-year, more selective, large, primarily residential, majority undergraduate. It found that we were typical in two key respects to others' first year curriculum. Sixty-four percent of peer institutions had a completely or partially common first year, and, of those peer institutions that had a completely or largely common first year, 48% of our peers required a single semester of introduction to engineering or its equivalent. Only 18% required two semesters, and 4% required three semesters of introduction to engineering. Further, the Task Force found that we were *atypical* in one substantial respect: our STS course requirements.

Our focus on STS was considered by many alumni and employers as a particularly strong feature of a UVA education, as was the embedded advising model.

Assessment of Introduction to Engineering and STS at UVA in 2020

Despite these strengths, the task force found that the content of our curriculum did not always match the needs expressed by faculty, alumni, and employers. For example, understanding of intellectual property was a key emphasis of the second half of our first-year STS course but all three groups ranked intellectual property lowest among all the proposed professional proficiencies. In contrast, technical, non-technical, oral, and graphical communication were ranked among the highest proficiency needs and, while some of these were taught in required STS courses, they were not uniformly delivered elsewhere in the core curriculum. Quoting an alumnus who responded to our stakeholder survey:

> "I wish that these [professional proficiencies like communication and ethics] were covered in some form throughout more of the curriculum than just STS courses. While it was good that the STS courses covered most of these in some detail, there was never much of a chance to actually practice them in other classes and see for ourselves how effective they could be."

In other words, artificial distinctions between subject areas were inadvertently being made and emphasized by the structure of the curriculum. The task force concluded that integration of subject matter, specifically the technical content of introduction to engineering and the sociotechnical content of STS 1500, could improve the student learning experience and better demonstrate the importance of STS to engineering practice.

Compounding matters, there was no common set of learning objectives that was shared among all the course sections of our introduction to engineering course, meaning that students could have significantly different experiences from their peers in another section of the same course.

Finally, the task force determined that "habits of career management" was a guiding principle for the core curriculum, but this was not part of any general education requirement.

The Vision

The Task Force recommended that our "Introduction to Engineering" and "Science, Technology, and Contemporary Issues" courses be combined into a co-instructed two-semester sequence, "Engineering Foundations" 1 and 2 (4 credits and 3 credits, respectively). These courses were to be co-taught by faculty from degree-granting programs, STS faculty, and staff. There is precedent for combining technical training with training in communication [6], but STS includes theory, history, ethics, policy, and more in addition to communication. *The integration of STS with design training, as envisioned here is, to our knowledge, novel to the design of introduction to engineering courses.* The purpose of this integration would be to erase the distinctions between technical and sociotechnical instruction in order to train better rounded engineers, and to signal to students the importance of STS concepts in engineering practice.

The content of this two-course sequence would emphasize several technical and professional proficiencies, as guided by outcomes from the faculty, alumni, and employer surveys: (1) systematic design, (2) data analysis, (3) communication, (4) social factors, (5) leadership development, (6) research and learning, (7) career development, (8) project management, and (9) modeling – physical, computational, and/or mathematical. The first semester of Engineering Foundations would use a structure of multiple design modules, while the second semester would use an authentic design problem with a client. There is evidence that authentic design problems improve students' problem-solving skills [7]. The task force also felt that it was critical that we keep the embedded advising model that had been so successful. That is, the instructor would be the academic advisor to each student in their Engineering Foundations sections.

Implementation

We piloted the Engineering Foundations sequence in the 2021-22 and again in 2022-23 academic years before moving forward with a full-scale implementation in 2023-24.

Pilot 1: 2021-2022

A co-teaching team of an Electrical Engineering professor and a STS professor first piloted two sections of Engineering Foundations 1 and 2 win the 2021-22 academic year. Enrollments in each section were 35 & 35 in Fall 2021, and 37 & 28 in Spring 2022. Both instructors were present in class every class day. End-of-course evaluations show that students gave the Fall semester course high scores, with one student writing “I like this new pilot program, more than I think I would've liked STS1500 and ENGR1624.” The integration of technical and sociotechnical was addressed by one student who wrote that the class “was very good at introducing the gritty parts of engineering such as technical drawings in a way that had multiple approaches and could be easily linked back to the real world.”

