Building Innovation through Industry-Experiential Learning: A Pilot Program Integrating Engineering Education and Corporate Partnership

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Abstract

Preparing engineers to navigate rapidly changing industrial environments requires more than technical expertise; it demands creativity, adaptability, and innovative thinking. To address this educational need, an experiential learning program was developed to connect undergraduate engineering students with industry professionals to solve authentic, open-ended challenges identified by corporate partners. The initiative applies experiential learning frameworks and design thinking methodology, specifically the Double Diamond Model, to position students as active innovators rather than passive learners.

The program launched as a pilot that included collaboration with an industry partner and two distinct innovation projects. Each project was addressed by a multidisciplinary team of three engineering students representing different engineering majors. Over the course of a semester, the teams engaged in the full design thinking process, including stakeholder discovery, problem definition, ideation, prototyping, and implementation planning. Across both projects, the teams collected 38 stakeholder interviews and 43 survey responses. Students were encouraged to balance technical feasibility with business, environmental, and social considerations while developing viable, innovation-driven solutions to real industry challenges.

Outcomes from the pilot were promising. Students demonstrated significant growth in their ability to define ambiguous problems, collaborate across disciplines, and communicate technical ideas in professional contexts. Teams iteratively refined their problem framing based on stakeholder input, and final pitch presentations drew broad attendance across the partner organization. Industry mentors consistently noted that student work exceeded expectations and contributed fresh perspectives to authentic operational challenges. Preliminary self-assessment data from the second cohort indicate a meaningful increase in students' confidence applying innovation frameworks by the end of the program.

This work-in-progress paper presents the program's structure, implementation framework, and lessons learned from the pilot as well as modifications introduced in the second year including a formalized pre- and post-program assessment framework. The long-term goal is to expand this model to additional industry partnerships, enabling students to gain meaningful experiential education opportunities outside the classroom while remaining fully engaged during the academic semester.

1. Introduction

Engineering, by nature, is a continually evolving field. As engineering practice increasingly intersects with emerging technologies, sustainability imperatives, and global collaboration, the gap between academic preparation and industry readiness has become more pronounced. Engineering education must continually adapt to ensure that students are equipped not only with strong technical foundations but also with the ability to apply these skills in real-world contexts. At the university level, institutions play a vital role in preparing the next generation of engineers through rigorous coursework, laboratory experiences, and research opportunities that cultivate analytical thinking and structured problem-solving skills. Prior research has shown that the professional expectations of modern engineering practice increasingly extend beyond traditional academic preparation. This is causing renewed attention to how universities structure the education of engineering students for industry environments [1], [2].

Technical competencies remain essential; engineering practice in industry is rarely confined to isolated analysis or single-discipline problem-solving. In these contexts, the ability to explore multiple solution pathways, engage in divergent thinking, and iteratively converge on feasible, value-driven outcomes is crucial [3], [4]. Previous studies show that new engineering graduates often possess strong technical knowledge but limited exposure to professional skills such as communication, collaboration, leadership, and business awareness; competencies that are highly valued by employers and critical for navigating complex open-ended problems [1], [2], [5], [6].

This gap is partly due to the structure of many academic engineering programs, which tend to emphasize discipline-specific coursework and well-defined problems with a single "correct" solution. These approaches do not reflect current industry practices, where stakeholder needs often conflict and multiple viable solutions must be evaluated, tested, and justified. As a result, researchers and industry partners have increasingly emphasized the importance of complementary learning experiences, such as internships, industry partnerships, and scholars' programs, that expose students to open-ended challenges and support the development of workforce-ready professional and problem-solving competencies alongside technical training [5], [7].

Engineering students benefit most from industry engagement opportunities when these programs are accessible, embedded alongside academic coursework, and designed to complement rather than interrupt degree progress. Due to the nature of professional engineering problem-solving, which is inherently iterative, collaborative, and embedded within ongoing organizational work, learning experiences that run parallel to academic coursework more closely mirror engineering operating conditions. Traditional internships or cooperative education experiences often require students to leave campus for extended periods, which can create financial, logistical, or curricular barriers to participation, particularly for students with rigid degree plans or external obligations.

Scholar programs that operate concurrently with university semesters offer a more inclusive model, allowing students to engage with industry mentors, real-world projects, and professional development experiences while remaining enrolled in classes. By situating industry engagement within the academic term, these programs enable students to apply technical knowledge, professional skills, and problem-framing strategies in real time rather than in isolation or sequence. Prior work has shown that such integrated, work-aligned learning structures improve students' ability to transfer knowledge between academic and professional contexts and broaden participation in experiential learning opportunities [8], [9]. Research also suggests that students who engage in these programs report greater confidence, professional identity development, and motivation to pursue industry careers, outcomes that extend beyond technical skill acquisition [9]. At the same time, these programs provide tangible benefits to industry partners, including timely access to emerging engineering talent, opportunities to influence workforce preparation, and strengthened innovation pipelines through sustained university collaboration [1], [10].

