Biomedical Engineering Capstone Design

BEN 486 (FALL 2025)

Innovative Medical Device Solutions: From Concept to Prototype

Hands-On Learning, Industry Collaboration & Real-World Design

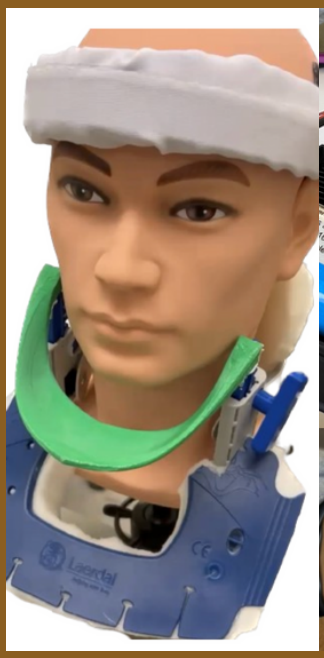
Preparing for a Future in Biomedical Engineering

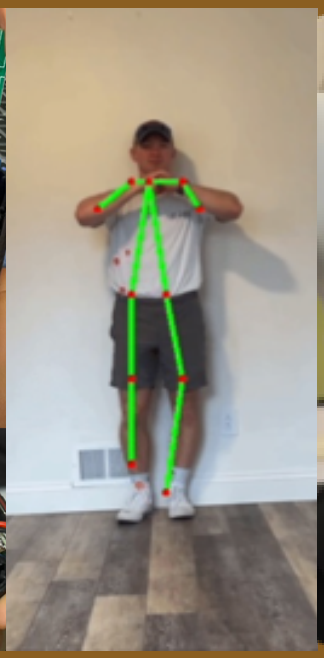
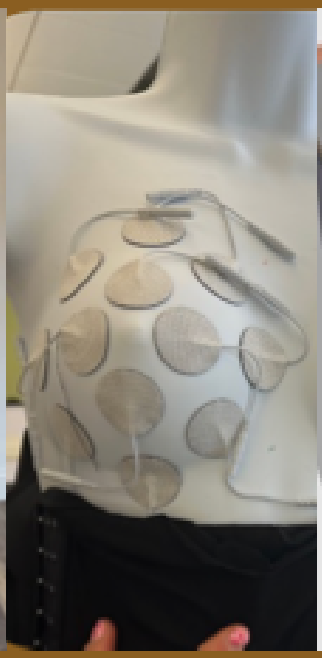
PROF. DOUG YUNG

Department of Biomedical & Chemical Engineering | Syracuse University

Course Syllabus

Course Information




Instructor

Dr. Doug Yung
Teaching Professor
Link 361 | ptyung@syr.edu

Teaching Assistant

Anand Wadurkar
aswadurk@syr.edu

Office Hours

Feel free to stop by whenever my door is open. Note that I may be assisting students in various lab locations. For guaranteed time, book a slot via (https://tinyurl.com/bookwithYung) or email me.

- Monday 2:15 – 3:15 Link 331/361
- Tuesday 10:00 – 11:00 Link 361
- Wednesday 2:15 – 3:15 Link 331/361
- Thursday 11:30 – 12:30 Link 361 (by appointment)
- Friday 10:30 – 11:30 Link 361 (by appointment)

Class Location & Schedule

LECTURE: **Link Hall 331 | Monday & Wednesday 11:40 am – 12:35 pm**
OPEN DESIGN: **Link Hall 331 | Monday & Wednesday 2:15 - 3:35 pm**
Link Hall 331 | Friday 2:15 - 5:05 pm
Link Hall 0044 | available 24/7 (combo: 5-4-3-2)

Number of Credits

1

Course Sequence

BEN 487 Capstone Design II

Course Websites

Blackboard: Announcement, course materials and submission of assignment

Course Materials

Course materials will be provided and made available via Blackboard.

- Avoid working alone in the lab, especially during off-hours.
- If necessary, inform someone about your schedule and expected duration in the lab.
- Wear appropriate PPE when necessary.
- Keep the lab clean and organized.
- Adhere to all university and lab-specific safety policies. Report any violations or unsafe conditions.

From the Instructor

Hello and welcome to **BEN 486 – Bioengineering Capstone Design I**. My name is Douglas Yung, and I am excited to be your instructor for this transformative journey into medical device innovation. I began my teaching career in Hong Kong, where I had the privilege of pioneering and helping to establish a biomedical engineering department. This early experience laid the foundation for my passion and long-term commitment to biomedical engineering education and pedagogy.

With over **15 years of experience in higher education**, I have dedicated my career to advancing biomedical engineering education. For the past 9 years, I have served as the sole director of capstone design at Syracuse University, mentoring more than 100 teams. These projects have involved collaborations with over 30 clinical departments, more than 40 industry partners, and numerous global organizations. Together they bring real-world challenges directly into the classroom. I have also helped student teams secure over $60,000 in SOURCE funding, with more than 25 award-winning projects. Many of our teams have gone on to present at the **Northeast Bioengineering Conference (NEBEC)**, showcasing the high standard and impact of their work.

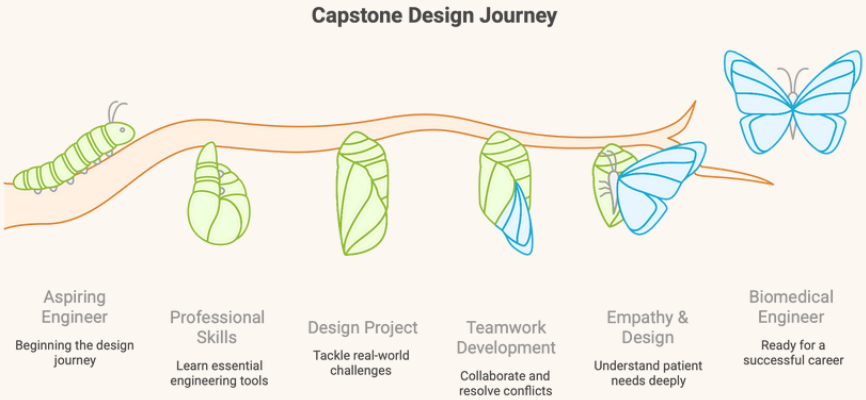
This course is more than just an academic requirement. It is a **journey through the development of medical devices**, blending innovation, hands-on learning, industry collaboration, and professional preparation. This year, we will also embrace the **inclusion of AI as a design team member**, mirroring how modern engineering teams increasingly integrate AI into research, design, and project management. This approach not only reflects real-world practice but also prepares you to critically evaluate and responsibly apply AI tools in professional settings.

We will also introduce and practice the **virtue of empathy**. Human-centered design in biomedical engineering requires understanding patient needs and societal contexts. Activities such as patient shadowing, empathy mapping, and case-based reflection will help you develop this virtue and apply it to your design process.
This course can be imagined as having several tracks running in parallel:

1. **Professional skills of a biomedical engineer**: project management, communication, teamwork, ethics, FDA regulation, intellectual property, and other career foundations.
2. **Capstone design project**: working through the entire design process of your assigned project from ideation to prototype.
3. **Teamwork development**: learning how to function effectively as a team, manage conflict, and build collective responsibility.
4. **Nurturing empathy as a virtue**: engaging in activities that strengthen your ability to understand patients, users, and broader societal contexts.

In addition to my teaching, I serve as a **Program Evaluator for ABET**, ensuring that engineering programs nationwide meet the highest standards of quality and rigor. My goal is to guide you in developing not only technical solutions but also professional skills, ethical reasoning, and collaborative practices that will carry you beyond the classroom.

Together, let us embark on this challenging and exciting journey to imagine, design, and deliver impactful biomedical solutions.