Pilot 2: 2022-2023

A single section of the second pilot of the course sequence with an enrollment of 26 began in Fall 2022. It was taught by the same STS faculty member and a Biomedical Engineering professor. In Fall 2022, the STS faculty member was present for approximately 25% of classes and the disciplinary faculty member was present as design instructor for the remaining classes, as envisioned by the task force. Both instructors were present on days when students did presentations. A three-module approach was used for this Foundations 1 implementation:

1. A two-week module, “Aloft”, introduced students to the engineering design process, technical communication, and sociotechnical theory. Students iteratively redesigned a piece of paper to remain aloft as long as possible when dropped from a set height.
2. A three-week module on “food insecurity” taught tools and approaches for research, including citation management. The module challenged students to identify problems in accessibility, taught them to write structured engineering problem statements, led them through brainstorming and selection of solutions, and trained them in oral and visual presentation. There was also a focus on care ethics in engineering: a branch of virtue ethics that prioritizes the cultivation of caring relationships.
3. The final module of the semester focused on solving client-driven problems. In this pilot, students served as one another’s clients. This was convenient for students to learn about client discovery and inclusion of the client in the design process. Students were required to research their problems, develop problem statements, ideate, select solutions, prototype and test. Students also expanded their understanding of ethical issues in engineering by applying ethical reasoning to their specific design challenges.

Throughout the Fall semester, students also learned the fundamentals of CAD, including technical drawings, using the interface of Autodesk Fusion 360, different ways of transforming 2D sketches into 3D objects, creating engineering drawings, finite element analysis, and 3D printing, via asynchronous online lessons. The instructional approach was modeled in part on an existing design course for second-year biomedical engineering students [8]. Students engaged in two days of career development delivered by the director of our Center for Engineering Career Development. The career development portion of the course was based on Burnett and Evans’ career and life design framework [9]. The course also included content centered on undergraduate advising and delivered directly through lecture to students. This included presentations on university and college-level resources for success and how to use them, course selection and registration, and engineering majors available to them.

The instructors engaged students in a reflection exercise during the final exam period. Students appreciated (1) the balance of in-person and online learning, (2) the balance of hands-on and lecture-based learning, (3) having clients, (4) the guest lectures (career development and student affairs), and (5) that the technical and the sociotechnical were not separated into two courses. However, they reflected that a full integration of sociotechnical and technical subject matter was lacking. In fact, having each day be one professor and content *or* the other emphasized the *separation* of the disciplines rather than showing their integration. Regardless, in end-of-course evaluations some students compared their experiences to those of their friends in traditional sections of ENGR 1624 and STS 1500 and agreed that the combined course was preferable.

In the spring semester of the second pilot, students were charged with identifying an external client with a problem in sustainability that they would then solve. They learned the three-fold lens of sustainability as being economic, social, and environmental in nature [10]. The solution was required to be a device, and students had to fabricate and test that device. Some teams had to learn skills in circuits and microcontrollers, though it was not built in as part of the pilot curriculum. Students were also taught the fundamentals of teamwork, including team charters and project management. STS topics included social construction of technology, design and values, and a framework for socially responsible and sustainable design. As in the fall semester, there were two sessions on engineering career development. The final exam, as it was in the fall semester, was a poster session with demonstrations of their solutions.

For this spring semester of the second pilot, we transitioned to a "one instructor, one voice" model in which the disciplinary faculty member was trained by the STS instructor in STS theory and practice and was provided materials to work from. In this way, students learned technical and sociotechnical content from one individual, often combined in a single day. This approach was received favorably, with one student writing in their end of course evaluation:

> "The mix of intro engineering material with STS and career design lessons was very helpful in developing a full grasp of engineering and the socio–technical side without having to do full STS lectures and papers. … I just want to reinforce how beneficial this will be to encourage students to stick with engineering and be passionate about what they are studying."

