Building an Industrial Engineering Program Through Industry-Embedded Learning: The Upstate Experience

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Abstract

Creating a novel Industrial Engineering (IE) program at a local, resource-limited university poses challenges, requiring innovative solutions to deliver high-quality, ABET-aligned IE education to students. Founded in 2025, the University of South Carolina Upstate's IE program was deliberately designed to leverage the region's vast automotive and manufacturing base via iterative consultation with local industry partners. Guided by informal industry surveys assessing market demand for local engineering programs, founding program documentation, and structured interviews with founding faculty and industry partners, this study documents the dynamic, practice-oriented development of the program and the creation of a novel "Lab-in-Industry" framework.

Rather than replicating manufacturing processes with academic equipment, USC Upstate elected to embed laboratory experiences directly within partnering industries. Students participated in hands-on, immersive exercises alongside engineers and technicians at facilities such as OP Mobility, Sage Automotive Interiors, and Dräxlmaier. This allowed students to gain practical exposure to production systems, ergonomics, lean operations, and safety practices. Early results and first-cohort qualitative feedback suggest that these engagements strengthen students' understanding of systems integration and increase the perceived relevance of course content through sustained industry contact.

This paper synthesizes qualitative data from interviews with the program's founding creators, program proposal materials, and early student reflections, and documents the program's dynamic development cycle, which implements continuous-improvement principles. The authors discuss lessons learned from building a program that responds to regional workforce needs while maintaining ABET alignment without dedicated campus laboratories, and from scaling experiential learning while preserving educational quality and safety. The USC Upstate model demonstrates how smaller institutions can leverage regional partnerships to establish sustainable, ABET-aligned engineering programs that prepare students for modern industrial practice.

Keywords: Industry Collaboration, Lab in Industry, Educational Program Development

1 Introduction

Industrial engineering (IE) uniquely focuses on designing, improving, and installing integrated systems of people, materials, information, equipment, and energy, using mathematical, physical, and social sciences [1]. According to the US Bureau of Labor Statistics, demand for industrial engineers will grow by 11% from 2024 to 2034, creating an average of 25,200 jobs per year [2]. With over 2000 companies, including around 600 international employers, the upstate region of South Carolina is a concentrated hub of manufacturing and logistics firms.

Approximately 80% of USC Upstate students come from Spartanburg and Greenville counties, with 68% of graduates staying in the region. However, prior to the IE program, no industrial engineering degrees were offered by local public universities. Therefore, creating the program addressed the needs of the regional workforce and the university's goal to serve the local community. However, launching an engineering program requires substantial financial resources, particularly for laboratory facilities. Due to funding constraints during program development, USC Upstate was unable to establish conventional laboratory facilities before enrolling the first student cohort. USC Upstate leadership and industry advisors therefore proposed an alternative framework, referred to in this paper as the "lab-in-industry" (LI^2) in which students conduct hands-on exercises at partner industrial facilities rather than on campus.

Engineering education researchers consistently argue that closing the gap between classroom learning and professional practice is essential for producing graduates who are industry-ready, and engineering programs have increasingly pursued this goal through university–industry partnerships and industry-embedded learning experiences [3]. Across the engineering education literature, these partnerships are associated with stronger technical competence and stronger professional skills (e.g., teamwork and leadership), because students engage authentic constraints, real systems, and workplace norms while still receiving structured academic guidance [3].

Evidence further suggests that participation in multi-term cooperative education or similar experiences is associated with higher academic performance and improved early-career outcomes. Structured immersion in industry accelerates both technical growth and professional readiness [4], [5]. Complementary partnership structures that bring industry into the curriculum also show promise: for instance, a required professional-skills program co-delivered with practicing engineers can meaningfully strengthen students' workplace expectations and professional competencies while deepening employer engagement with the institution [6]. Taken together, the literature supports the argument that industry-embedded learning is not merely an enhancement but a mechanism for aligning educational experiences with workforce demands in ways that directly shape students' employability and skill development [3], [4], [6], [7]. To the authors' knowledge, very few industrial engineering programs in the United States employ a LI^2 concept in which conventional laboratories are completely replaced by lab instruction taking place in active industrial facilities. This makes the IE program at USC Upstate a potential framework for other institutions interested in developing hands-on, industry-relevant curricula. This paper presents a case study of the development and implementation of the LI^2 model in the new IE program. It describes how this model emerged and how it aligns with ABET program criteria and student outcomes. In addition, the paper synthesizes feedback from the inaugural student cohort and provides recommendations for future improvement of LI^2.