Building on these findings, a university–industry partnership was established to pilot a scholar's program as an alternative industry engagement model, one designed to enhance professional, business, and industry-facing capabilities without requiring students to leave campus. This paper contributes to the growing body of literature on such models by documenting the design, implementation, and early outcomes of this semester-aligned initiative. The primary goal was to provide students with structured opportunities to develop the professional and innovation-facing competencies that traditional coursework rarely provides. These include the ability to navigate ambiguity, communicate across organizational boundaries, and engage meaningfully with real industry stakeholders [11]. This goal was pursued through collaborative, team-based experiences conducted while students remained enrolled in their coursework. A secondary objective was to design a scalable problem framework, one with clearly defined processes and adaptable components, that could be replicated across different institutional and corporate contexts without extensive redesign.

2. Program Design and Methods

2.1 Program Framework

The scholar's program was developed through a university–industry partnership to provide undergraduate engineering students with structured exposure to contemporary, open-ended industry challenges while remaining enrolled in academic coursework. The program was housed within the Engineering Innovation Institute (EII) and the Engineering Leadership Institute (ELI) within the University of Florida, Herbert Wertheim College of Engineering. EII emphasizes innovation, creativity, and entrepreneurial thinking across disciplines, while ELI focuses on leadership development, professional readiness, and organizational decision making. Together, these institutes provided a complementary foundation for the program.

This program was structured as a selective, cohort-based experiential learning initiative operating across an academic year. Two teams of three students each engaged in industry-defined projects supported by faculty advisors, industry mentors, and a paid student coordinator. The coordinator role was filled by a dedicated paid student, providing a peer-level facilitation presence that supported day-to-day program operations and student-mentor communication. Participation required a semester-long commitment spanning fall and spring components, including milestone-based project work and a culminating professional presentation. Selected students received a $2,000 scholarship funded by the industry partner, recognizing the value of student contributions and supporting broader access to the program. This program was intentionally designed to complement traditional engineering education by providing industry-facing experiential learning without requiring a full-time internship or cooperative experience. This approach aligns with experiential learning theory, emphasizing learning through concrete experience, reflection, and active experimentation rather than passive content absorption [12].

Program development followed a phased academic-year structure. The fall semester was intentionally dedicated to program design and alignment, during which the program coordinator, faculty advisors, and industry representatives met regularly to define project scope, learning objectives, and operational expectations. This dedicated design phase represented an intentional departure from programs that launch student engagement without systematic upfront alignment between academic and industry stakeholders. This phase included a literature review of experiential learning and innovation concepts, benchmarking against comparable models.

Structured report-outs were delivered to faculty with a specialization in innovation and entrepreneurship and to industry partners. These sessions ensured goal alignment and finalized the program structure, assessment approach, and innovation framework for the spring semester. This allowed student teams to begin project work within clearly defined and intentionally designed environments.

The primary learning objectives focused on developing students' ability to navigate ambiguity, apply structured innovation methodologies, and communicate technical and strategic ideas effectively in professional industry settings. The program pursued these objectives by embedding students in authentic, open-ended challenges where competency development occurred through doing rather than instruction alone. Additional emphasis was placed on cultivating continuous improvement mindsets, learning to incorporate constructive feedback, and balancing technical feasibility with business, environmental, and social considerations [11]. Through direct engagement with industry professionals, students were positioned as active innovators rather than passive learners [12]. Prior research has demonstrated that active and experiential learning approaches improve student engagement, problem-solving ability, and professional skill development [13].

To support these objectives, the innovation process was guided by the Double Diamond framework, which emphasizes iterative cycles of divergent and convergent thinking. The framework structures the innovation process into two diamonds, the first focused on exploring and defining the right problem, the second on developing and delivering the right solution, ensuring that teams invest adequately in problem understanding before converging on solutions. This framework was selected to encourage broad exploration of problem spaces early in the process while maintaining structure and clarity as solutions were refined [3], [14].

2.2 Industry Partnership and Projects

Industry partners contributed authentic, open-ended problem statements reflecting current organizational or market-facing challenges. Due to confidentiality requirements, specific company and problem identifiers were omitted from this paper. The pilot program included two distinct innovation projects addressing challenges from different organizational units within the partner company. Projects were selected based on their open-ended nature, organizational relevance, and potential for multidisciplinary exploration, ensuring alignment with the program’s learning objectives.

The industry partnership was initiated by the corporate partner, who approached the university seeking a structured engagement model to connect their organization with emerging engineering talent and perspective. Mentor participation drew primarily from mid-to-senior career professionals, including managers and senior engineers, whose organizational experience and domain expertise provided students with contextually grounded guidance throughout the innovation process.

These projects were intentionally ambiguous and required students to define problem boundaries, identify stakeholders, and justify assumptions as a part of the innovation process. Prior work in engineering design education has emphasized that exposure to ill-structured, open-ended problems more accurately reflects professional engineering practice, where problem statements are rarely fully defined at the outset, and supports the development of higher-order problem-solving skills [15], [16].

2.3 Participant Recruitment and Selection

Student participation in the program was voluntary and structured as a selective, application-based experience. Interested students applied through a written application, designed to assess attributes aligned with the program's learning objectives, including teamwork, creativity, professionalism, communication skills, and openness to ambiguity.