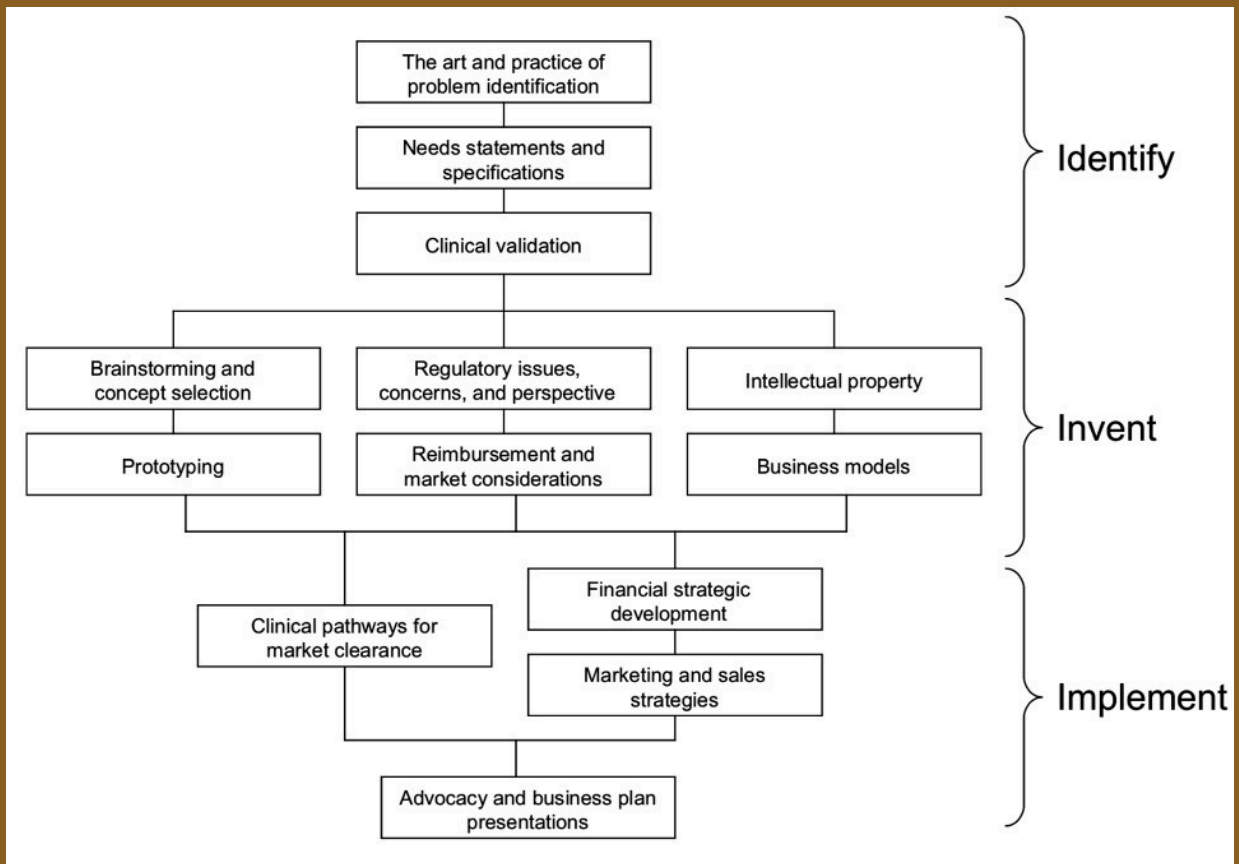


Course Overview

Medical device innovations that seemed like science fiction a decade ago are now **setting new standards of patient care.** Innovation, leading to ***lower cost of care***, ***minimally invasive procedures***, and shorter recovery times, is crucial for ***healthcare business leaders, educators, clinicians, and policy-makers***. It drives ***regional economic development*** and wealth creation in organizations from start-ups to Fortune 500 companies. The rapid pace of ***translational research***, resulting in product and service innovation, is ***highly interdisciplinary***. New products and services arise from team efforts using a ***systematic, structured approach*** to ***bringing medical technologies to market***, impacting patient care.

In this course, we examine medical technology innovations in the context of:
(A) **addressing unmet clinical needs,**
(B) the process of **inventing new medical devices** and instruments, and
(C) implementing these advances in patient care.

In short, students learn the process of "**identify, invent, implement**" in the field of **bio-design**.



This course exposes students to the entire **engineering design process** from problem definition to prototype validation, organized like a biomedical engineering company, with ideas generated from you. Alongside BEN 487 (Capstone Design II), it comprises six main components:

1. **Problem Definition** – Students will be assigned a project and expected to decompose the problem, generate design specifications, and plan out the project.

2. **Concept Generation and Evaluation** – Students will use brainstorming and decision evaluation tools to generate and evaluate solutions to reach a design consensus.

3. **Detailed Design** – Students will generate a paper design of their proposed prototype, including device specifications, key materials and components, detailed drawings, and principle of operation with all choices justified and supported through proof-of-concept.

4. **Fabrication and Validation** – Students will fabricate and conduct testing of their prototype, assess the degree to which the prototype meets the design specifications, and recommend design modifications to improve the prototype.

5. **Project Management** – Students will create and update a project timeline, budget, design history file, and maintain engineering notebooks throughout all phases of the project.

6. **Technical Communication** – Students will be required to describe, explain, and support the progress and solutions of their project at all phases of the design process.

This course offers a capstone design experience that incorporates appropriate **engineering standards** and **multiple constraints**, leveraging knowledge and skills acquired in earlier coursework. The **iterative approach** ensures that students practice engineering design in a practical and comprehensive manner.

Learning Outcomes

Design and Analysis (Program Outcomes 1, 2, 4)

- Design a biomedical system, component, or process that meets specified needs while applying relevant constraints and sound engineering judgment.
- Analyze historical design solutions, potential use cases, and failure modes to inform design decisions.
- Utilize computational and AI-enabled design tools to model and evaluate system components.

Teamwork and Collaboration (Program Outcome 5)

- Function effectively on multidisciplinary teams in a simulated start-up environment by fulfilling defined roles, contributing equitably, integrating diverse perspectives, and supporting collaborative decision-making.
- Demonstrate empathy and respect for teammates to foster a collaborative and inclusive design environment.

Entrepreneurship and Commercialization (Program Outcomes 2, 6, 7)

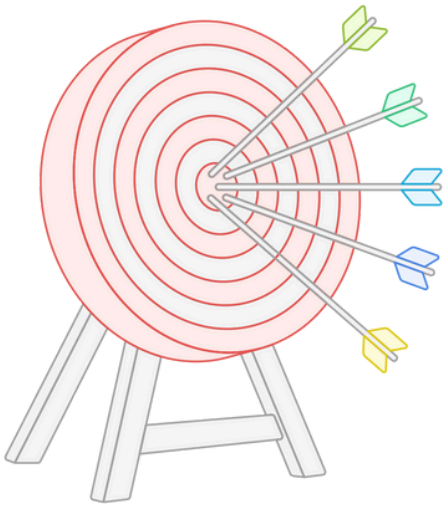
- Validate unmet medical needs and perform market
- and competitive technology assessments.
- Analyze intellectual property and evaluate its role
- in medical device commercialization.
- Apply entrepreneurial tools, including AI-assisted
- market analysis, to outline a business plan for a
- biomedical innovation.

Ethics & Professional Responsibility (Program Outcome 4)

- Recognize professional and ethical responsibilities in biomedical engineering practice and make informed judgments that consider impacts on patients, healthcare systems, and society.
- Apply empathy as a guiding virtue in ethical decision-making and patient-centered design.

Communication (Program Outcome 3)

- Communicate effectively with diverse audiences by tailoring content and style to technical experts, non-specialists, and business stakeholders.
- Deliver professional presentations, proposals, design reviews, and pitches that integrate both technical and entrepreneurial perspectives.
- Use multiple formats (oral, written, and visual) to convey complex engineering concepts clearly and persuasively.



Ethics and Professional Responsibility
Guiding principles for ethical decision-making

Communication
Effective interaction with diverse audiences

Entrepreneurship and Commercialization
Market analysis and business planning

Teamwork and Collaboration
Functioning in multidisciplinary teams

Design and Analysis
Creating and evaluating biomedical systems

Program Outcomes: ABET-accredited engineering programs must demonstrate that their graduates have:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics;
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;
3. an ability to communicate effectively with a range of audiences;
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts;
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. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions;
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies;
8. an understanding of biology and physiology, and the capability to make measurements on living system and solve associated bioengineering problems.

Grading Philosophy and Structure

There is no "curve" for the grade earned under the assumption that each class participant is motivated to seek their personal best against a series of tasks and milestones, not competing against each other. Grades follow a traditional **90–A / 80–B / 70–C scale**.