Full Deployment

Engineering Foundations 1 was taught at full scale for the first time in the fall semester of 2023. It was delivered to 705 students across 18 sections in two studio-style classrooms. A group of six faculty, all authors on this manuscript, were recruited to teach this new course sequence, and a new academic center, the First Year Engineering Center, was formed to administratively house them. They were joined by an existing faculty member teaching a single section; the extra section allowed us greater flexibility in course delivery. The seven faculty who delivered this course in Fall 2023 also served as the academic advisors for 684 of the students in the course. To support this endeavor, the faculty engage in monthly advisor training sessions on topics ranging from the general education curriculum to course selection, resources for students, and academic accommodations. Students also were encouraged to attend office hours for their faculty advisor to continue conversations focused on their engineering academic and career path.

Significantly, the STS faculty member who was involved in the pilot offerings joined the group as a weekly consultant and instructor, training the faculty in STS theory and best practices in delivering STS material. In addition to technical engineering design-based content, several sociotechnical topics, including care ethics and actor network theory, were introduced during the semester to illustrate the enmeshment of engineering design and socio-technical and ethical concerns. The combination of these technical and socio-technical subjects underscored the integration of theoretical frameworks with a direct engineering application.

Additionally, guest lecturers from the university's STS department presented one lecture to each class section on a topic of their choosing. These topical lectures helped students appreciate the importance of considering social and ethical aspects of engineering challenges in addition to addressing technical requirements and performing quantitative analysis. They also gave students a vision for how engineering work could contribute productively to social and environmental good. Topics included designing for environmental and social sustainability, accessibility and inclusivity in design, and cultural intelligence in engineering, among others. Through the guest lectures, students were also able to make a personal connection with faculty members whose courses on engineering ethics and professional practice they would be taking later in the curriculum. Results from a survey students took after the guest lectures indicate a high level of interest in learning more about the role social and ethical considerations play in shaping engineering design practices that work to enhance human well-being.

The course was organized much like the pilot, with three project-based modules aimed at integrating engineering mindsets, technical skills, socio-technical skills, and advising topics:

1. A two week "Aloft" module, like that of the pilot program, that established protocols and practices for effective communication and teamwork as well as introduced the students to the engineering design process and data collection and analysis.
2. A three week module on sustainability that focused on problem definition. Through this unit, students applied Actor Network theory and a framework for defining problems.
3. The final project for the remainder of the semester required design teams to identify, define, analyze, and pose a solution for an accessibility-related issue on campus. Students engaged in the engineering design process in its entirety as they explored applications of Care Ethics and teamwork. The final deliverables included a working prototype and poster presentation.

All three of these modules incorporated problem-solving, peer reviews, reflections and assessments. Graded submitted work from students included creating and updating an engineering notebook during the design process, work plans, detailed designs, and bills of materials. Technical communication skills were additionally addressed through the preparation and delivery of oral presentations and through the technical writing of precise problem definitions and poster presentations. Students were introduced to fundamentals of CAD modeling and technical drawing along with basic fabrication skills, including 3D printing, and the safe use of band saws, drill presses, and other fabrication hand tools. Finally, the first two out of four-session career design sessions were facilitated by career advisors in Fall 2023. Using Burnett and Evans' career and life design framework [9], career advisors encouraged students to think of their career as a design challenge and empowered them to design their futures using six key tenets: engaging their curiosity, having a bias to action, ideating multiple pathways, prototyping career ideas, seeking support from others, and reframing questions and problems. The career and life design framework invites students to develop empathy for themselves and others, articulate their values, and reflect upon what kind of impact they want to have in the world. These sessions included in-class reflective activities, class discussions, and out-of-class assignments. In addition to these activities, career advisors also wove in practical aspects of career development including resume writing and informational interviewing. The final two class sessions of the career design curriculum will be implemented in the spring semester.

In short, the course sequence operationalizes the several guiding principles that were presented near the beginning of this manuscript.

