Engagement in Practice: Promoting Engineering Work Experiences in Rural Sustainability Contexts

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Background

In engineering, there have been continued calls for higher education institutions to partner with industry on high-impact practices [1]. Simultaneously, there have been calls to consider meaningful community engagement and for engineering institutions to engage thoughtfully in rural spaces [1], [2], [3]. Recent national calls and efforts have also emphasized the importance of and need for research and investment in STEM workforce development in rural places and connecting students to careers and industries to demonstrate the relevance of STEM in rural places [3],[4],[5]. In alignment with these simultaneous calls, we propose work-integrated learning as a promising practice for the future of engineering education with the goal of promoting authentic work experiences and community engagement.

This paper describes the first pilot of an innovative, community engaged, work-integrated learning program for undergraduate engineering students. The purpose of this engagement-in-practice paper is to describe the project partners, program design, and lessons learned. The semester-long program includes a 3-week pre-internship preparation session and a 12-week work-integrated experience. The short-term goal of this model is to support learning and connections between students' internships and their coursework. The longer-term goals of this model include future work opportunities for students and meaningful partnerships with local community members and engineering employers.

Partners Involved

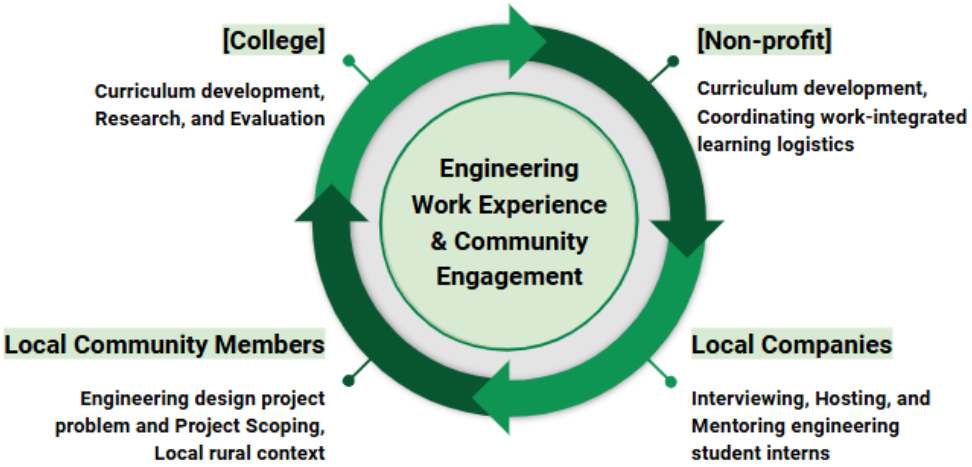
The two primary institutional partners are the School of Engineering and Computer Science at Elizabethtown, a small private teaching-focused institution located in Pennsylvania, and the Greenway Institute, a non-profit focused on reimaging engineering education located in Vermont. The Greenway Institute was recently recognized by the Central Vermont Regional Economic Development Corporation and the Central Vermont Regional Planning Commission at the top of the Regional Project Prioritization List for 2025 for their engineering education initiatives. Elizabethtown College and the Greenway Institute established the Greenway Center to pilot an innovative work-integrated learning engineering curriculum. During the pilot program, the students left their primary campus in Pennsylvania and spent the semester in Vermont.

The Greenway Center engaged in additional partnerships with local companies and community members in Vermont. During the pre-internship preparation session, local community members met with students to inform and scope an engineering design project relevant to the community. The community engineering design project was part of the curriculum and unrelated to students' internships. During the work experience, company partners employed and mentored engineering student interns during the work-integrated learning session. During the partner recruitment process, the Greenway Center specifically reached out to local companies that had the capacity to interview and employ engineering interns and who had shared values about the community. These partners were crucial to the success of the pilot semester and the work-integrated learning experience. Through the support of local companies and community members students effectively engaged with the local community and participated in authentic

engineering work experiences. An overview of the partners and roles can be found below in Figure 1.

Furthermore, in alignment with the mission of the grant, students were deeply engaged as partners and co-creators in the program. As a pilot program, the students were highly involved in shaping the program and providing insight throughout the semester. The pilot semester consisted of four students and although small in number, the cohort had diverse representation across multiple demographics and targeted underserved and underrepresented populations (race, socio-economic status, first-generation status, rural). It is worth noting that while several women expressed interest in the program, they were unfortunately unable to participate due to varying external factors, and all four participants identified as men. Recruitment for future cohorts will explicitly focus on gender diversity and representation.

Figure 1. *Summary of Partnerships and Roles*



Program Design

The program design focused on work-integrated learning and community engagement. The students engaged in these through their coursework, community design project, internship, and other planned program activities.

An outline of the semester-long schedule focused on the community engagement and work-integrated learning activities can be seen below in Table 1. Throughout the semester students were enrolled in five courses worth 14 credit hours including: Calculus III (4 credits), EGR470: Internship in Engineering (4 credits), EGR355: Sustainable Resource Engineering & Design (3 credits), EGR201: Community Based Engineering Project (2 credits), and EGR395: Industry Speakers Series (1 credit). The students enrolled in similar classes as their peers at the primary campus, however, five of their credits are focused on work-integrated learning in their internship and industry speakers whereas students at the primary campus are taking electives for those credits. The courses themselves are all offered at the primary campus, however, due to the work-integrated learning model the delivery of the courses is different at each campus. Both the primary campus and the work-integrated learning program use mastery-based assessment. Furthermore, the research team is conducting on-going research and evaluation to compare both academic and professional outcomes across the two campuses to ensure quality of education.

The community design project and the work-integrated learning aspects of the program design will be described in detail in this paper as these were the most relevant to community engagement. Other activities included volunteering, career treks (site visits) of local companies outside of internship hosts, informal recreational activities, and a community celebration during the final examination week. Furthermore, for additional information on students' perceptions and experiences the project has published additional papers [6], [7], [8].

Table 1. *Schedule Outline*

Month	**Week**	**Work-Integrated Learning**	**Community Engagement**
January	*Week 0*	● Orientation	● Volunteering in Local Community
	Week 1	● Pre-Internship Prep Bootcamp	● Community Design Project ● Three Career Treks to Local Companies
	Week 2		
	Week 3		
February	*Week 4*	● Internship	● Work-Integrated Learning Experience and Internship with Local Company ● Informal Activities
	Week 5		
	Week 6		
	Week 7		
March	*Week 8*		
	Week 9		
	Week 10		
	Week 11		
April	*Week 12*		
	Week 13		
	Week 14		
	Week 15		
May	*Week 16*	● Final Examination	● Community Celebration

Community Design Project

In the initial planning phases of the program, it was determined that students would take a project-based course, specifically “EGR201: Community Based Engineering Project.” Upon

hearing about the program, a local community member in Central Vermont came to the Greenway Institute and explained the challenge they were facing. From this conversation, the curriculum design team integrated the community design project into the Spring semester with the community member's input. The students were provided with a project description, goal, and specifications from the stakeholder.

Through the community design project students were able to work on a real problem, learn about sustainability, interview stakeholders, and go through the engineering design process. Furthermore, through this project and process the students were able to meaningfully engage with the local community in Central Vermont and apply their engineering education. The community design project is an example of intentional community engagement with community partners and community engaged learning that allows engineering students to apply their learning while acknowledging and incorporating knowledge held by local community members [8].

Table 2. *Project Description, Goal, and Specifications*

Goal	Design a bike station that is unique to our context and climate, reflecting the values and aesthetics of the local community, while meeting best practice for sustainability.
Description	The bike station is intended to serve as an access point for 6-8 electric-assist bikes that will be used in a trial that will determine user acceptability of the amenity. The trial is planned for the end of the 'bike season' Sep-Oct. 2025. The trial may be extended into the winter months to investigate effectiveness of weatherproofing, unlocking and secure return of bikes, and optional battery swap and charging facility. The trials will give proof of concept for a novel community bike share in the Central [State] region.
Specifications	● Enable access from roadside, parking, and securing the bike to the structure by means of a cable lock that is integral on each bike. The cable reach may be limited to 24 inches. ● Weatherproofing to protect from falling rain and snow is essential. ● A panel sized about 3 feet wide and 4 feet high is incorporated to give multiple functions - informational or marketing space. ● Climate control features that will keep the batteries on the parked bikes within the acceptable range of temperature is an optional feature. ● Accommodating a lockable climate-controlled cabinet for battery swaps and recharging up to 10 batteries - can be another add-on feature of the design. In the case of battery charging in situ, connection to a power supply (either solar or municipal grid) will be needed.

Work-Integrated Learning

In this context, work-integrated learning is defined by students' learning experience that is co-facilitated by academic partners at the Greenway Center and industry partners at the students' worksites in rural Vermont. During the work-integrated learning session, the students will spend 30-40 hours per week on-site at their internship and will also have approximately 12-credits coursework. This program is unique in that students were intentionally targeted employers local to the community to promote regional workforce development and build connections with the local engineering employers that students may not otherwise know about or have access to.