In this course, you are not measured solely by the grade for your semester project, but rather by what you gain from the course itself. The more effort you invest—through participation, reflection, thought, and persistence, the more real-life learning you will achieve. The more you put into this course, the more you will professionally benefit, far beyond just a letter grade. To reflect this philosophy, grading emphasizes the **design process**, **teamwork**, and **professional growth**, not just the final product.

Team Design Process (40%)

- Includes project management documents, needs statements, brainstorming, concept evaluation, interim design reviews, and iteration cycles.
- These assignments are team-based but adjusted by peer evaluations to ensure fair recognition of contributions.

Major Team Deliverables (20%)

- Includes the white paper, design review, and low-fidelity prototype.
- Grades here reflect both the quality of the final outcomes and how well your team's process led to them. Peer evaluations apply.

Individual Contributions (25%)

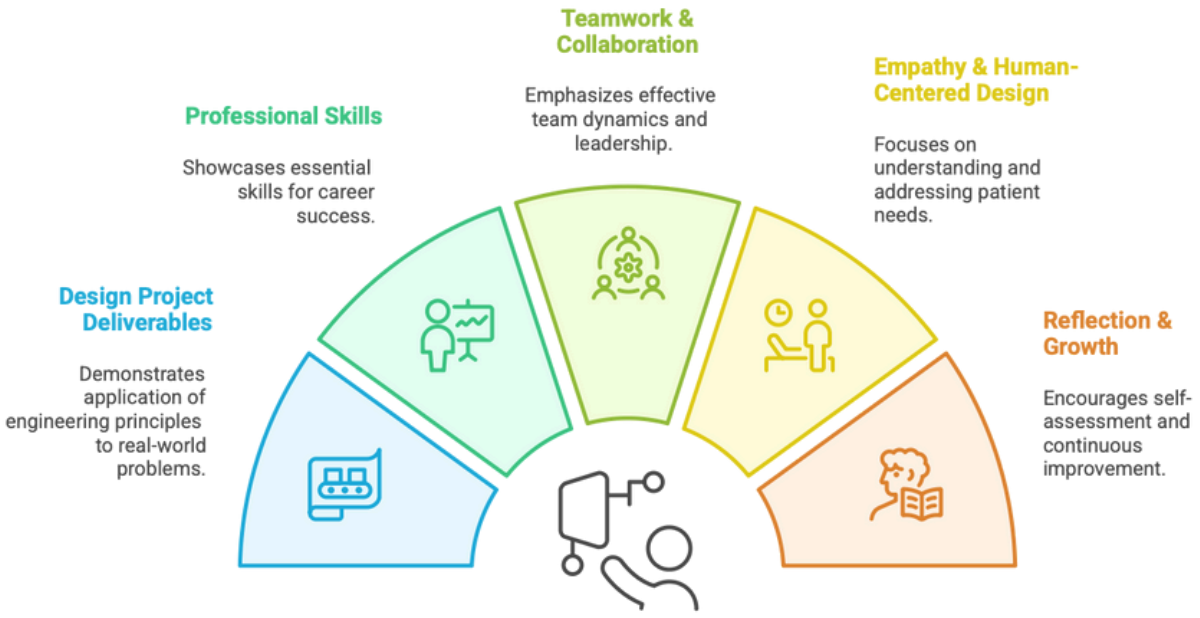
- Includes reflection essays, empathy mapping, individual skill assignments, and professional participation.
- These ensure accountability and personal growth within the team setting.

Professionalism & Motivation (15%)

- Includes attendance, communication, regular check-ins, SOURCE application, and engagement in career/professional development opportunities.
- Frequent, low-stakes credit designed to keep you on track and motivated.

Peer Evaluation

All group deliverables are subject to peer evaluation. Individual grades for team assignments will be scaled up or down to reflect your contribution as recognized by your peers



Course Schedule

Week 1 8/25 - 8/29

Overview

The course begins with an overview and **introduction to engineering design principles**, laying the groundwork for understanding the iterative design process. Students will **meet with clients who will introduce their projects**, defining the problem and setting the stage for the entire design journey. This initial week focuses on grasping the scope and constraints of the project, essential for successful concept generation and development in subsequent weeks.

Week 2 9/1 - 9/5

Project Intro

There is no class on 9/1 due to Labor Day. The rest of the week will be dedicated to continuing **project introductions by clients**. This phase reinforces the **understanding of project requirements, constraints, and expectations**. Engaging with clients ensures that students grasp the real-world context and specific needs of the projects, setting a solid foundation for effective problem definition and successful design outcomes in the later stages.

Week 3 9/8 - 9/12

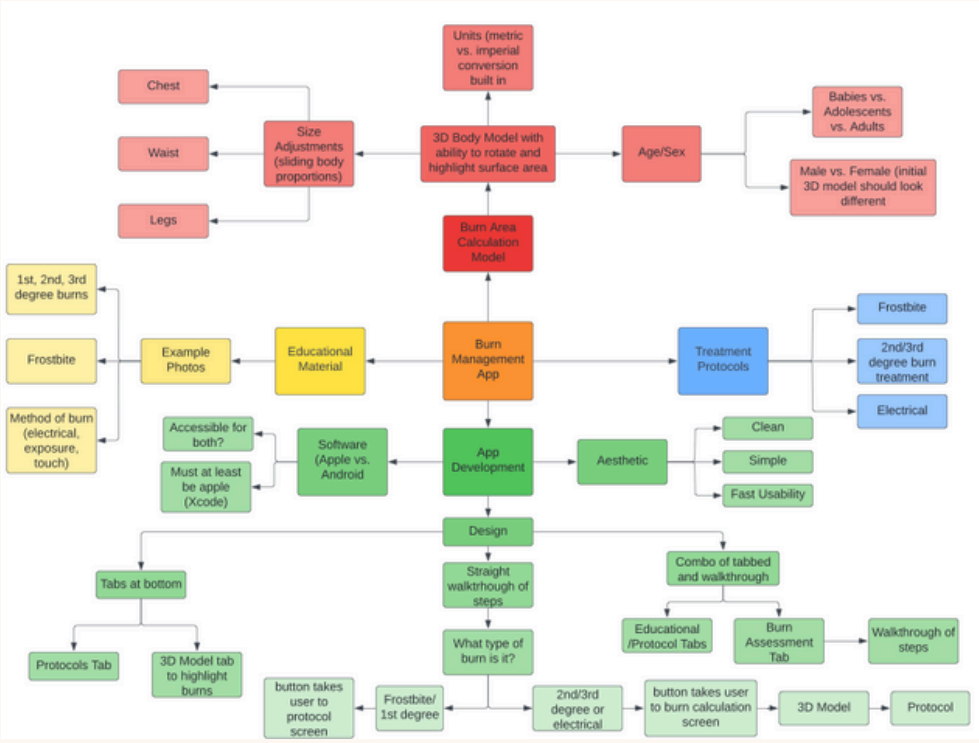
Team Building

This week, teams will focus on **forming and identifying needs** through observation and problem identification. A **team contract** will be drafted to define roles, responsibilities, and collaboration norms. Establishing a **strong teamwork foundation** is crucial for project alignment. Identifying needs and defining problems are key steps in the engineering design process for innovative solutions.

Week 4 9/15 - 9/19

Needs Analysis

Students will develop **needs statements** based on **observations** and **background research**. This process involves articulating the specific needs that their projects aim to address and gathering relevant information to inform their designs. The focus on needs statement development ensures that students clearly understand the problem scope, while background research provides a foundation of knowledge to guide informed decision-making in the subsequent design phases. This week is **critical for generating viable and effective solutions.**



Course Schedule

Week 5 9/22 - 9/26

Ideation

Students will engage in **ideation and brainstorming** sessions to generate a range of potential solutions for their projects. This creative phase is crucial for **exploring diverse approaches and fostering innovation**. Additionally, students will be encouraged to attend the **ECS Career Fair** on Sept. 25 at the Dome and submit their "intent to apply" for **SOURCE funding**.

Week 6 9/29 - 10/3

More Ideation

students will **continue their ideation and brainstorming activities** to **further explore and refine potential solutions**. This extended focus on creative thinking allows teams to **delve deeper into innovative ideas and assess their feasibility**. The **iterative** nature of this phase is crucial for ensuring that a wide range of possibilities are considered before moving forward. This week emphasizes the importance of thorough exploration and the **generation of multiple viable solutions**.

Week 7 10/6 - 10/10

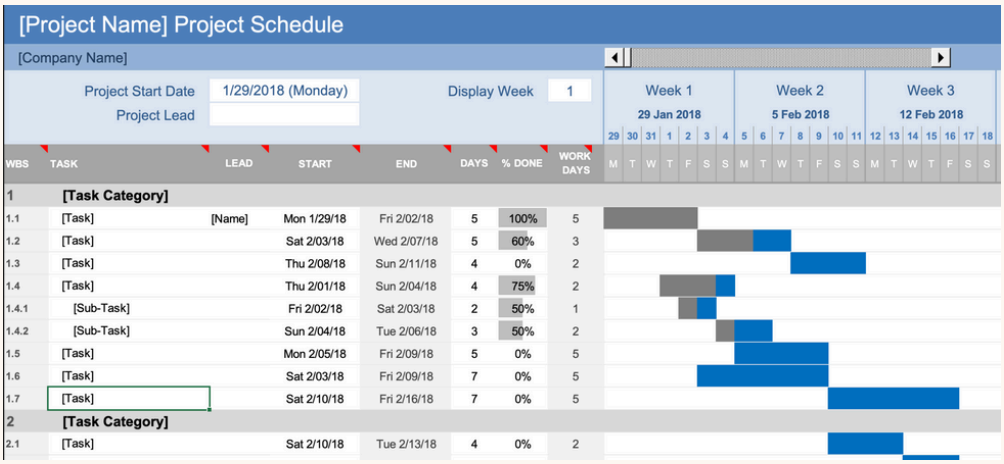
Proposal Writing

Students will participate in an **entrepreneurship session led by Blackstone Launchpad**, gaining insights into turning their ideas into viable business ventures. Additionally, the focus will shift to technical writing and citation management, crucial skills for preparing their **funding proposal** submissions due next week. This week emphasizes the importance of **effective technical communication** and considering the commercialization potential of their designs.

Week 8 10/13 - 10/17

Design Review

students will have **professional headshots** taken, an essential step for creating a professional online presence. The week will also include a **preliminary design review**, where students present their initial design concepts for feedback. Additionally, students will **submit their funding proposals**, a critical milestone that combines their technical writing and citation management skills with their innovative ideas. This week aligns with the engineering design process by **validating initial designs** and securing necessary resources to advance their projects.



Course Schedule

Week 9 10/20 - 10/24

Compliance & IP

Students will develop an **intellectual property strategy** to protect their innovations. They will also learn about relevant **standards and regulations**, including FDA requirements, ensuring that their designs comply with industry norms and legal standards. This week emphasizes the importance of **regulatory knowledge** and **IP protection**, critical components for the successful **commercialization and ethical implementation of biomedical devices**.

Week 10 10/27 - 10/31

Market Analysis

Students will engage in **customer discovery** and **market analysis** to **understand the needs and preferences of potential users**. This process involves gathering and analyzing data to identify market opportunities and validate their product's **value proposition**. Aligning with the engineering design process, this week emphasizes the importance of market research in ensuring that the **design meets real-world demands and has a clear path to successful adoption**.

Week 11 11/3 - 11/7

Budgeting

Students will focus on **budgeting** and developing a **preliminary business plan**. This includes **estimating costs**, **allocating resources**, and **planning for financial sustainability**. Crafting a business plan involves outlining the market strategy, operational plan, and financial projections. This week integrates financial planning and business strategy into the project, **ensuring that the proposed solutions are not only technically viable but also economically feasible**.

Week 12 11/10 - 11/14

Pitching

Students will prepare for their final design review and participate in a **workshop on pitching and presentation**. This preparation involves refining their designs, ensuring all documentation is complete, and practicing effective communication techniques. The workshop will equip students with the skills needed to confidently present their projects to stakeholders. This week aligns with the engineering design process by emphasizing the **importance of clear, persuasive communication and thorough preparation for final evaluations.**

Week 13 11/17 - 11/21

Final Prep

Students will dedicate time to preparing for the **final design review (FDR)**, scheduled for after Thanksgiving break. This preparation includes finalizing all aspects of their project, such as the **budget, detailed plans, and comprehensive documentation**. The focus this week is on ensuring that every element of the design is complete and ready for evaluation. Aligning with the engineering design process, this stage emphasizes the **importance of thoroughness and attention to detail in presenting a polished, viable final product**.

Week 14+ 12/1 - 12/12

Final Review

Students will conduct their FDR with the instruction team and clients, presenting their comprehensive project plans, budgets, and purchase lists. This **critical evaluation phase** allows for **feedback and validation from stakeholders**, **ensuring that the designs meet all requirements and constraints**. Additionally, students will plan for the next semester, outlining steps for further development and implementation. This week emphasizes the importance of **stakeholder engagement, thorough review, and strategic planning for project continuation.**

Responsibilities and Policies

University Attendance Policy
Attendance in classes is expected in all courses at Syracuse University. Students are expected to arrive on campus in time to attend the first meeting of all classes for which they are registered.Students who do not attend classes starting with the first scheduled meeting may be academically withdrawn as not making progress toward degree by failure to attend. Instructors set course-specific policies for absences from scheduled class meetings in their syllabi.

It is a federal requirement that students who do not attend or cease to attend a class to be reported at the time of determination by the faculty. Faculty should use “ESPR” and “MSPR” in Orange Success to alert the Office of the Registrar and the Office of Financial Aid.A grade of NA is posted to any student for whom the Never Attended flag is raised in Orange SUccess. More information regarding Orange SUccess can be found here, at http://orangesuccess.syr.edu/getting-started-2/.

Students should also review the University’s religious observance policy and make the required arrangements at the beginning of each semester.

Syracuse University Policies: Syracuse University has a variety of other policies designed to guarantee that students live and study in a community respectful of their needs and those of fellow students. Some of the most important of these concern:

Diversity and Disability (ensuring that students are aware of their rights and responsibilities in a diverse, inclusive, accessible, bias-free campus community) can be found here, at: https://www.syracuse.edu/life/accessibilitydiversity/.

Religious Observances Notification and Policy (steps to follow to request accommodations for the observance of religious holidays) can be found here, at: http://supolicies.syr.edu/studs/religious_observance.htm

Orange SUccess (tools to access a variety of SU resources, including ways to communicate with advisors and faculty members) can be found here, at: http://orangesuccess.syr.edu/getting-started-2/

Responsibilities and Policies

Disability-Related Accommodations: Syracuse University values diversity and inclusion; we are committed to a climate of mutual respect and full participation. There may be aspects of the instruction or design of this course that result in barriers to your inclusion and full participation in this course. I invite any student to meet with me to discuss strategies and/or accommodations (academic adjustments) that may be essential to your success and to collaborate with the Center for Disability Resources (CDR) in this process.

If you would like to discuss disability-accommodations or register with CDR, please visit Center for Disability Resources. Please call (315) 443-4498 or email disabilityresources@syr.edu for more detailed information.

CDR is responsible for coordinating disability-related academic accommodations and will work with the student to develop an access plan. Since academic accommodations may require early planning and generally are not provided retroactively, please contact CDR as soon as possible to begin this process. https://disabilityresources.syr.edu/

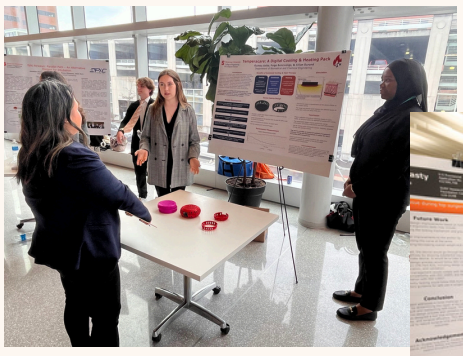
Academic Integrity Policy:
Syracuse University's Academic Integrity Policy reflects the high value that we, as a university community, place on honesty in academic work. The policy defines our expectations for academic honesty and holds students accountable for the integrity of all work they submit. Students should understand that it is their responsibility to learn about course-specific expectations, as well as about university-wide academic integrity expectations. The policy governs appropriate citation and use of sources, the integrity of work submitted in exams and assignments, and the veracity of signatures on attendance sheets and other verification of participation in class activities. The policy also prohibits students from submitting the same work in more than one class without receiving written authorization in advance from both instructors. Under the policy, students found in violation are subject to grade sanctions determined by the course instructor and non-grade sanctions determined by the School or College where the course is offered as described in the Violation and Sanction Classification Rubric. SU students are required to read an online summary of the University's academic integrity expectations and provide an electronic signature agreeing to abide by them twice a year during pre-term check-in on MySlice.