2 Methods and data sources

The establishment of the IE programs was examined in a retrospective study using qualitative interviews and feedback from faculty involved in the process, as well as the program proposal submitted to the South Carolina Commission on Higher Education. Semi-structured interviews were conducted in 2025 with Dr. Jeannie Chapman (JC), who led the operational team that developed the program, and Mr. Don Bent (DB), an executive-in-residence with decades of manufacturing experience. Their narratives provided insight into strategic decisions and industry partnerships. Notes were drawn from existing IE-adjacent faculty in other USC Upstate programs who supported the curriculum structure and benchmarked it against other ABET-accredited IE programs.

The establishment of the LI^2 concept was also examined in a retrospective study that used many of the same sources as the IE program itself. However, the LI^2 concept is also evaluated through an observational study that drew on qualitative feedback surveys from four students in the first LI^2 cohort to understand students' perspectives. They were then analyzed using thematic coding to identify potential benefits, challenges, and learning outcomes.

3 Results

3.1.1 Conceptual basis for the IE program

Although the Industrial Engineering (IE) program officially launched in Fall 2025, internal documentation indicates that the concept had circulated in university academic and strategic planning discussions for several years, with regional partners, especially in automotive and advanced manufacturing sectors, expressing interest in a locally accessible IE pathway. A key inflection point occurred in 2021 with the arrival of a new chancellor, who prioritized regional engagement and responsiveness to workforce demand. This leadership shift created an institutional champion capable of providing the administrative momentum needed to move the program from concept to implementation.

3.1.2 Market validation

Market research conducted with regional industry associations and employers identified strong demand for graduates with systems-level thinking, process optimization, and operations management skill sets that map directly to industrial engineering.

Over 700 job postings for the roles of Industrial Engineer, Industrial Production Manager, and Quality Engineer were found in 2024 for the Upstate region [8], [9]. Given that Industrial Engineering graduates can fill a broader range of positions than those listed, this initial evaluation, combined with the Bureau of Labor Statistics prediction of growth in the IE field, was sufficient to confirm the need for the degree [2].

3.1.3 Curriculum design and benchmarking

A central feature of the program's foundation is an explicit ABET-forward posture: faculty with prior ABET experience guided early work on Program Educational Objectives (PEOs), student outcomes, and assessment mechanisms so the program would not need extensive retrofits later. A comparative review of IE curricula at benchmark institutions external to, and within the University of South Carolina system, was conducted, focusing on common core sequences (operations research, systems modeling, ergonomics, quality), credit-hour distributions, and applied-learning/industry-engagement structures.

Between requirements and benchmarking, the proposed program included 30 credit hours of mathematics and basic science and 45 credit hours of engineering topics, consistent with ABET guidelines [10]. According to the program proposal, students must complete 123 credit hours in total, distributed across foundational sciences, general education, and specialized IE courses, culminating in a two-semester capstone project [11]. Table *1* documents the courses that are slated to have LI^2 and the one course that has piloted the model.

Table 1: Courses using the lab-in-industry model:

Course title	Role in curriculum	Course fit for Lab-in-Industry
Ergonomics and Human Factors Engineering (INDE U215/U215L)	Examines work design, posture, reach, lifting, fatigue, safety practices, and the interaction between people, tools, and production systems through workplace visits.	Human factors are difficult to teach authentically in a classroom alone because workstation design, operator motion, environmental constraints, and safety culture are best understood in real-world settings.
Manufacturing Processes (INDE U220/U220L)	Implemented LI^2 course in the current paper. Multiple site visits to observe manufacturing processes and complete hands-on activities tied to course concepts such as time study, waste identification, assembly, process observation, and quality-related tasks.	This course was the clearest early fit for LI^2 because the region contains diverse processes that would be expensive and difficult to recreate on campus. Industry partners in the region already operate modern, mixed-generation manufacturing systems that would give students a broad range of experience.
Lean Engineering (INDE U330/U330L)	Engage with live production systems observing waste, flow, standardized work, visual management, material staging, bottlenecks, and continuous improvement practices.	Lean concepts are especially well-suited to LI^2 because waste, flow disruptions, handoffs, visual controls, and non-value-added activities are more meaningful when experienced in real-world operations than in contrived classroom examples.
Facilities Planning and Logistics (INDE U410/U410L)	Examine the facility layout, space allocation, material flow, warehousing, point-of-use storage, transportation paths, and internal logistics systems, such as AGVs or kitting systems.	These topics depend on seeing real distances, congestion points, inventory presentation, and flow relationships in context. The broader LI^2 model already draws heavily on authentic production environments.
Quality Control and Management (INDE U415)	Engage with inspection systems, SPC-related practices, quality documentation, defect identification, metrology, process auditing, and structured improvement thinking.	Several existing partner visits have already exposed students to the class concepts. That makes INDE U415 a strong future LI^2 course because live quality systems are easier to understand.

3.2.1 Origin of the lab-in-industry idea

The decision to combine laboratories within partner companies emerged during curriculum planning discussions. Dr. Chapman was concerned that the university lacked the space and funding to have dedicated laboratories by the time the program was meant to be implemented. Mr. Bent then proposed leveraging industry facilities instead, suggesting that corporate plants in the region use state-of-the-art equipment:

"…What labs do we have to create? And if you take a look at our curriculum, some of those classes, starting with manufacturing and processes, it was pretty clear that there were some labs or lab learning that could apply to industry in our region…"

Because Mr. Bent was from Industry, with several existing local industry connections, and transitioned to becoming the University of South Carolina Upstate's Executive in Residence after his retirement, establishing the program came swiftly. Leveraging his "rolodex of industry contacts", as noted by Dean Chapman, industry connections were made, and promises of collaboration were swiftly extracted. To quote Mr. Bent:

"...we partnered with industry to go and see what they're using and to actually do a hands-on activity at those sites… that was the key, to talk to industry and say, the need for a hands-on (active, experiential) component. Because the industry in general is used to providing tours. You could call up any industry in the area and say, hey, can you do a tour for our students?"

The concept resonated with faculty, and through conversations, industry partners were also convinced of the benefits for themselves: they get to meet with and aid students, and, as noted by Mr. Bent, they get to see and coach potential future employees at their company. The phrase LI^2 became central to the program's identity and was quickly embraced by administrators and partners.

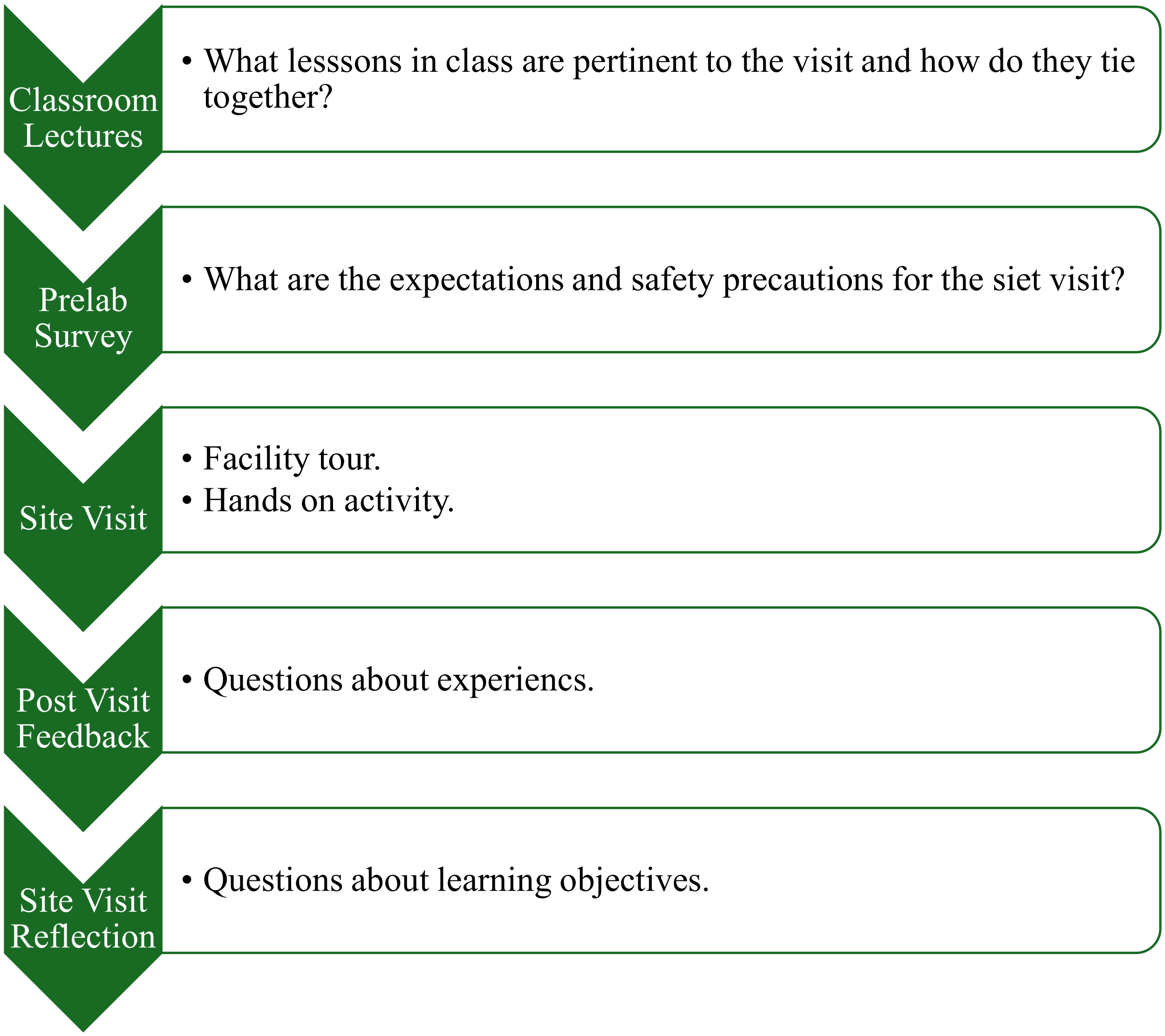

Figure 1: Process flow for students in lab-in-industry courses

Figure 1 outlines the basic process for students in an LI^2 course. Specifics regarding LI^2, what educational materials were used, how partners were contacted, and how future LI^2 courses are planned to scale up are covered in another proceedings paper [12].

3.2.2 Student experiences and feedback

The first course taught with an accompanying LI^2 component was Manufacturing Processes, taught in Fall 2025, the first semester of the newly founded IE program. This course was selected for LI^2 because processes can be observed easily. As such, the data, both qualitative and quantitative, is based on learning objectives from this course. Four students from the inaugural cohort completed qualitative surveys after each laboratory visit. Responses were grouped by facility to identify themes. Overall, students appreciated the opportunity to observe real processes, collect data, and interact with engineers in the field. They reported that the hands-on activities that followed site tours at each LI^2 location helped them connect theoretical concepts with practice, and that pre-lab lectures/assignments prepared them for on-site tasks. General technical suggestions for improvement included allocating more time for shadowing engineers, increasing overall time, going deeper into specific steps/processes/materials, following a process from start to finish, and exploring more areas of certain sites. Some non-technical suggestions included learning more about the engineers and how they got to where they are, having headsets for better communication in louder facilities, and minor comments on the flow of activities or on specific aspects of certain activities, such as seeing fiber-optic cables first rather than the end at AFL. Table 2 consolidates feedback from each partner site. Descriptive phrases in the table summarize common observations and suggested improvements.