The initial written application required students to submit a résumé and respond to a series of open-ended prompts. Some of the questions included "Tell us about a time you faced a challenge working with a team," and "What does innovation mean to you, and how have you incorporated innovation in your work or studies?" These prompts were designed to assess applicants' teamwork experiences, comfort with ambiguity, motivation for industry engagement, and reflective thinking related to innovation and problem solving, consistent with best practices in experiential program selection [17], [18]. In Fall 2024, the application process resulted in 54 submissions. Applications were reviewed by the program coordinator and a faculty advisor, who evaluated candidates based on alignment with program objectives, company objectives, and readiness for experiential, collaborative work.

Following the initial application review, a subset of 12 applicants was presented to the industry partner and institute leadership for alignment and review. This step provided industry stakeholders with early visibility into the applicant pool and ensured that the final candidates were identified from both academic and industry perspectives before the group interview stage. Industry stakeholders noted the strong caliber of candidates presented during this review stage.

Selected applicants were invited to participate in a structured group interview process. The group interview format intentionally departed from traditional individual interviews to prioritize team dynamics, creative thinking, and collaborative problem solving over isolated technical proficiency. This is consistent with prior research demonstrating that collaborative behaviors and interpersonal dynamics are critical predictors of success in team-based engineering and design projects [17], [18].

The interview exercise was adapted from forced association and combinational creativity and ideation techniques commonly used in innovation and design pedagogy, in which participants are prompted to synthesize unrelated concepts to explore novel problem spaces within a constrained timeframe [19], [20]. Forced association and divergent ideation techniques of this nature have been shown to promote creative thinking, reduce fixation, and surface collaborative problem-framing behaviors in design contexts [21]. Nine students attended the group interview. During the group interview, candidates were assigned to temporary teams and asked to complete a time-constrained design challenge. Each team randomly selected two unrelated prompt words and was tasked with identifying a problem that connects the two concepts and proposing an innovative solution. For example, one of the teams picked "Scramble" and "Pest." Teams were given approximately 90 minutes to develop their ideas and prepare a short pitch presentation.

The group interview was observed by a panel consisting of faculty reviewers and members of the institute's leadership board. Observers rotated between teams, documented team interactions, and evaluated behaviors related to communication, leadership, adaptability, and collective problem framing. At selected points during the exercise, individual participants were briefly removed to answer target questions, allowing evaluators to observe how the remaining team members adapted and functioned without that individual. This approach reinforced the program's emphasis on assessing team performance rather than individual dominance [15], [22].

Of the 54 applicants, 12 were advanced to an industry review stage, 9 participated in the group interview, and 6 were ultimately selected, a selection rate of approximately 11%. Following the group interview, faculty and student reviewers met with industry representatives to evaluate the finalists' performance. Industry representatives expressed strong interest in the interview methodology and its potential applications. Final presentations submitted after the interview demonstrated a notable level of work quality given the constrained timeframe. Consistent with the program's team-centered design philosophy, final selection decisions prioritized forming two balanced teams of three students rather than selecting six individuals independently. Team composition emphasized complementary skill sets, interpersonal dynamics, and disciplinary diversity.

2.4 Team Formation and Composition

The final cohort consisted of six undergraduate engineering students organized into two teams of three. Each team drew from three different engineering majors and spanned multiple academic levels to maximize disciplinary and experiential diversity. This composition was intentional: prior research demonstrates that diverse, interdisciplinary teams are more effective at addressing complex, open-ended problems by surfacing a broader range of perspectives and approaches [17], [23].

Team size was selected to balance diversity with functionality. Teams of three allowed for active participation, shared accountability, and effective communication while remaining small enough to support agility and coordination during iterative design work. This structure also reflected common team configurations in early-stage innovation and industry project environments.

2.5 Structured Innovation Process Implementation

To support consistent execution across teams while preserving flexibility, the innovation workflow was operationalized through a six-stage process adapted from established design thinking and experiential learning frameworks. These stages included (1) Discover/Empathize, (2) Investigate/Define, (3) Ideate, (4) Prototype, (5) Testing, and (6) Implement [3], [20], [21]. Terminology and sequencing vary across frameworks; the Discover/Empathy and Investigate/Define stages align with the divergent and convergent phases of the Double Diamond's problem space. The stages Ideate, Prototype, Testing, and Implement correspond to the solution space and delivery phases described in design thinking and product development literature.

The Discovery/Empathy phase highlighted understanding as a primary methodological component. Teams focused on understanding company context, broader problem space, stakeholder perspectives, and organizational or market constraints. This phase relied heavily on qualitative and quantitative data collection through stakeholder interviews and surveys, supplemented by background research and reflective analysis. Students examined the company's values, industry standards, and existing practices to identify unmet needs and surface underlying assumptions. Prior research in engineering and human-centered design highlights the importance of early-stage problem exploration and empathy to avoid premature solution fixation and to improve solution relevance [15], [24], [25].

This emphasis on early-stage understanding was intentionally embedded into the program's initial phases through structured stakeholder engagement activities. Teams conducted semi-structured, open-ended interviews and short surveys designed to minimize bias by utilizing neutral wording and consistent questioning where appropriate. The student coordinator emphasized open-ended, non-leading questions to encourage participation and to articulate experiences, perceptions, and unmet needs in their own words, consistent with established qualitative research practices [26], [27].

Stakeholders were selected to align with preliminary personas and target user groups to gather role-relevant insights, while additional interviews outside the primary personas were conducted to broaden perspectives and reduce blind spots. Depending on the project context, teams engaged with both internal stakeholders (e.g., individuals within the partner organization) and external stakeholders representing multiple sides of the relevant ecosystem (e.g., buyers and sellers). This multi-perspective approach enabled triangulation of identified pain points and needs across stakeholder groups, consistent with best practices in qualitative design research [15], [27]. Insights from these interviews were then synthesized to refine personas, identify recurring needs and constraints, and support convergence on a clearly defined problem statement [15], [26], [28].

Building on insights gathered during discovery, the Investigate/Define phase focused on narrowing the problem scope, articulating opportunity statements, and defining success criteria. Emphasis was placed on framing the appropriate problem before considering solution development, consistent with design research demonstrating that problem framing is a central driver of innovation quality and downstream design outcomes [4], [15].

With a clearly defined problem statement established, the Ideate stage prioritized divergent thinking and creative exploration. Teams generated multiple solution pathways using a range of brainstorming techniques. At the beginning of the stage, the teams participated in a facilitated workshop based on the Pollard Method, a structured approach to design thinking that guides participants through the full innovation cycle [29]. The workshop emphasized creative confidence, idea quantity, and deferral of judgment, principles widely recognized as foundational to effective ideation in the design thinking literature [21].

Additional ideation techniques included Worst Idea, Reverse the Problem, Brainwriting, among others [21], [30], [31]. These methods were selected to promote perspective-shifting, equal participation, and independent idea generation prior to group evaluation, thereby supporting divergent exploration before convergence on promising concepts [21].

In addition to generative brainstorming techniques, the Ideate stage incorporated structured opportunity exploration using the *Ten Types of Innovation* framework. This framework categorizes innovation across ten dimensions, spanning profit model, network, structure, process, product performance, product system, service, channel, brand, and customer engagement. By explicitly examining innovation opportunities across these dimensions, teams were encouraged to move beyond solution concepts limited to product or technical performance. This allowed teams to consider systemic, organizational, and experiential forms of innovation. The framework supported identification of "white space" opportunities by highlighting underexplored innovation types and enabling teams to evaluate where existing solutions clustered and where gaps remained within the competitive landscape [32].

Building on the ideation outputs, the Prototype stage had teams create low-fidelity representations of their initial solutions, such as conceptual models, workflows, or business logic diagrams. Prototyping was treated as a learning mechanism rather than a final deliverable, enabling rapid iteration and knowledge generation. This approach aligns with established product development methodologies that emphasize prototyping as a tool for learning and risk reduction [33].

The Testing phase involved evaluating proposed concepts against predefined criteria, including feasibility, stakeholder alignment, and anticipated impact. Testing activities incorporated follow-up stakeholder interviews and informal concept validation exercises, allowing teams to assess assumptions, identify gaps between intended and perceived value, and refine concepts based on real-world feedback. This iterative validation approach is consistent with human-centered design and innovation methodologies that embed user feedback throughout development rather than at the end of the process [20], [25].

Drawing on all prior stages, the final Implement stage focused on synthesizing refined concepts into actionable recommendations suitable for industry presentation. Teams developed structured pitches articulating problem framing, solution rationale, and implementation considerations. The emphasis on translating ideas into value-oriented proposals reflects best practices in innovation management and design-led decision making. Solution viability was evaluated in terms of feasibility, alignment with stakeholder needs, and potential value creation [34].

2.6 Program Structure Calibration and Content Balance

The initial design of the scholar's program emphasized a structured innovation framework intended to be applicable across industry contexts. In its original creation, 80% of the program's content focused on the core innovation methodology, tools, and staged process, with the remaining 20% allocated to company-specific context. This structure was intended to provide students with a solid foundation while limiting reliance on proprietary or organization-specific information.

During the pilot cohort, it became evident that this balance constrained students' ability to fully contextualize and apply the innovation process to the industry partner's specific challenges. This became evident through coordinator observations and mentor feedback, which indicated that students struggled to connect innovation tools to the specific organizational context of their projects. While the structured framework supported consistency and foundational knowledge, the limited emphasis on company and problem-specific content reduced opportunities for deeper engagement with organizational constraints, stakeholder dynamics, and domain-specific industry knowledge.

The program structure was redesigned to balance content with problem- and industry-specific details. The revised model allocates approximately 60% of program content to core innovation processes and program-level instruction, 20% to company-specific context, and 20% to problem-specific exploration. This adjustment preserved the integrity and transferability of the program's innovation methodology while providing sufficient contextual information to support the design processes described above.

This rebalancing enabled students to effectively integrate process knowledge with real-world constraints and stakeholder realities, aligning the program more closely with professional engineering practice. Importantly, the revised structure maintains the program's scalability and replicability by clearly delineating which components are fixed (program and process) and which are adaptable (company and problem context), allowing the model to be transferred across different industry partners without extensive redesign. This rebalancing offers a practical guideline for institutions seeking to implement similar models: while a strong methodological foundation is essential, sufficient contextual grounding is equally critical to student success.

2.7 Mentorship, Coordination, and Feedback Mechanisms

Industry mentorship was integrated into the program as a core institutional component. The goal was for each team to engage with industry mentors at a target cadence of weekly to biweekly. In practice, engagement frequency varied by project phase, with more frequent touchpoints during early discovery and testing stages when student teams required greater contextual guidance. Mentors primarily served in an advisory capacity, providing contextual insight, constructive critique, and guidance related to feasibility, professional expectations, and industry relevance. This is consistent with prior research highlighting the role of mentorship in supporting student learning and professional development [35].