Appendix

List of Capstone Design Projects 2023-24

List of Capstone Design Projects 2024-25

Enhancing Engineering Capstone Design Preparedness - A Systematic Curriculum Approach



Capstone Design 2023-24

Triple C+: An Adaptive Neck Orthotic

Develops a neck orthotic focused on comfort, adaptability, and safety for patients with neck muscle weakness

Colin Babick, Shaila Cuellar, Roxana Gomez, Brenna Henderson
Client: Sarah Seib

BiRed Breast Cancer Imaging Table

Aims to revolutionize breast cancer diagnosis by enhancing patient comfort and accessibility

Jonathan Hernandez, AMathieu Barthelemy, Dominic Clinch, Jonathan Ngo, Alyssa Shelburne
Client: Dr. Satish Kandlikar, CEO of BiRed Imaging

Gait 2 Go: Gait Analysis Anytime Anywhere

Simplifies gait analysis for clinicians by eliminating the need for expensive labs and gait experts

Jade Carter, Shane Corridore, Cait Mehl, Lukas Cook
Client: Dr. Rajin Shahriar, Pediatric Orthopedics, SUNY Upstate Medical University

Epic Airways: Parallel Path – An Alternative Method for Intubation

Develops a hybrid intubation device combining endotracheal tube and laryngeal mask to reduce procedure risks and costs

Jonathan Hernandez, Adam Spadafora, Haven Wittmann, Julian Zorn
Clients: Keith McKenna and Eric Moses at Epic Airways Systems, Inc.

Temperacare: A Digital Cooling & Heating Pack

Creates a versatile therapeutic device providing both cooling and heating to aid

Oumou Azika, Paige Bencivenga, Jillian Durand
Client: BZDesign, Inc. (*later withdrawn*)

Prognosis of Prostate Cancer Metastasis Risk Through qPCR

Focuses on improving the detection of a specific prostate cancer biomarker using optimized qPCR

Anthony Watt, Emily Labour, Ethan Masters
Client: Dr. Leszek Kotula, Urology, SUNY Upstate Medical University

P.I.B.I. Check: A Portable Impedance Breast Imaging Device

Designs an accessible, low-cost device for early breast cancer detection based on tissue impedance

Carly Ward, Elizabeth Su, Isabelle Lewis, Mia-Marie Fields, Anthony Acierto
Clients: Dr. Neb Duric and Dr. Jennifer Harvey, Imaging Sciences, University of Rochester

Capstone Design 2024-25

OrthoClamp: Total Hip Drill Guide Clamp

Designing a hip surgery drill guide to improve accuracy, ergonomics, and sterilization for orthopedic procedures

Jack Sipperly, Luke Spears, Farrah Sousa

Client: Dr. Tim Damron, Orthopedic Oncology & Joint Reconstruction, Upstate Medical University

Peptify: Generation of Versatile Prokaryotic-based Peptide and Protein Library Interaction Screening

Developing a prokaryotic peptide and protein library platform to accelerate drug discovery and screening

Ashraf Alnatour, Jennifer Gonzalez, Samantha Fernandez

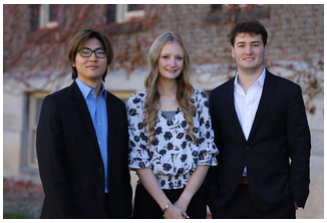
Client: Dr. Aliji Bah, Biochem & Molecular Biology, Upstate Medical University

VISABLE: Rotational Laparoscopic Lens

Creating a surgical device with advanced motor control for rehabilitation and functional support

Aidan McCarthy, Luke Rogers, Jason Bae

Client: Timothy Shope, MD, Surgery, Upstate University Hospital



EyeVRgence: Optimizing Vision Restoration Therapies Using VR Technology

Building a VR-based vision training and rehabilitation system using custom hardware and real-time data processing

Quinn Langdon, Danny Vu, Shayna Marcano

Client: Dr. Darwin Babino, Ophthal Vis Sci, Upstate Medical University

Dare to DAIR: Enhancing Hydro-Pressure Debridement Procedures

Engineering a hydro-pressure debridement device to enhance infection removal during orthopedic revision surgeries

Katherine Monroe, Kerrin O'Grady, Jenna Grutzmacher

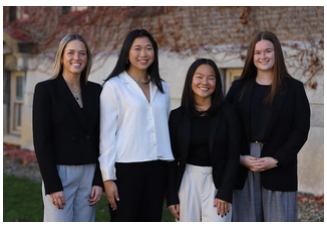
Client: Zimmer Biomet

StepAware: Custom Pressure-Sensing Insoles for Early Detection of Charcot Foot

Designing pressure-sensing insoles for early detection and prevention of Charcot foot in diabetic patients

Mia Paynton, Olivia Etienvre, Tessa DeCicco, Bridget Sides

Client: Zimmer Biomet



HydraCare+: Ichthyosis Management

Developing a wearable glove that delivers controlled moisturizer flow to improve skin health and hydration

Abdullah Swati, Amira Salihovic, Blanca Lopez

Client: Ryan Licursi

Medicline: Revolutionizing Patient Comfort and Caregiver Support

Integrating smart pressure management systems into recliners to prevent pressure sores and improve patient comfort

Juliana Sepulveda Gonzalez, Tessa Galipeau, Sophie Grady

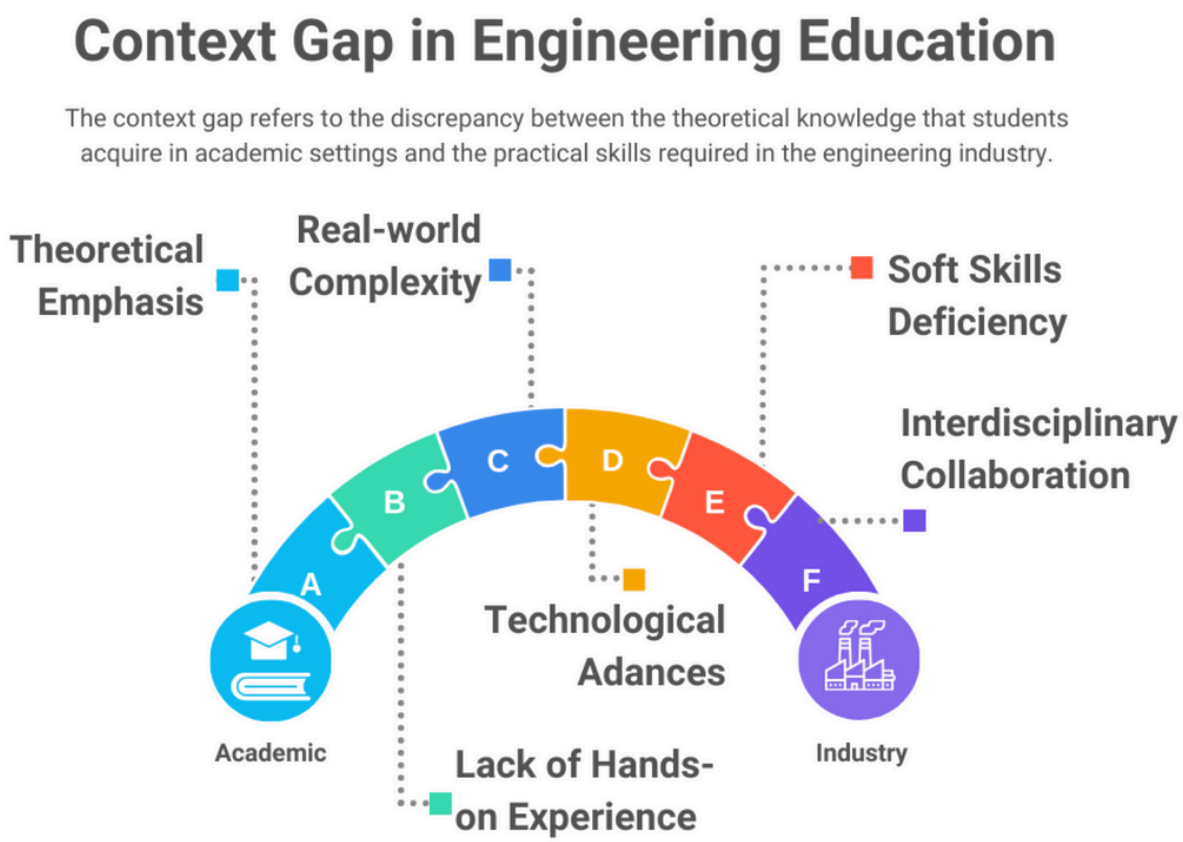
Client: Theresa Galipeau

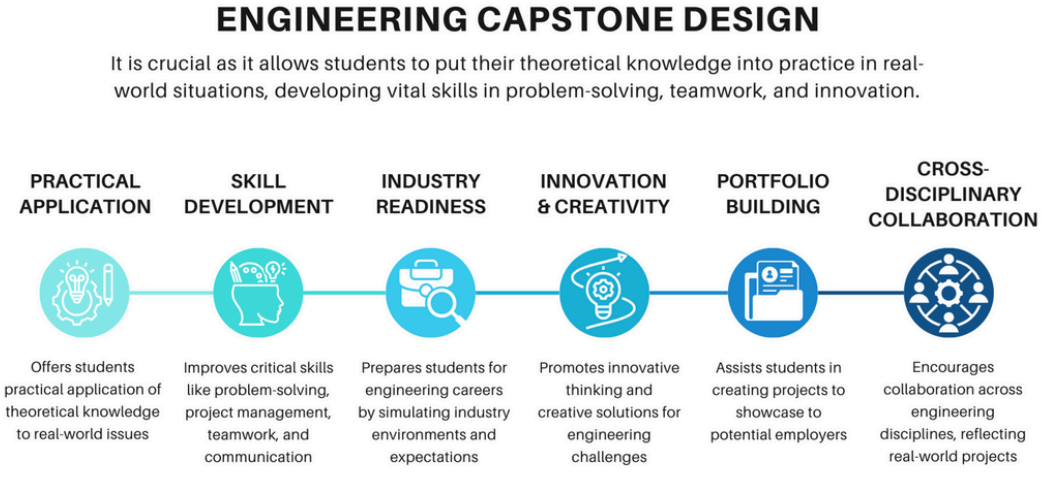
Enhancing Engineering Capstone Design Preparedness - A Systematic Curriculum Approach

Doug Yung, American Society for Engineering Education Annual Conference 2024

Introduction

Engineering education is critical in equipping students with the necessary technical and soft skills to address real-world problems. One of the most pivotal experiences in this educational journey is the capstone design project undertaken in the final year. This project, which epitomizes the culmination of years of study, aims to bridge the gap between theoretical knowledge and practical application. However, a recurring challenge faced by many instructors is the students' lack of preparation leading into this decisive year. The objective of this study is to present a systematic approach integrated into the curriculum, aimed at enhancing students' readiness for the capstone design project, and consequently, their overall design thinking capabilities.





Enhancing Engineering Capstone Design Preparedness - A Systematic Curriculum Approach

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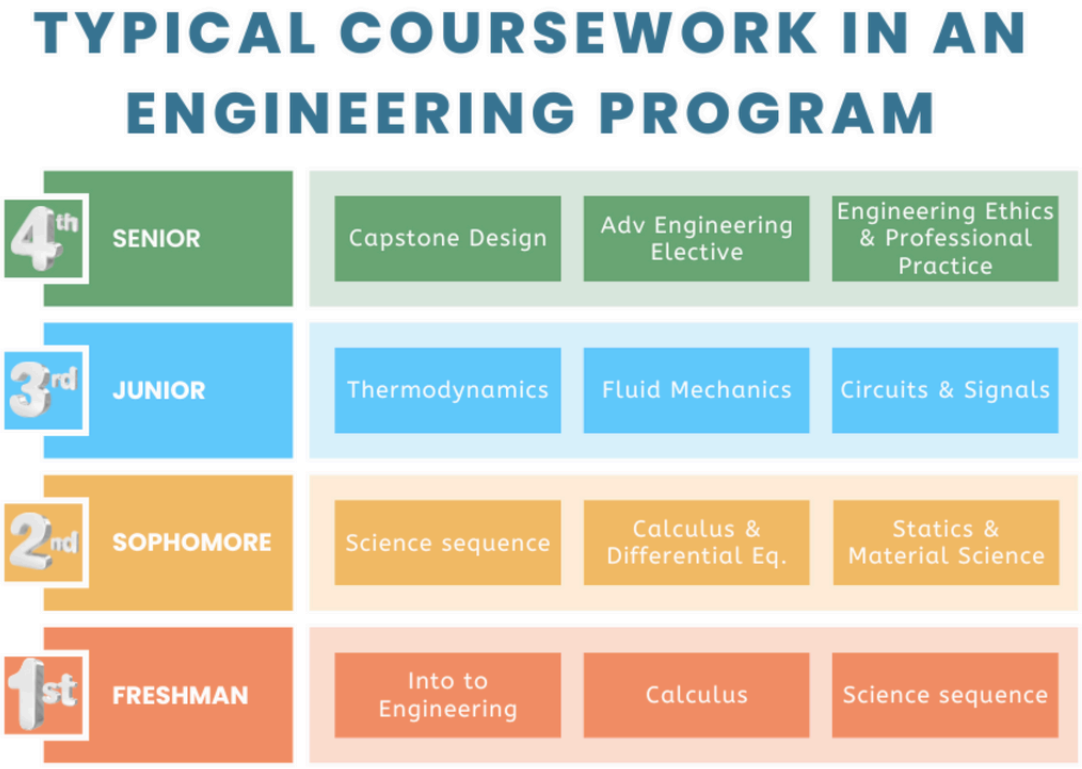