Table 2 Summary of student experiences during industry-embedded laboratories:

Company / Facility	Processes Observed	Hands-On Activity	Student Feedback: Lessons learned	Student Feedback: Learning outcomes
Dräxlmaier (automotive interior components)	Injection molding, plastic welding, thermoforming, and automated door assembly.	A time study of an assembly cell. Waste (TIMWOODS) walkthrough observing a finishing cell	Exposure to lean manufacturing and the importance of standard work. Practice collecting cycle-time data and identifying waste.	Aided in reinforcing classes on plastic forming. Timing could be improved with a time study. Students enjoyed connecting with engineers, which reinforced their decision to pursue IE.
Sage Automotive Interiors	Fabric weaving, dyeing, and finishing, safety, waste management, flame lamination, cutting, and embossing	Observation of quality control, statistical process control, and fabric management.	Reinforced statistical concepts and variability. Appreciation for the scale of textile operations. Practice in recommending new equipment for the plant.	Covered a variant on sheet cutting from lectures. Students enjoyed learning about employees' early careers and found the swiftness, adaptability, and OSHA involvement interesting.
OP Mobility (plastic trim and interior components)	IM, painting, an automated inventory management system, and a 14-step assembly process	Conducted time studies on the injection molding process. Studied quality documentation and environmental health and safety (EHS) systems	Real-time understanding of quality documentation, injection-molding operations, and the relationship between manufacturing and safety.	Aided in reinforcing classes on plastic forming and post-processing. Discussed homegrown QA systems at the plant. Students found shadowing workers and operators was incredibly valuable.
Spartanburg Steel	Die forging, welding, punching/blanking, bending, flattening, hemming, laser welding, metal stamping, Stamping presses, blanking, welding, assembly, and painting. and assembly	Reviewed different manufacturing cell orientations and how risk is assessed and managed in high–risk industries.	Appreciation of stamping complexity. importance of safety and ergonomics. An understanding of line balancing and scheduling.	Aided in reinforcing class concepts, especially in metal shaping and material properties (crystal structure). Cooling, process speed, and the amount of safety hazards could be areas an IE could help, according to students.

Table 2 Continued:

Company / Facility	Processes Observed	Hands-On Activity	Student Feedback: Lessons learned	Student Feedback: Learning outcomes
Oshkosh Defense	Complete van assembly process, and painting, Vehicle assembly, kitting, welding, and painting.	Observation of modular assembly and part flow for mail vans.	Insight into large-scale assembly and material handling. Reinforcement of lean principles and team collaboration.	Aided in reinforcing assembly and joining processes. Students observed that the automated guide vehicle routing could be improved, and IEs could conduct a study to increase process speed. Assembling parts on one's own, seeing what operators see, crane systems, and automated guided vehicles are all interesting.
Rhino Tool (custom tooling)	This was an on-campus remote demonstration covering CNC automation, assistive tools for packaging and shipping processes, and digital modeling.	Hands-on operation of tools such as lift aids, torque tools, and robotic arms.	Students learned about plant setup while getting hands-on experience with assistive tools.	Aided in reinforcing concepts on process planning and automation. Students learned how a tooling company assists with plant layout and systems.
Keurig Dr Pepper (KDP)	Roasting, grinding, and the automated high-speed packing of K-Cups.	A first-hand account of how quality data is gathered and tested continuously, and how brew quality is assessed via taste testing.	Understanding quality data capture and analysis. Learning that sensory experience makes KDP's quality control process more nuanced than others.	Reinforced principles parallel to particulate processing. Efficiency, speed, and safety/quality concerns were all reinforced. Students identified many ways in which IE’s can assist, as KDP’s plant operated at a larger unit scale than other sites.
Milo’s (tea bottling)	Bottling, brewing, and automated packaging in a food-safe, cold-storage environment, and maintenance of complex fluid transport systems.	Time studies and process observations.	Hands-on time-study exercise. Students saw the importance of maintenance in ensuring machine uptime and quality.	Reinforced concepts of shaping and molding. Not particularly related to the syllabus. Students noted that safety, community, and process flow were well done. Students were able to relate this process back to Keurig. The end-of-day taste test was the most interesting to students. .