For this pilot semester, the students were hired by several different employers. It is worth noting that while staff at the Greenway Center made initial contact with the companies regarding the possibility of hiring a Spring semester summer intern, each student went through a traditional, merit-based hiring process including a resume screening and interview before hiring. Most students submitted their resumes and interviewed at multiple companies before finding their final internship. The employers included employee-owned businesses and small businesses in the Central Vermont region. Ultimately, all of the companies that hosted students were all mission aligned with the sustainability, equity, and/or professional development focuses of the Greenway Center. While most of the employers conducted sustainability related work, they ranged in industry focus from solar energy to EV charging stations. An overview of the employers and their mission can be seen below in Table 3. We chose to de-identify company names for the purposes of this paper.

Table 3. *Local Companies Overview*

Company	**Company Mission**
Green Technology Company	Company 1 develops, commercializes, and deploys forward looking clean energy innovations for our commercial, community, and utility customers. From US Department of Energy R&D funded grants to hundreds of commercial solar and EV charging installations, Company 1's experience and services are supporting all communities' transition to a cleaner robust future.
Solar Installation Company	Company 2 is a local, Vermont-based, member-owned worker's cooperative specializing in affordable, high-quality solar power system design and solar installation services. Company provides residential and business customers in Vermont and New Hampshire[Neighboring State] with a full range of electric hot water and heating system options designed to meet their unique needs.
Engineering and Automation Company	Company 3 is a 100+-person engineering and automation company that designs MEP systems for facilities and plants, engineers control and automation solutions, and ensures safety and regulatory compliance through arc flash studies, commissioning, and validation. Company 3's team excels at solving complex technical challenges and what's important to their clients and employees becomes everything to Company 3 as a company.
Ice Cream Manufacturer	Company 4 is a global ice cream manufacturer with headquarters in Vermont that has approximately 1000 employees. Company 4 was founded on and is dedicated to a sustainable corporate concept of shared success. The company is focused on thoughtful ingredients, shared success, and making a difference. At the manufacturing facility, they are dedicated to continuous improvement and high quality production.

Discussion and Lessons Learned

The pilot of a community-engaged, work-integrated learning program for undergraduate engineering students demonstrated the potential for aligning experiential learning with regional, rural workforce development needs. Furthermore, this work has reinforced the importance of designing meaningful community engagement and authentic work experiences in engineering and can serve as an example for other programs.

During the pilot semester several lessons learned stood out from our work. Particularly, the importance of mutually beneficial relationships and partnerships across institutions and local stakeholders. The community-centered project and local internships were central aspects of the program. The project team set out to intentionally design meaningful opportunities for students to engage with local stakeholders. From our work, we found that students in the pilot valued the formal and informal community engagement activities. Furthermore, the pilot semester reinforced the need for workforce development and engineering education that balances student and community needs. Work-integrated learning has promise for sustaining rural communities, both in terms of providing pathways for local rural students where there are limited opportunities to attend postsecondary engineering programs [10] and in terms of attracting students from outside of the local area to create pathways for a strong engineering workforce. Furthermore, the internships and community engagement in this program had direct relevance in the local community, demonstrating not only the relevance and possibility of engineering careers but also the responsiveness to the needs of the rural communities.

While the evidence and research-based practices the program was designed with are not by themselves novel, there are few engineering colleges in the United States who operate on a true work-integrated learning model. For example, the Iron Range Engineering supported by Minnesota State, Mankato which served as a "proof of concept" for the design of this pilot. The majority of programs engaging in work-based learning often use a coop or internship model where students generally engage in coursework and work as separate activities. While some programs have courses focused on professional development before or during coops and internship experiences, these are often one-off courses. The goal of the pilot program was to explore a work-integrated learning curriculum where students' engineering coursework is connected to their internship. Furthermore, there are on-going research and evaluation efforts to assess the pilot program in forthcoming publications. Specifically, the team is monitoring students' experiences in the program, quality of curriculum, and students' internships.

Based on our work, we highly recommend that engineering programs and practitioners consider work-integrated learning. The pilot program demonstrated that work-integrated learning can be mutually beneficial for students, local companies, and community members when designed thoughtfully. Furthermore, work-integrated learning has significant promise for engineering education in rural contexts as a way to engage students in meaningful experiences, sustain rural communities and industries, and contribute to regional development goals.

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Acknowledgements
This material is based upon work supported by the National Science Foundation under Grant No. 2219807. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.