In parallel, teams met weekly with a program coordinator who facilitated structured check-ins and delivered targeted programming and instructional support. These meetings often incorporated lesson-plan-style guidance to reinforce innovation processes, professional communication practices, needs assessment, and continuous improvement. The coordinator played a key role in the program's planning and progression, as well as in aiding students in translating mentor feedback into actionable next steps while maintaining alignment with program objectives.

Feedback throughout the program was intentionally formative and iterative rather than summative. As a first-time pilot, the program emphasized adaptability, communication, and responsiveness. This flexibility was critical to managing uncertainty inherent in open-ended innovation work and informed continuous adjustments to both project direction and program logistics over the course of the semester [12], [35].

The program culminated in a sequence of structured pitch presentations delivered to industry stakeholders, including brand and business leaders. Rather than a single final presentation, teams participated in two pitch iterations designed to support formative feedback and iterative refinement [36]. This two-pitch structure was a deliberate pedagogical decision, designed to mirror the staged gate review processes commonly used in industry innovation pipelines. An initial pitch delivered earlier in the semester served as a checkpoint for validating problem framing, stakeholder alignment, and preliminary solution direction.

Feedback from industry mentors and stakeholders following the initial pitch was incorporated into subsequent stages of concept development and testing. Teams then delivered a second pitch later in the semester that reflected refined problem definitions, strengthened value propositions, and more clearly articulated implementation considerations. This iterative presentation structure reinforced learning through feedback and revision while mirroring professional innovation and decision-making processes commonly used in industry [34], [36].

In the second year of the program, the coordinator role was filled by a student who participated in the pilot cohort, bringing firsthand experience to program facilitation and peer mentorship. This evolution of the coordinator role represented a meaningful program design refinement, enabling more authentic peer-level guidance for incoming student teams.

3. Program Outcomes and Discussion

3.1 Pilot Program Completion and Deliverables

The pilot cohort successfully completed the full semester-long program, progressing through all stages of the structured innovation framework and delivering a comprehensive set of industry-facing deliverables. Two multidisciplinary student teams each addressed a distinct, industry-defined challenge and produced artifacts that reflected the full innovation lifecycle, from early-stage stakeholder discovery through concept refinement and implementation planning. In addition to a final written deliverable, each team delivered two formal pitch presentations to industry stakeholders throughout the semester, providing structured opportunities for feedback and iterative refinement.

Each team's final written deliverable served as a synthesis of the semester's work. This final submission was designed to mirror professional innovation and consulting-style reports commonly used in industry settings and functioned as a consolidated record of the teams' analytical process, decision rationale, and validated recommendations. Rather than focusing solely on final solutions, the deliverables emphasized transparency of thought, documentation of iteration, and evidence-based justification for design decisions.

The final deliverables incorporated outputs from multiple stages of the innovation process, including stakeholder interview summaries, survey findings, synthesized personas, and situation or ecosystem maps that captured relationships between key actors, constraints, and opportunities within the problem space. Teams documented how insights from stakeholder engagement informed successive refinements to problem definitions and solution concepts, highlighting the iterative nature of the work. Together, both teams collected 38 interviews and 43 survey responses. This approach reflected the program's emphasis on process-driven innovation rather than outcome-driven solution selection, and the volume of primary research is notable for an undergraduate program and reflects the depth of stakeholder engagement embedded throughout the innovation process.

Each team’s submission also included structured concept descriptions, feasibility considerations, and implementation roadmaps outlining potential next steps, assumptions, risks, and success metrics. By integrating qualitative and quantitative inputs across the semester, the final deliverables demonstrated students’ ability to translate ambiguous, open-ended challenges into coherent, actionable recommendations appropriate for industry evaluation.

Together, the pitch presentations and written deliverables served as concrete evidence of student learning, professional skill development, and the program’s capacity to produce industry-relevant innovation work. These artifacts provided industry stakeholders with both proposed solutions and a clear understanding of how those solutions were developed, validated, and refined through systematic stakeholder engagement and iterative design. A full breakdown of deliverables, components, and competencies by stage is provided in Appendix A (Table A1).

3.2 Student Learning Outcomes and Skill Development

Students demonstrated growth across several targeted professional and innovation-related competencies aligned with the program’s learning objectives, as reflected in post-program reflections, coordinator documentation, and mentor feedback.

A central area of development was students’ ability to navigate ambiguous problem spaces. Both teams revised their problem statements at least once before advancing to ideation, demonstrating a shift away from solution-first tendencies common in traditional coursework toward a more deliberate, process-oriented approach. This iterative problem framing was reinforced by stakeholder input at every stage. One team fully re-evaluated their solution direction following their first pitch presentation, while the other team used prototype testing to gather stakeholder feedback and pivot their concept accordingly. Together, both teams collected 38 interviews and 43 survey responses across the semester, reflecting a sustained commitment to evidence-based problem definition and solution refinement.