Table 2 Continued:

Company / Facility	Processes Observed	Hands-On Activity	Student Feedback: Lessons learned	Student Feedback: Learning outcomes
AFL (fiber-optic cables)	Die compression, extrusion, rolling, powder coating, welding, forming, drawing, stranding, sheathing, stainless-steel tubing, and cable manufacturing.	Hands-on experience with visual management tools and line balancing exercises.	Students valued practicing line balancing and observing visual management tools used in modular production. Aided in reinforcing metal shaping and drawing concepts. Students noted that safety was good, though quality control did not happen during the process, and not everything was documented. Being hands-on with pipes and manufacturing, meeting people, and seeing the braided cables were of interest for the students.	Deeper involvement in problem-solving activities.
SEW-Eurodrive (gear and motor assembly)	Picking, assembly, testing, painting, and packing of gear reducers and motors, machining, heat treating, tooling, metrology, assembly, and repair operations.	Inspection of spiral-bevel gears and pinions. Assembling a gearbox in the training center.	Insight into modular assembly, quality testing, and automated large-scale machining. Hands-on assembly task taught tolerance and fit.	Aided in reinforcing metrology and CNC machining concepts. Students noted that efficiency and the level of automation were higher than at any other site. Students found AGVs, CNC machines, and the plant layout interesting.

3.3.1 ABET requirements

The USC Upstate IE program was specifically designed to meet the general and program-specific criteria set by ABET's Engineering Accreditation Commission. The program-specific criteria require a curriculum that spans engineering science, computer science, and design topics, including the analysis, operation, and improvement of integrated systems that produce goods or services, and the incorporation of real-world experiences and business perspectives [10]. To meet students' educational and resource needs, remote or virtual access may be implemented in accordance with ABET standards, provided that the learning objectives and program goals are adequately met. Given the nature of industry partners in the region, all resources, tools, and equipment are modern and maintained, and, due to the program's structure, students are educationally primed for their labs and well informed of all safety requirements.

3.3.2 Lab-In-Industry alignment with ABET guidelines

The LI^2 model embeds weekly laboratory sessions within partner companies, fulfilling the ABET mandate to incorporate design, analysis, and improvement of integrated systems and to utilize real-world experiences [10]. The compatibility with some specific ABET outcomes is as follows:

- Identifying and solving complex problems (Outcome 1). During each visit, students conducted various analytical tests, such as time studies, 5S audits, line balancing, and quality analyses, and proposed improvements afterward. These exercises required identifying inefficiencies and formulating solutions based on engineering principles and real-time observations.
- Applying design with consideration of context (Outcome 2). Most labs end with a feedback session that allows students to speak with engineering teams about improvements they would make to their facility. After which, the feasibility of these ideas is discussed to build IE intuition.
- Communicating effectively (Outcome 3). Students generated post-lab reports, discussed findings with company hosts, and presented recommendations to industry partners, peers, and instructors, fostering oral and written communication skills.
- Ethics and professional responsibility (Outcome 4). Safety requirements and briefings featured heavily in all labs. Discussions about safety regulations and observations of how safety is a core priority at sites encouraged students to reflect on ethical considerations and professional standards IEs need to maintain.
- Teamwork (Outcome 5). Students worked in groups to collect data and conduct analyses during labs, coordinating tasks and supporting each other's learning while briefly experiencing how industry professionals run their teams through the hands-on activities.
- Experimentation and data analysis (Outcome 6). Many activities involved measuring cycle times, learning the practical applications of statistical process control, and

interpreting experimental results, thereby teaching experimental methods and data interpretation.

- Lifelong learning (Outcome 7). Post-lab reflections asked students to identify new skills acquired and to consider how these experiences build their IE intuition. The experiential learning component teaches intangible IE skills that encourage students to be inquisitive as they approach new environments. A key takeaway from labs was that students realized frontline workers have extremely valuable insights into site operations.

Through these structured activities, the LI^2 framework not only satisfies ABET requirements but also enhances students' readiness for professional practice.

4 Discussion

USC Upstate's IE program illustrates a program-design approach that treats curriculum development and laboratory delivery as a single, coupled problem. The founding conditions were clear: regional workforce demand and strong local student retention created a compelling case for a locally hosted IE degree, but the institution lacked the resources to build conventional laboratory facilities prior to the first cohort. The program's creators used benchmarking, outcomes framing, and assessment planning to design an accreditation-ready program. However, the approach was flexible and allowed for local integration. Within this design logic, the LI^2 framework emerged as the program's defining innovation. The model leverages the Upstate manufacturing ecosystem as an industry-embedded laboratory: students visit partner sites and complete hands-on activities aligned to course topics, thereby gaining exposure to production systems, safety practices, quality documentation, and lean operations. This aligns with the broader engineering education literature, which supports university–industry partnerships and experiential learning as mechanisms for strengthening technical competence and professional readiness through authentic contexts and structured guidance [3], [5]. Importantly, the USC Upstate approach aims to integrate these experiences into required coursework, rather than relying solely on internships or co-ops.

Student feedback suggests that the model is promising but site-dependent. Students consistently reported that the combination of tours and hands-on tasks helped them connect lecture concepts to real-world experiences, and they requested more time with frontline workers to understand processes and more time with engineers to discuss career paths. This indicates that students found the labs meaningful and wanted more engagement with people. These patterns imply that the model's success depends on avoiding drift into passive tour-like observation. Maintaining the hands-on component and interaction with industry professionals is also important for meeting ABET requirements. Each site visit must allow students to measure or analyze a real process element, ideate on an improvement recommendation with evidence, and communicate results in an assessed format. This emphasis is consistent with ABET's focus on measurable outcomes, continuous improvement, and providing adequate learning resources.

The LI^2 model's key challenges are operational and scale-related. Scheduling volatility with industry partners, safety and liability constraints, transportation logistics, and variable site capacity for hands-on engagement are just a few challenges the team is working to address in anticipation of a much larger cohort than the initial four from this year. Some of these issues can be addressed by reducing the number of labs and scheduling several visits to the same site with smaller groups. Discussions about rotating through several activities have also been proposed for visits to a single site. More broadly, this case suggests that industry-embedded labs require extensive planning: clear visit protocols, early scheduling windows, concurrent student activities, consistent safety procedures, and a structured activity template that enhances the student experience across facilities. When treated as a system rather than a series of independent visits, the LI^2 approach can deliver authentic, modern manufacturing exposure while remaining compatible with an ABET-aligned outcomes and assessment framework.

5 Conclusion and Future Work

USC Upstate's IE program demonstrates that a resource-constrained regional university can develop an engineering program that remains aligned with ABET requirements by engineering the program around regional partnership capacity. The founding approach combined (1) market and mission alignment to local workforce needs and student retention patterns, with (2) an ABET-forward curriculum and assessment structure designed early. Under these constraints, the LI^2 framework emerged as a practical and educationally rich solution to USC Upstate's lack of laboratory resources. Labs-in-industry leverage advanced industry partner facilities to provide in-field laboratory learning while educators work to preserve structure through preparations, curated hands-on activities, and post-visit reflections, which are discussed in a separate paper [12]. Early student responses indicate high engagement and perceived relevance, and identify clear targets for refinement in future labs to provide more interaction with professionals. Future work should prioritize three areas. First, formalize a repeatable assessment architecture for LI^2 sessions (common deliverables, rubrics, and evidence collection) so each visit generates consistent artifacts and learning outcomes aligned to targeted ABET requirements. Second, develop scalable logistics that preserve the labs' interactive nature. Third, evaluate longitudinal outcomes once sufficient cohorts are available, including retention, internship placement, first-destination employment, and employer satisfaction. Ultimately, the Upstate case suggests that LI^2 can be a credible model for small IE programs when it is managed and treated as a system designed for partner sustainability, structured immersive learning, and the achievement of shared community goals for industry and academia.

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7 Appendix

Appendix 1

Post-visit Feedback

Question 1

Was the pre-lab preparation sufficient to help you understand what you would see?

- Yes
- No

Question 2

Explain your answer to the previous question. What about the prelab preparation helped you understand what you saw at this site visit?

Question 3

Be an Industrial Engineer and analyze the last site visit. What would make the lab visit more effective for your learning?

Question 4

Are there additional questions or activities you wish had been included in this lab? What else would you have liked to see or experience at this site?

Appendix 2

This appendix shows feedback from two students for a company visit.

Feedback or Reflection	Question	BG	ES
Feedback	Was the pre-lab preparation sufficient to help you understand what you would see?	Yes	No
Feedback	Explain your answer to the previous question. What about the prelab	The prelab helped me understand what I needed to bring and wear, which was sufficient to make me prepared to retain	I don't think the pre-lab was very good at helping understand what Draxelmeir made or their processes. It was useful knowing what

	preparation helped you understand what you saw at this site visit?	information and be professional.	clothing was allowed, but it didn't relate very well to the processes we would see.
Feedback	Be an Industrial Engineer and analyze the last site visit. What would make the lab visit more effective for your learning?	The lab visit would have been more effective if I could have understood the gentleman who conducted the time study section.	It would have been useful being taught more about what could go wrong in the process and how they do "damage control". I think it is important to learn the common defects pieces may have and how that affects the production line as a whole.
Feedback	Are there additional questions or activities you wish had been included in this lab? What else would you have liked to see or experience at this site?	I would have liked to have spent more time in the injection molding process.	In my opinion, this lab visit was well conducted and included a lot of useful information. The only suggestion I have is to go more in-depth with the things that could go wrong in the manufacturing process and how to fix them. I would have liked to learned about examples of projects engineers are given or come up with to improve efficiency and such.
Reflection	Describe the key manufacturing processes you observed at this facility. Which process was most familiar from class lectures, and which was most surprising or new to you?	The key manufacturing processes observed were primarily injection molding and welding. The process most familiar was the injection molding process. What surprised me the most was welding plastic as I had not realized you can weld plastic as I have only welded metal.	Injection molding (a mix of fiber glass, resin and plastic is out into a "blender" where it is ground into finer pieces, then it is put through a heated tube to melt. After the mix is melted, it is pushed at high pressure into the desired mold), Automated trimming/cutting (after a piece comes out of the injection mold, it is picked up by a hydraulic arm, and with another arm equipped with a cutting tool the excess plastic is trimmed off.), Laser welding (a laser focuses energy to raise the temperature of the plastic and two pieces can be fused together), Friction welding (plastic pieces are rubbed at a high velocity and frequency so that the friction between them generates heat to melt a specific part of both pieces and fuse them together), Manual assembly (an operator manually clicks pieces together, glues them or screws them in place to complete a part of the production of a piece that has not been automated yet. The process most familiar was injection molding because it is a formative process. The most surprising process was

			friction welding, I think its interesting how the are able to have only a small piece of the surface melt instead of the whole thing.
Reflection	How did what you observed reinforce or challenge what we've discussed in lectures and readings? Give at least one concrete example.	What I observed helps reinforce the TIMWOODS Motion waste. When we were watching the last section of the Manufacturing process, carts were pushed in everyone's way, causing them to have to walk further around, creating that waste.	Watching their senior engineer walk us through the process of a time study reinforced the lecture and activity we did in class. It showed me that in order to get a correct time study, the most minute things have to be accounted for, like the number of steps taken by the operator, allowance for the operator to talk to other people, take breaks, and restock parts. These are all factors that have a major influence on the production flow and output of pieces, so accounting for these outside factors (human factors) gives us the most accurate data and allows us to give employees freedom and not make them feel constrained by time, while allowing for the best time efficiency.
Reflection	Identify one area where an industrial engineer might contribute to improving efficiency, safety, or quality at this facility. What evidence led you to this conclusion?	The last assembly section had inefficient movement, with everyone walking around in that area, causing a bottleneck.	In the final assembly area, Chuck mentioned that if they were working at a very specific pace, the pieces from final assembly could be loaded into trucks and immediately shipped out, but, because it is too hard to achieve that flow, the pieces from final assembly have to be stored and then shipped, taking up space in the facility and delaying shipment. I think an industrial engineer might be able to figure out a layout in which it is possible to load and ship pieces as soon as they are finished.
Reflection	What did you personally find most interesting or valuable about this visit? Did it affect your perception of manufacturing careers in any way?	I personally found the injection molding section to be the most interesting. It did not affect my perception of manufacturing.	The most valuable thing I learned from the trip was the tour as a whole. When we stepped into the facility, seeing the injection molding machines and talking about what it takes to make the plant run efficiently and smoothly made me think industrial engineering was the right choice for me. What I found most interesting was the blend of polymers and plastics used for the injection molding, and what makes that specific blend a good material to be used to be cost-effective and have the characteristics required for the panels that were being molded.