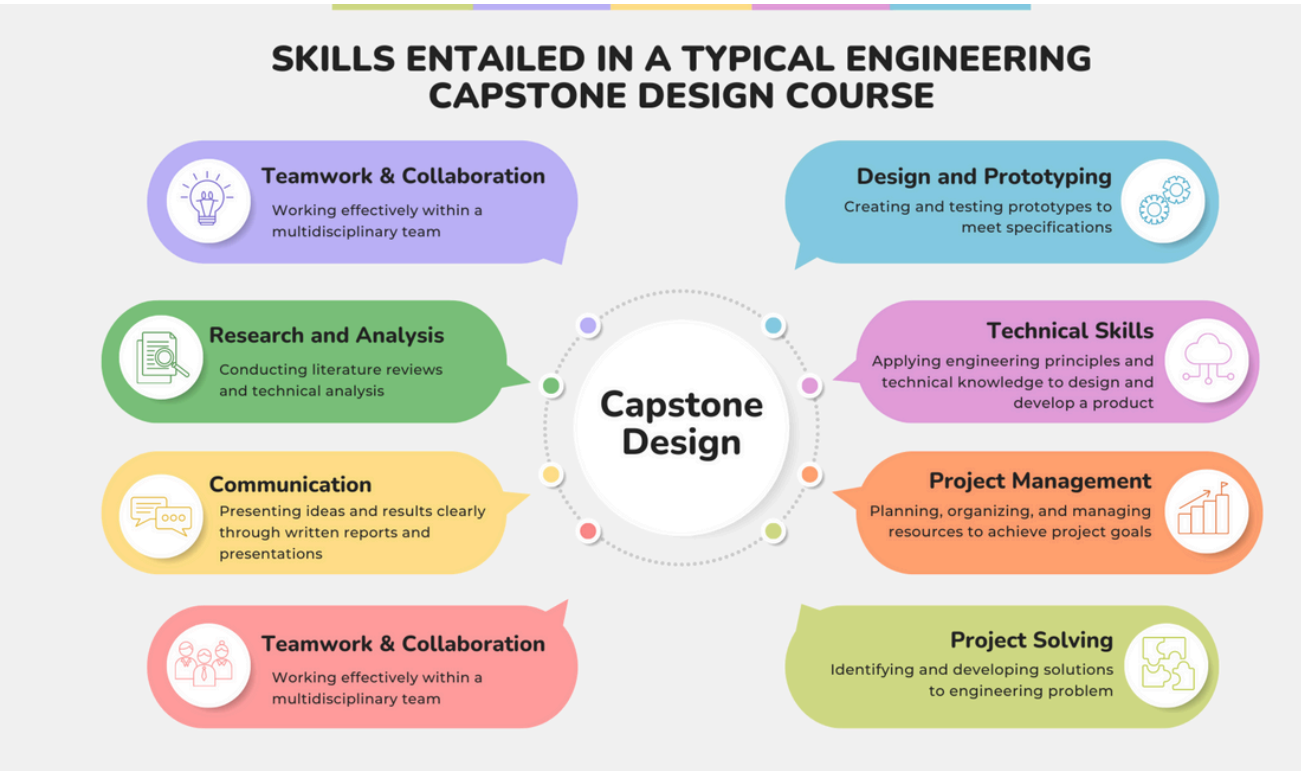

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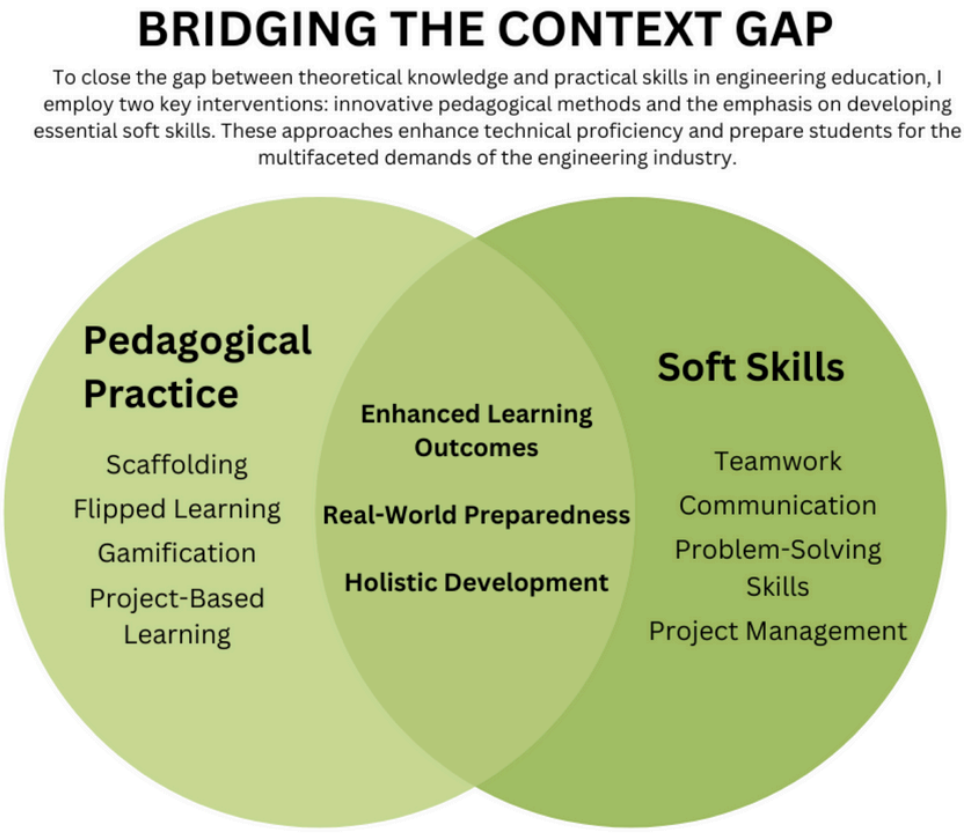
Methodology

To address the aforementioned challenge, a multi-tiered strategy was implemented across the undergraduate engineering curriculum:

- Sophomore Year Initiatives: Introduced open-ended design projects aimed at exposing students to basic design principles and fostering an innovative mindset from an early stage.
- Junior Year Interventions:
  - Mini Custom Projects: Two distinct mini custom projects were introduced to provide hands-on experience in problem-solving and design execution.
  - Shadowing Senior Projects: In the latter part of the junior year, students were given the unique opportunity to shadow senior students during their capstone design projects. This provided a spectator's perspective, allowing juniors to observe and learn the intricacies of executing a full-scale design project.

The methodology revolved around constant formative assessment activities, ensuring that learning is iterative and feedback-driven. These assessments gauged students' grasp of engineering design and their ability to integrate it with other vital components like sustainability, teamwork, and Intellectual Property Law (IPL).



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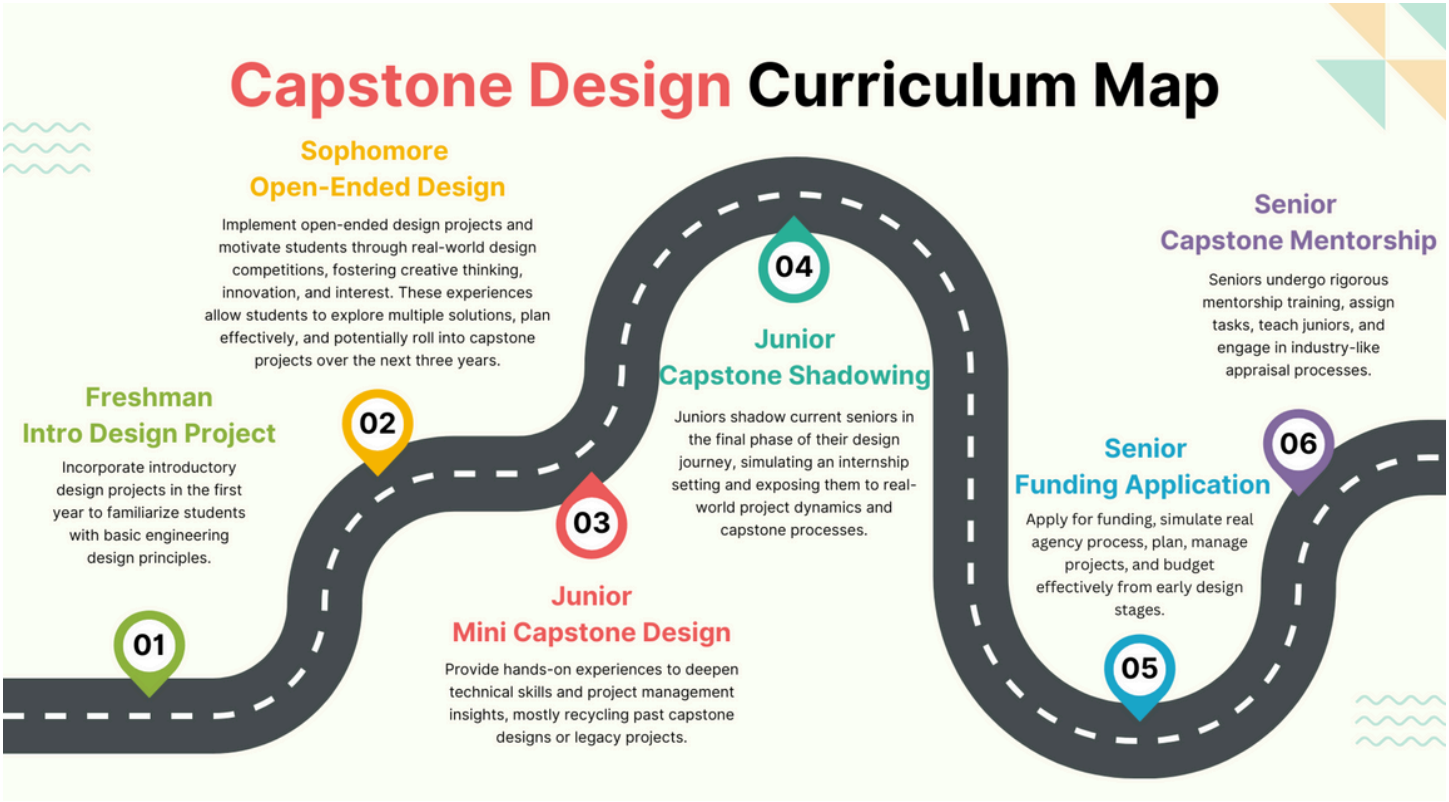

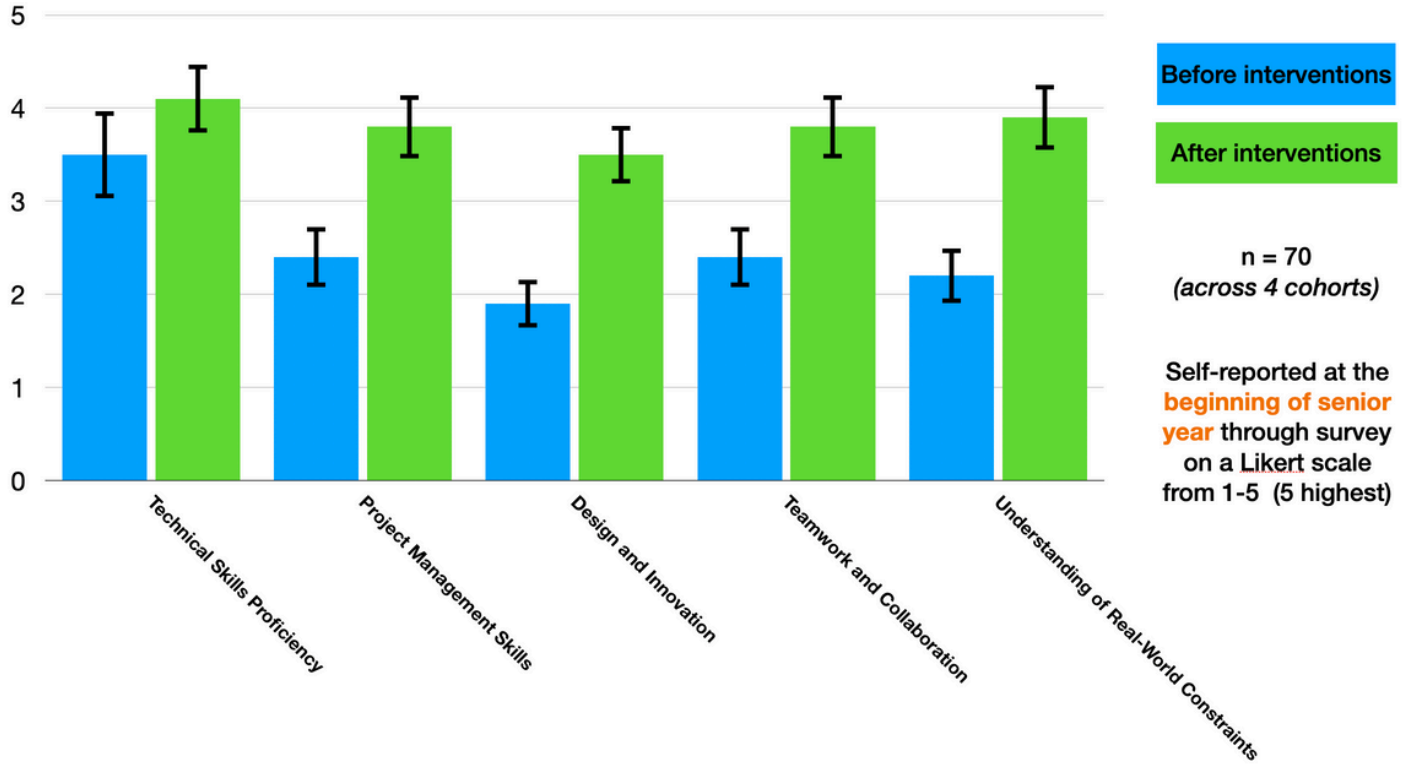

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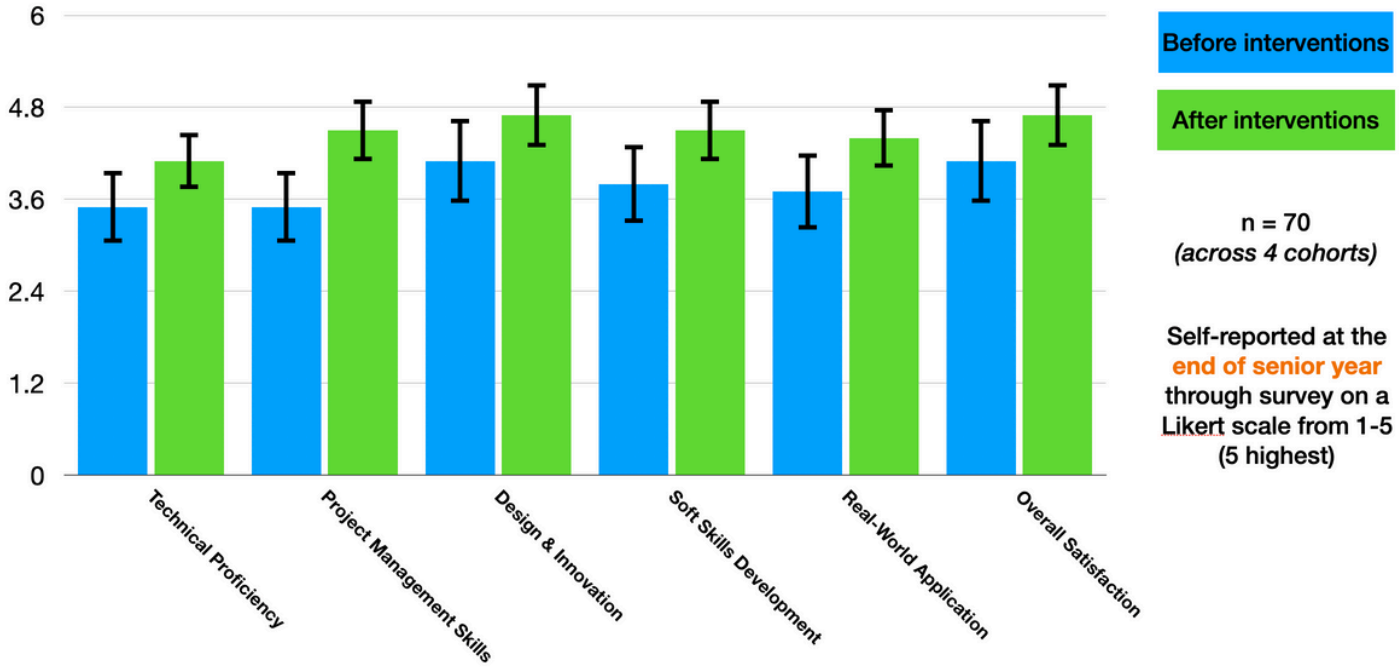

Results:

The systematic curriculum approach yielded several noteworthy outcomes:

- Increased Preparedness: Juniors who shadowed the senior projects displayed a significant increase in confidence and preparedness when they embarked on their capstone projects.
- Enhanced Design Thinking: The exposure to open-ended projects from the sophomore year and the mini custom projects in the junior year fostered a robust design thinking mindset. Students displayed a more holistic understanding of the design process, focusing not just on the technical aspects but also considering sustainability, ethical implications, and societal impact.
- Improved Soft Skills: One of the unintended yet beneficial outcomes was the enhancement of soft skills. Teamwork, communication, and problem-solving skills saw marked improvement, attributed to the collaborative nature of the design projects and the diverse challenges they posed.
- Positive Feedback Loop: The constant formative assessments created a feedback-rich environment. Students received timely feedback on their design approaches, allowing them to refine their strategies and learn from their mistakes.

Conclusion:

The capstone design project is undeniably a cornerstone of engineering education, acting as a bridge between academic learning and real-world application. The challenges associated with preparing students for this crucial phase are multifaceted. However, through a systematic curriculum approach, it is possible to not only enhance students' technical proficiency but also cultivate a holistic design thinking mindset. This study underscores the importance of early exposure to design principles, hands-on projects, and continuous feedback in shaping future engineers who are not only technically competent but also innovative, ethical, and socially responsible.