Growth in professional communication was also evident. Students consistently reported that engaging with industry professionals and delivering tangible deliverables to a real corporate partner was among the most valuable aspects of the program. As one student noted, “The program gave me a unique opportunity to work on solving a real problem the company was facing, allowing me to learn new skills like interviewing and using that information to develop a prototype that showcased an innovative solution.” The experience of presenting to and receiving critique from industry stakeholders pushed students to adapt technical language for professional audiences and justify design decisions using evidence rather than intuition.

Preliminary data from the second cohort provides early quantitative support for these observations. At the start of the semester, students completed a self-assessment measuring confidence across innovation-relevant competencies including creative thinking, assumption challenging, adaptability, collaborative role flexibility, conflict management, and complex problem decomposition, rated on a 1–5 scale. Initial ratings averaged 4.3 out of 5 across all domains, suggesting students entered the program with above-average confidence. Notably, the lowest-rated competency at baseline was assumption challenging, averaging 3.6 out of 5; a skill central to the innovation process and one the program explicitly targets. Mid-semester ratings averaged 4.2 out of 5, representing only a modest numerical shift; however, the qualitative responses from this checkpoint revealed a more meaningful pattern. Students expressed genuine uncertainty about solution feasibility, stakeholder access, and the novelty of their concepts, concerns that reflect productive engagement with the complexity of real innovation work rather than a decline in capability. This pattern is consistent with research on experiential learning curves, in which temporary uncertainty and disorientation are recognized as indicators of deeper cognitive engagement rather than setbacks [12]. At the time of this writing, end-of-program assessments are still being collected as part of the second cohort evaluation. Full pre–post comparison data will be incorporated in future reporting, though the trajectory observed thus far suggests that the program not only builds skills but also recalibrates students' understanding of what professional innovation practice requires.

Prior to the program, students generally reported limited familiarity with structured innovation processes and insufficient confidence to apply them independently. By the end of the semester, repeated exposure to the full design thinking cycle had meaningfully shifted that baseline, with students reporting greater comfort navigating ambiguity, applying structured innovation methods, and engaging with industry stakeholders in professional contexts.

3.3 Industry Mentor and Stakeholder Perspectives

Industry mentors consistently expressed that student work exceeded expectations across all deliverables. Mentors frequently entered check-ins with concerns due to tight timelines and constraints and left with confidence in what the teams had produced. This pattern was observed throughout the semester rather than only at the culminating presentations. The primary feedback mentors provided centered not on quality of work but on domain-specific gaps, such as nuances of the business context or organizational constraints that students, without significant industry experience, could not have been expected to fully anticipate.

Mentors noted that the structured innovation framework supported productive engagement with ambiguity while maintaining forward progress. In particular, the emphasis on early-stage stakeholder engagement and documentation was identified as a distinguishing feature of the program relative to more solution-driven student projects. This enabled students to justify assumptions, articulate constraints, and adapt recommendations based on real-world considerations, a process-oriented foundation that was reflected in the quality of the final deliverables.

At the final pitch presentations, more than 30 industry stakeholders attended across both teams, representing a broad cross-section of organizational departments. The breadth of attendance reflected the perceived relevance of the student work to real organizational priorities. Mentors noted that virtually every attendee left with actionable insights or concepts that they could build upon within their own organizational contexts. Several mentors remarked that they themselves would not have been able to produce work of comparable quality for an industry audience, and highlighted students' ability to reframe the original problem statements in a professionally and organizationally sensitive way as a particularly impressive outcome. One team's final pitch was evaluated using a structured rubric scored on a 1–3 scale. Presentation quality and pitch delivery received scores of 3 out of 3, confirming that evaluators regarded the work as meeting professional standards. Feasibility scores of the solution in its current state were modest, which was expected. Students were proposing early-stage concepts without full access to the organizational and technical constraints that would govern real implementation. Mentors framed this not as a shortcoming but as an appropriate outcome for early-stage innovation, one that provided a meaningful foundation for stakeholders and mentors to build upon going forward. Several stakeholders indicated interest in exploring the proposed concepts further, suggesting that the student work generated tangible value beyond the academic context of the program. This did not in any way diminish their overall assessment that the work was impressive.

3.4 Program-Level Outcomes and Post-Mortem Insights

A structured post-mortem review was conducted following completion of the pilot cohort to evaluate program design, implementation effectiveness, and areas for improvement. The review was conducted through structured written reflections and a facilitated debrief session involving all key program stakeholders, including the program coordinator, faculty advisors, and industry mentors, documenting observations related to program execution and participant experience.

One observed outcome of the pilot was that a semester-aligned, industry-embedded scholars' program could be implemented without requiring students to interrupt their academic progress. Students remained fully enrolled in coursework while engaging with open-ended, industry-defined challenges, indicating that the program structure was compatible with existing academic commitments. Additionally, student engagement levels remained consistently high throughout the semester, and the quality of final deliverables exceeded initial expectations across both teams, observations that affirmed the program's core design assumptions.

The post-mortem review identified areas where additional scaffolding would have supported more efficient early-stage execution. Variability was observed in how teams approached stakeholder engagement, documentation practices, and interpretation of early milestone expectations during initial project phases. A distinction was made between productive ambiguity, which supports exploration, and structural ambiguity, which can hinder momentum if not appropriately addressed.

Communication cadence and role clarity emerged as key factors influencing team efficiency. Even in small, highly motivated groups, unclear task ownership during early innovation phases introduced inefficiencies as teams negotiated responsibilities and workflows. This underscored the importance of facilitating early norm-setting and role clarification in team-based experiential learning environments.

Finally, the team-based selection process was consistently identified as a positive element of the program. Observers noted strong collaboration within teams throughout the semester, with balanced participation and sustained engagement across all project phases, suggesting that the team-centered selection process contributed to a positive and productive team dynamic.

3.5 Ongoing Evaluation and Program Iteration

Based on lessons learned from the pilot cohort, several targeted refinements were implemented in the second year of the program. These modifications addressed early-stage structural ambiguity, communication cadence, and assessment rigor, areas identified through the post-mortem review as opportunities for improvement. Baseline and mid-semester data have been collected for the second cohort, with post-program assessments and cross-stakeholder feedback planned for later in the academic year. A full description of program modifications and the updated evaluation framework is provided in Section 5.

4. Lessons Learned from the Pilot Program

The pilot cohort provided a unique opportunity to evaluate the design and facilitation of a semester-aligned, industry-embedded experiential learning program in a real academic context. Analysis of post-mortem reflections, coordinator documentation, and stakeholder feedback surfaced several key lessons with implications for future program design and replication.

The first lesson concerned the need for early, explicit clarification of structural expectations. While productive ambiguity is an intentional and valuable feature of open-ended innovation work, ambiguity around documentation standards, milestone deliverables, and stakeholder engagement expectations created avoidable inefficiencies in early project phases. The distinction between productive ambiguity, which supports creative exploration, and structural ambiguity, which can impede momentum, is not always intuitive for students entering open-ended projects for the first time. Future implementations should clearly distinguish between the two and provide explicit scaffolding around structural expectations from the outset.

The second lesson concerned mentorship structure. Regular interaction with industry mentors provided critical context and professional relevance; however, the pilot revealed the need for clearer alignment between mentor feedback and student action planning, an observation that informed changes to the coordinator's facilitation role in the second year. Without intentional follow-through mechanisms, valuable mentor guidance risks remaining conceptual rather than being translated into concrete next steps within the innovation process.

A third lesson concerned internal team communication and role definition. Even in small, highly motivated groups, unclear task ownership during early project phases introduced inefficiencies as teams negotiated responsibilities and workflows. This highlighted the importance of facilitating explicit norm-setting and role clarification at program outset, particularly in multidisciplinary teams navigating open-ended challenges where disciplinary boundaries do not naturally define task ownership.

Fourth, the pilot affirmed the effectiveness of the group interview and team-centered selection process. Selecting participants based on collaborative behaviors and team dynamics rather than solely on individual technical performance contributed to sustained engagement and productive collaboration throughout the semester. This approach mitigated several common challenges associated with student project teams and supported more balanced participation across team members. The group interview format, which assessed real-time collaborative problem solving under time constraints, proved particularly effective at surfacing interpersonal dynamics that traditional individual interviews would not have revealed.

Together, these lessons highlighted that the success of industry-embedded experiential learning programs depends not only on program structure and content but also on the intentional design of the human and relational elements, including mentorship alignment, team formation, and communication scaffolding. These findings directly informed the targeted modifications implemented in the second year of the program, described in Section 5.

5. Program Modifications Implemented in Year Two

Building directly on the lessons identified through the pilot post-mortem, several targeted modifications were implemented in the second year of the program to improve clarity, coordination, and assessment rigor.

First, the application and group interview timeline was moved earlier in the academic year, with applications closing in September, enabling industry project scopes to be finalized before student onboarding and allowing teams to begin the semester with greater clarity and context. Additionally, the coordinator role in the second year was filled by a student who had participated in the pilot cohort, enabling more authentic peer-level facilitation and bringing firsthand program knowledge to day-to-day operations.

Second, additional structure was introduced during the program's initial weeks to reduce avoidable early-stage inefficiencies. This included clearer milestone definitions, standardized documentation templates for stakeholder engagement and synthesis, and facilitated discussions focused on role definition, task ownership, and internal communication expectations. These changes were designed to preserve the benefits of open-ended problem solving while maintaining the program's exploratory character.

Third, the assessment framework was refined to support more systematic evaluation of student learning outcomes. Students now complete an initial self-assessment at the beginning of the semester to establish baseline confidence across domains including professional communication, teamwork, problem scoping, industry awareness, and leadership initiative. Parallel post-program assessments at the conclusion of the semester enable pre-post comparison of self-reported competencies. End-of-cycle instruments are also administered to industry mentors and student leaders to capture sponsor satisfaction, communication effectiveness, and perceived value of student contributions. At the time of this writing, data collection for the second cohort is ongoing.

Early observations from the second cohort suggest that these modifications have contributed to a more structured and cohesive program start, with teams demonstrating clearer role definition and more consistent documentation practices in the early project phases.

6. Future Recommendations

Building on findings from the pilot cohort and informed by ongoing evaluation efforts, the following recommendations are proposed to guide future implementations and broader adoption of the scholars' program model.

Future iterations should prioritize continued iterative refinement grounded in systematic assessment. Sustained use of pre- and post-program evaluations, peer-feedback measures, and industry partner input will enable precise identification of instructional elements, mentoring structures, and project design features that most strongly contribute to student professional growth. As additional cohorts are completed, combining quantitative self-assessment data with qualitative reflections will support more robust evaluation of learning outcomes.

Expanding the program to include additional industry partners would strengthen the generalizability of the findings and enable comparisons across different organizational contexts and problem types. Longitudinal tracking of participants beyond program completion may also provide insight into longer-term impacts on career readiness, professional confidence, and industry engagement. Future iterations should also consider expanding scholarship support and broadening recruitment efforts to ensure the program reaches students who face the greatest barriers to traditional industry engagement opportunities. Additionally, exploring pathways to integrate the scholars' program into formal degree requirements or offer academic credit for participation would further strengthen institutional commitment and broaden student access.

To support broader adoption, future work should focus on developing and publishing implementation guidelines, partnership frameworks, and assessment tools that enable other universities and industry collaborators to replicate this model with fidelity. The scholars' model, characterized by semester-aligned engagement, integrated mentorship, structured innovation processes, and team-based problem solving, can be adapted across institutions and disciplines where experiential learning and professional skill development are essential.

Collectively, these recommendations reflect a commitment to building a rigorous, inclusive, and scalable model for industry-embedded experiential learning, one that prepares engineering students not only with technical competencies but with the professional and innovation-facing skills that modern engineering practice demands.

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Appendix A:
Table A1: Innovation Framework Deliverables by Stage

Innovation Stage	**Component**	**Purpose**	**Skills and Competencies Demonstrated**
Stage 1: Discover / Empathize	Company and brand background	Establish organizational and market context	Industry awareness, contextual analysis
	Mind map	Visual exploration of space and related factors	Systems thinking, divergent exploration
	Initial problem framing	Early articulation of the challenge prior to refinement	Problem scoping, ambiguity navigation
	User personas	Representation of target stakeholder groups	Human-centered design, empathy
	Empathy maps	Synthesis of stakeholder thoughts, feelings, and behaviors	Qualitative synthesis, perspective-taking
	Stakeholder matrix	Identification and prioritization of internal and external stakeholders	Stakeholder analysis, strategic thinking
	Stakeholder pains and gains	Documentation of unmet needs and value drivers	Needs identification, value analysis
	Market research findings	Summary of secondary research on industry and market context	Research literacy, evidence-based reasoning
	Key players	Identification of major actors within the ecosystem	Competitive awareness, systems mapping
	Market trends	Analysis of relevant industry and consumer trends	Trend analysis, foresight
	Market segmentation	Categorization of user or customer groups	Strategic segmentation
	Existing solutions	Review of current approaches addressing the problem	Competitive analysis, benchmarking
Stage 2: Investigate / Define	Interview protocols by persona	Structured interview questions aligned to stakeholder roles	Research design, bias mitigation
	Surveys	Quantitative validation of assumptions and trends	Data collection, survey design
	Interview results and summaries	Documentation of stakeholder responses	Qualitative analysis
	Interview takeaways	Key insights derived from individual interviews	Insight synthesis
	Survey results	Aggregated quantitative findings	Data interpretation

	Survey insights	Interpretation of patterns and implications	Analytical reasoning
	Need statements	Refined articulation of core stakeholder needs	Problem definition
	Key challenges framework	Organization of constraints and opportunity areas	Strategic framing
	Pain points	Validated areas of friction or unmet need	Opportunity identification
Stage 3: Ideate	White space matrix and table	Identification of unmet or underexplored opportunity areas	Opportunity mapping
	Continued background research	Targeted research to inform ideation	Knowledge integration
	Worst idea brainstorming	Divergent ideation technique to reduce fixation	Creative thinking
	Innovation literature review	Review of multiple innovation types and frameworks	Innovation literacy
	Innovation gaps analysis	Identification of underutilized innovation approaches	Strategic insight
	Customer journey maps	Visualization of stakeholder interactions over time	Experience design
	Early solution concepts	Initial idea generation outputs	Ideation fluency
	Competitive solution analysis	Review of existing market solutions	Competitive positioning
	Identification of “what is not happening”	Recognition of unmet or ignored opportunities	Critical analysis
	Preliminary profitability considerations	Early assessment of economic viability	Business reasoning
Stage 4: Prototype & Testing	Team perspective synthesis	Internal alignment on concept direction	Team reflection
	Buying trends analysis	Evaluation of relevant purchasing behaviors	Market analysis
	Riskiest assumption testing	Identification and testing of core uncertainties	Risk assessment
	Prototype v1	Initial low-fidelity concept representation	Iterative design
	Stakeholder feedback	Input gathered on early concepts	Feedback integration
	Final prototype	Refined concept incorporating feedback	Iteration

	Prototype survey	Structured feedback instrument	Validation
	Feedback results	Summary of stakeholder responses	Evidence-based refinement
	Problem revisited	Re-evaluation of problem definition post-testing	Reflective practice
	Alignment with company values	Assessment of solution alignment with organizational principles	Ethical and strategic alignment
	Viability assessment	Evaluation of feasibility and impact	Decision-making
Stage 5: Implement	Implementation roadmap	Outline of proposed next steps	Strategic planning
	Partnership considerations	Identification of internal or external collaborators	Stakeholder coordination
	Marketing and rollout considerations	High-level go-to-market thinking	Business communication
	Implementation risks and assumptions	Identification of potential challenges	Risk awareness