Initial outcomes – a brief retrospective on one semester

Opinions of the course have generally been positive, based on student evaluations of the Fall semester of 2023. Students were particularly fond of their instructor-advisors, noting that the dual role allowed their faculty to get them to know them more personally, support individual needs, and be more accessible than some of their other instructors. This is in line with previous findings on embedded advising [1], [2]. This intentional curriculum design fostered more conversations outside of the classroom between advisors and students.

Students praised the hands-on portions of the course, primarily centering on the third module's design project. Traditional lecture-style classes were less popular, though students did appreciate the inclusion of the career and STS guest lectures. By making engineering human through the ethical and socio-technical lens, students and faculty engaged in meaningful dialogues about the ramifications of engineering work in the classroom and in the world more broadly. While these conversations carried the benefit of giving students a meaningful way of wrestling with sometimes difficult and emotionally charged facets of engineering work, they also provided the faculty a better understanding of the students' perspectives and how they evolved over the course of the semester.

Students expressed a desire for more content introducing the specific engineering majors available to them. The dual role of the instructor-advisors once again helped somewhat in this space, as students could consult with their professors about major selection outside of class as well. While areas for improvement have been identified from the student evaluations, initial responses to the course are promising that the program is achieving its targeted outcomes.

[1] L. Lampe and B. Calhoun, "Full Paper: First Year Engineering Undergraduate Academic Co-Advising Improvement," presented at the 2020 First-Year Engineering Experience, Jul.

2020. Accessed: May 30, 2023. [Online]. Available: https://peer.asee.org/full-paper-first-year-engineering-undergraduate-academic-co-advising-improvement
[2] L. Lampe, J. F. Groves, and E. Berger, “First Year Engineering Advising: Shift from Transactional to Developmental,” presented at the First Year Engineering Experience (FYEE), Columbus, OH, 2016, p. T2B1-T2B8.
[3] D. J. Lang, “The Impact of a First-Year Experience Course on the Academic Performance, Persistence, and Graduation Rates of First-Semester College Students at a Public Research University,” *J. First-Year Exp. Stud. Transit.*, vol. 19, no. 1, pp. 9–25, 2007.
[4] M. W. Sidle and J. McReynolds, “The Freshman Year Experience: Student Retention and Student Success,” *NASPA J.*, vol. 46, no. 3, pp. 434–446, Jul. 2009, doi: 10.2202/1949-6605.5019.
[5] G. Kuh, “High-Impact Educational Practices,” Association of American Colleges & Universities. Accessed: Feb. 24, 2016. [Online]. Available: https://www.aacu.org/leap/hips
[6] P. L. Hirsch and C. Yarnoff, “Integrating Design and Communication in Engineering Education: A Collaboration Between Northwestern University and the Rehabilitation Institute of Chicago,” *Top. Stroke Rehabil.*, vol. 18, no. 4, pp. 361–366, Jul. 2011, doi: 10.1310/tsr1804-361.
[7] K. E. Cook, Y.-L. Han, T. R. Shuman, and G. Mason, “Effects of integrating authentic engineering problem centered learning on student problem solving,” *Int. J. Eng. Educ.*, vol. 33, no. 1, pp. 272–282, 2017.
[8] W. H. Guilford, “A Skills-focused Approach to Teaching Design Fundamentals to Large Numbers of Students and Its Effect on Engineering Design Self-efficacy,” in *Proceedings of the 2017 ASEE Annual Conference and Exposition*, Jun. 2017. Accessed: Mar. 21, 2019. [Online]. Available: https://peer.asee.org/a-skills-focused-approach-to-teaching-design-fundamentals-to-large-numbers-of-students-and-its-effect-on-engineering-design-self-efficacy
[9] B. Burnett and D. Evans, *Designing Your Life: How to Build a Well-Lived, Joyful Life*. Knopf Doubleday Publishing Group, 2016.
[10] G. H. Brundtland, “Report of the World Commission on Environment and Development: Our Common Future,” United Nations, 1987. Accessed: Jan. 29, 2024. [Online]. Available: https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf