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Innovation Lab: Community, Outreach, and Experiential Learning in ECE

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1 Abstract

Electrical and computer engineering (ECE) is a discipline grounded in making, experimentation, and design, yet many undergraduate programs offer limited opportunities for hands-on engagement early in the curriculum. This paper describes the development and sustained use of the Innovation Lab, a department-based makerspace embedded within the ECE program at Seattle University. The Innovation Lab integrates experiential learning, community building, and outreach through accessible, low-barrier activities that support students across academic stages and extend engagement beyond campus.

Rather than functioning as a centralized makerspace or stand-alone project center, the Innovation Lab is aligned with departmental priorities and supports a range of curricular and co-curricular activities. Signature hands-on workshops, particularly soldering and printed circuit board (PCB)-based activities, are used with current students, prospective students, transfer students, and pre-college participants. These activities emphasize authentic engineering practices, creativity, and artifact-centered learning while remaining approachable for participants with little prior technical experience.

The paper describes the institutional context, design, and operation of the Innovation Lab; highlights key hands-on activities and outreach models; and presents observations from multiple years of implementation. Lessons learned are discussed to inform other ECE departments interested in leveraging department-based makerspaces to support experiential learning, student leadership, recruitment, and community engagement.

2 Introduction

Electrical and computer engineering (ECE) is a discipline grounded in making, experimentation, and design. Yet in many undergraduate ECE programs, early coursework emphasizes mathematics, physics, and theory, with limited opportunities for hands-on engagement. As a result, students may spend their first years in the major with little exposure to the practices, tools, and creative processes that define engineering work. This gap can affect student engagement, confidence, and persistence, particularly for students who enter ECE without prior experience in electronics or fabrication. In response to concerns about student sense of belonging and retention, many ECE programs have introduced hands-on experiences into the curriculum through first-year introductory courses, project-based learning, and makerspace-integrated activities[1,2,3,4,5,6,7].

To address this challenge, the Department of Electrical and Computer Engineering at Seattle University established the Innovation Lab, a department-based makerspace designed to integrate experiential learning, community building, and outreach into the ECE program. Rather than functioning as a centralized campus makerspace or a stand-alone project center, the Innovation Lab is intentionally embedded within the department and aligned with departmental priorities related to hands-on learning, student leadership, and recruitment. The lab provides a flexible environment where students engage in authentic engineering practices through making, collaboration, and creative exploration, both within and beyond formal coursework.

The Innovation Lab supports a broad range of activities, including course-related prototyping, student organization projects, creative workshops, and department-wide community events. Central to the lab's operation are low-barrier, hands-on soldering and printed circuit board (PCB)-based activities developed and refined over multiple academic years. These activities introduce participants to core ECE practices such as component identification, circuit assembly, and troubleshooting while remaining accessible to individuals with little or no prior technical experience. Emphasis is placed on creativity, personalization, and immediate feedback, allowing participants to produce functional artifacts and develop a sense of ownership over their work.

In addition to serving enrolled students, the Innovation Lab plays a significant role in outreach and recruitment, particularly in supporting transfer pathways from local community colleges. Faculty and students regularly bring Innovation Lab activities to partner institutions as part of recruitment visits. Rather than centering these visits on extended presentations about curriculum or facilities, the approach emphasizes brief contextual framing followed by hands-on engagement. Faculty provide a short overview of the ECE program and transfer pathways, after which current ECE students lead the activity, guide participants through the build process, and share their experiences as ECE majors.

Through these on-campus and off-campus efforts, the Innovation Lab functions as both a physical space and a portable engagement model. Within the department, it supports informal mentoring and community formation by bringing together students from different cohorts and levels of experience. Beyond campus, it lowers barriers to participation and demystifies engineering for prospective and transfer students. By combining accessible hands-on activities with student leadership and adaptable programming, the Innovation Lab integrates experiential learning, outreach, and recruitment in ways that are scalable and transferable to institutions with varied resources.

This paper describes the institutional context, design, and operation of the Innovation Lab; highlights signature hands-on activities and outreach models; and presents observations from sustained implementation. Lessons learned are discussed to inform other ECE departments interested in leveraging department-based makerspaces to support experiential learning, student leadership, community building, and engagement beyond the classroom.

3 Institutional Context and Development of the Innovation Lab

The Innovation Lab was established within the Department of Electrical and Computer Engineering at Seattle University in response to a recognized need for expanded hands-on

learning opportunities and shared project space for students. Prior to the lab's creation, students interested in pursuing extracurricular projects or extending course concepts beyond the classroom had limited access to dedicated facilities and equipment. While the curriculum included laboratory components, there was no centralized space that supported open-ended exploration, creative prototyping, or informal collaboration across courses and student cohorts.

The development of the Innovation Lab was initiated through a department-led effort to reimagine how experiential learning could be integrated more fully into the undergraduate ECE experience. Alumni engagement played a central role in this process, both in shaping the vision for the lab and in providing financial support for space renovation and initial equipment purchases. Several alumni contributions were made in memory of Francis P. Wood, S.J., a long-time faculty member in the department whose teaching emphasized strong foundations in electrical engineering fundamentals, innovation, and the application of engineering knowledge for the benefit of society. This legacy informed the lab's guiding philosophy: that students should engage with engineering concepts through making, experimentation, and iterative design from early in their academic careers.

From its inception, the Innovation Lab was envisioned as more than a collection of tools or a project room. Early planning documents emphasized the importance of sustainability, staffing, and community engagement alongside physical infrastructure. In particular, the department identified the need for dedicated personnel to support student projects, mentor student workers, and cultivate connections with alumni and industry partners. This led to the creation of an Innovator-in-Residence role during the lab's early years, which helped establish initial workshop offerings, supported student-led projects, and contributed to the development of hands-on curricular and co-curricular activities.

As the lab became operational, student use expanded rapidly beyond its original scope. Students began using the space for independent projects, skill-building outside of coursework, and collaborative exploration of emerging technologies. This organic growth led to the formation of student-led initiatives, including a Maker Club, and reinforced the lab's role as a shared community space rather than a resource tied to a single course or program requirement. Over time, the Innovation Lab evolved into a flexible platform that supports course-integrated projects, creative workshops, outreach activities, and department-wide events.

Today, the Innovation Lab reflects this iterative development process. Its current structure and programming are the result of multiple years of refinement informed by student use, faculty involvement, and outreach experience. The lab continues to operate with an emphasis on accessibility, adaptability, and student ownership, serving as a foundation for experiential learning, community building, and engagement with prospective students.

4 Innovation Lab Design and Operation

The Innovation Lab is designed as a department-embedded makerspace that supports a wide range of hands-on activities while remaining accessible to students with varied levels of prior experience. Its design and operation reflect a deliberate emphasis on flexibility, student ownership, and integration with departmental priorities rather than on scale or specialization. The

lab functions as both a physical space and an operational model that enables experiential learning, community building, and outreach.

4.1 Physical Space and Equipment

The Innovation Lab is housed within the Department of Electrical and Computer Engineering and is configured to support simultaneous, small-group, hands-on activities. The space includes multiple workbenches equipped for electronics assembly and prototyping, along with shared access to fabrication and testing tools. Rather than dedicating the lab to a single type of activity, the layout supports rapid reconfiguration for workshops, open project work, course-related activities, and outreach events.

Core capabilities of the lab include soldering and electronics assembly, printed circuit board (PCB) prototyping, and basic fabrication. Equipment and tools are selected to support authentic engineering practices while remaining approachable for novice users. This balance allows first- and second-year students, as well as visitors with little prior exposure to electronics, to engage meaningfully in hands-on work without extensive onboarding, while still supporting more advanced projects by upper-division students.

The lab is intentionally stocked with consumable materials, example components, and partially prepared kits to reduce startup friction for students. This design choice prioritizes engagement and exploration over efficiency or optimization and enables spontaneous use of the space for short-duration activities as well as longer-term projects.

4.2 Staffing and Student Leadership

Operation of the Innovation Lab is supported by a combination of professional staff and student assistants. A lab manager oversees daily operations, equipment maintenance, and safety, while student assistants play a central role in facilitating activities, supporting peers, and leading workshops. This staffing model emphasizes peer-to-peer learning and positions students as active contributors to the lab's culture and programming.

Student assistants are involved not only in supervising equipment use but also in developing and refining hands-on activities, particularly soldering and PCB-based workshops. Through this role, students gain experience in mentoring, communication, and technical leadership. This structure also allows the lab to scale activities without relying solely on faculty presence, making it feasible to support frequent workshops and outreach events.

Faculty engagement with the lab is intentionally flexible. Faculty may use the space for course-related projects, advise student organizations that meet in the lab, or participate in community-building events. However, the day-to-day operation of the lab does not depend on continuous faculty supervision, reinforcing the lab's role as a student-centered environment.

4.3 Operating Philosophy

The design and operation of the Innovation Lab are guided by several core principles. First, the lab prioritizes low barriers to entry. Activities are designed so that participants can begin working quickly, often within minutes of entering the space, without requiring prior coursework or

extensive instruction. This approach is particularly important for early-stage students and for outreach participants who may be encountering electronics for the first time.

Second, the lab emphasizes authentic, artifact-centered experiences. Students work with real components, tools, and fabrication processes, and activities are structured so that participants leave with a functional artifact they have assembled themselves. This "make something real" philosophy reinforces ownership, confidence, and connection to the discipline.

Third, creativity and exploration are treated as integral to engineering practice. Many Innovation Lab activities intentionally incorporate aesthetic or expressive elements, such as custom PCB shapes or themed designs, alongside technical content. This framing broadens perceptions of what counts as engineering work and invites participation from students with diverse interests and backgrounds.

Finally, the Innovation Lab is designed to be adaptable. Activities evolve in response to student interest, outreach needs, and emerging technologies, and the lab's operating model allows new workshops or project ideas to be introduced without significant restructuring. This adaptability has been essential to sustaining the lab over time and to extending its use beyond the department through mobile, off-campus activities.

Together, these design and operational choices position the Innovation Lab as a flexible, student-centered makerspace that supports experiential learning, leadership development, and community engagement within the ECE department.

5 Signature Hands-On Activities and Workshops

The Innovation Lab supports a portfolio of hands-on activities that are intentionally designed to be accessible, authentic, and adaptable across multiple contexts. These activities form the core of the lab's experiential learning model and are used to support undergraduate engagement, student leadership, outreach and recruitment, and community partnerships. While the specific formats vary, all activities share common design principles: low barriers to entry, emphasis on real engineering tools and practices, opportunities for creativity and personalization, and the production of tangible artifacts.

5.1 Soldering and PCB-Based Workshops

One of the most visible and widely used Innovation Lab activities is a series of soldering and printed circuit board (PCB)-based workshops. These workshops are designed as short, self-contained experiences that introduce participants to fundamental electronics concepts and practices, including component identification, soldering techniques, circuit assembly, and basic troubleshooting (Figures 1 and 2). Activities are intentionally structured so that participants can begin hands-on work quickly, often within minutes, without requiring prior coursework or technical background.

A distinguishing feature of these workshops is the use of custom-designed PCB projects developed specifically for the Innovation Lab. Boards are often themed or visually expressive, incorporating creative shapes, graphics, or motifs alongside standard electronic components

Figure 1: Students participating in a soldering activity in the Innovation Lab, assembling printed circuit board (PCB) projects as part of a hands-on introduction to core electrical and computer engineering practices.

(Figures 3, 4, 5). This design choice lowers intimidation barriers and reframes electronics as a creative and approachable medium, while still exposing participants to authentic engineering workflows. Participants assemble functional circuits and leave with a completed artifact, reinforcing a sense of ownership and accomplishment.

The workshops are facilitated primarily by trained student assistants, with staff oversight to ensure safety and smooth operation. Student facilitators guide participants through the build process, answer questions, and model troubleshooting strategies. By placing current ECE students in visible facilitation roles, the workshops support peer-to-peer learning and position students as leaders and mentors for peers, prospective students, and community participants.

Soldering and PCB-based workshops are offered regularly throughout the academic year and are used in multiple contexts, including open lab events, department community activities, outreach programs, and recruitment initiatives. In addition to department-led programming, these workshops are regularly incorporated into university-organized open house events for prospective students and their families. During open houses, the activities provide a hands-on counterpoint to traditional informational sessions, allowing visitors to engage directly with ECE practices while interacting with current students.

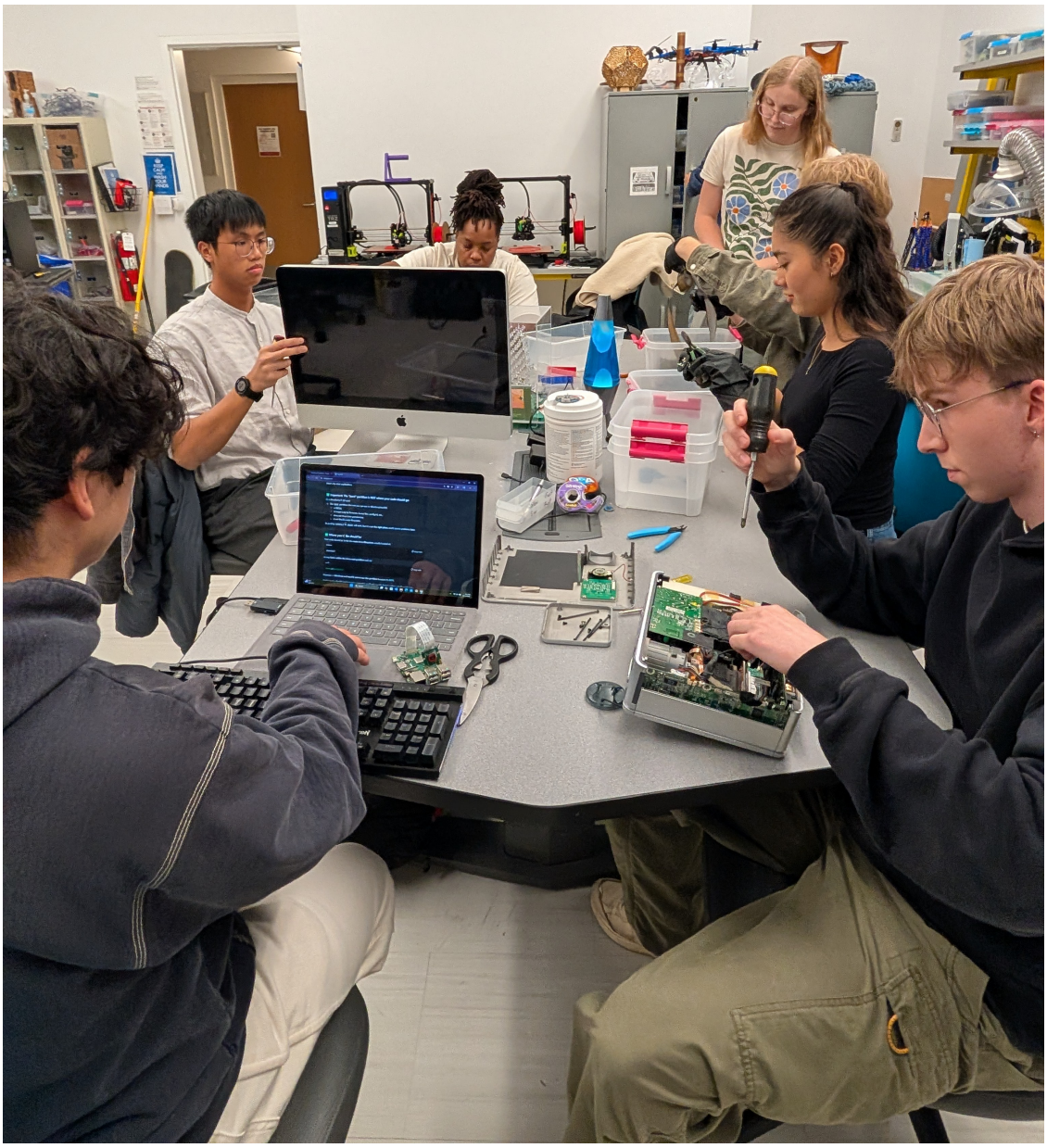

Figure 2: Students participating in an electronics teardown activity in the Innovation Lab, examining components and internal structure to better understand how electronic systems are assembled and function.

5.2 Mobile Makerspace Outreach to Community Colleges

In addition to on-campus programming, the Innovation Lab operates as a mobile makerspace for outreach and recruitment, particularly in support of transfer pathways from local community colleges. Faculty and students bring portable versions of Innovation Lab activities to partner institutions, allowing prospective transfer students to engage directly with hands-on ECE experiences in their own environments (Figure 6).

These outreach visits are structured to prioritize experience over information delivery. Rather than

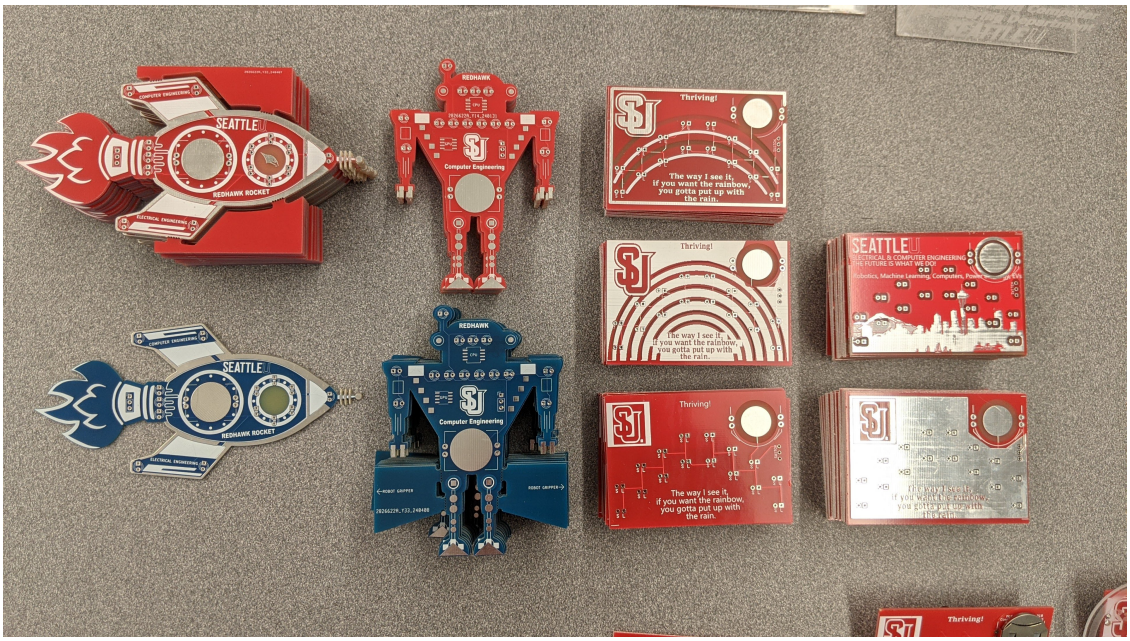

Figure 3: Examples of custom-designed printed circuit boards (PCBs) developed for Innovation Lab workshops, featuring themed and visually expressive designs that incorporate standard electronic components.

centering the visit on extended presentations about curriculum or facilities, faculty provide a brief overview of the ECE program and transfer pathways, typically lasting no more than fifteen minutes. Current ECE students then lead the hands-on activity, guiding participants through a soldering or PCB-based project while answering questions about coursework, student life, and their own academic trajectories.

This student-led format leverages peer interaction as a powerful recruitment tool and allows prospective students to interact directly with both the discipline and departmental culture. The activities are designed to be robust to varied settings and time constraints, enabling the Innovation Lab to support outreach without requiring specialized facilities at the host institution. Through this approach, the lab extends its impact beyond campus and demonstrates how experiential learning can be integrated into recruitment and transfer engagement.

5.3 Community-Engaged Summer Internships

The Innovation Lab also supports extended, community-engaged learning through a summer internship program conducted in partnership with the City of Seattle via the Seattle Youth Employment Program (SYEP). Each summer, the Electrical and Computer Engineering Department hosts a cohort of low-income high school students for six-week, paid internships that provide sustained exposure to engineering practice and design.

Interns work primarily within the Innovation Lab and engage in a range of project-based activities designed to be accessible to students with limited prior technical experience. Projects include preparing instructional laboratories for the upcoming academic year, developing introductory

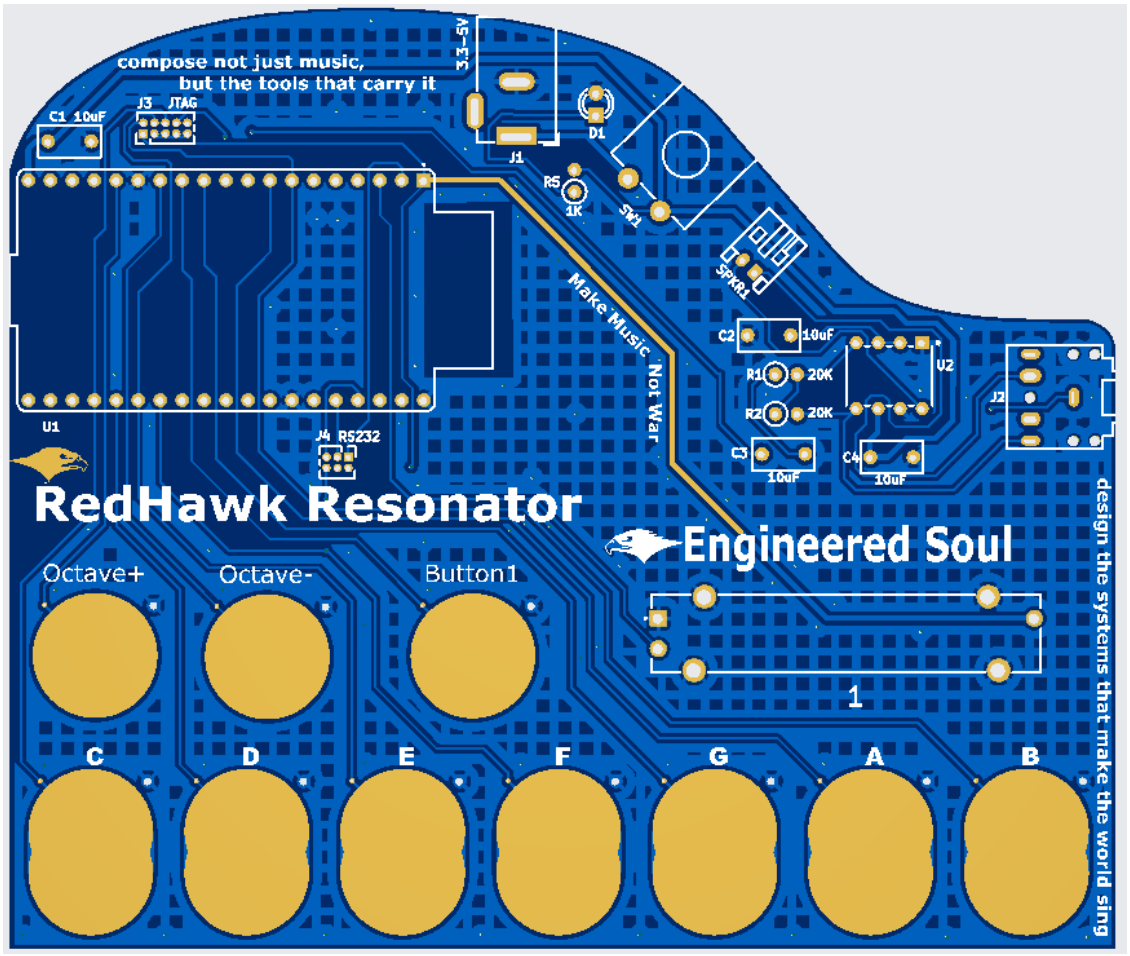

Figure 4: Examples of a custom-designed printed circuit board (PCB) developed for an advanced Innovation Lab workshop, featuring a music synthesizer design. Identifying information has been redacted.

robotics and coding activities, and participating in design-and-build projects with visible, tangible outcomes. The structure of the internships emphasizes iterative design, teamwork, and problem solving, allowing interns to experience engineering as an active and creative process.

A distinctive element of the summer program is the inclusion of interdisciplinary projects that connect engineering with art, sustainability, and community spaces. In recent years, interns have designed and fabricated large-scale 3D artwork installations for campus buildings, transforming underutilized spaces into engaging visual environments. Some projects incorporate both modern and legacy electronic components, intentionally repurposing materials that might otherwise be discarded (Figure 7). These activities broaden participants' perceptions of engineering and highlight its relevance to societal and environmental contexts.

Through the YEP partnership, the Innovation Lab extends its mission beyond undergraduate education by creating early pathways into STEM and strengthening connections with the local community. At the same time, the internship program reinforces the lab's core design principles: low barriers to entry, hands-on engagement, student ownership, and the creation of meaningful

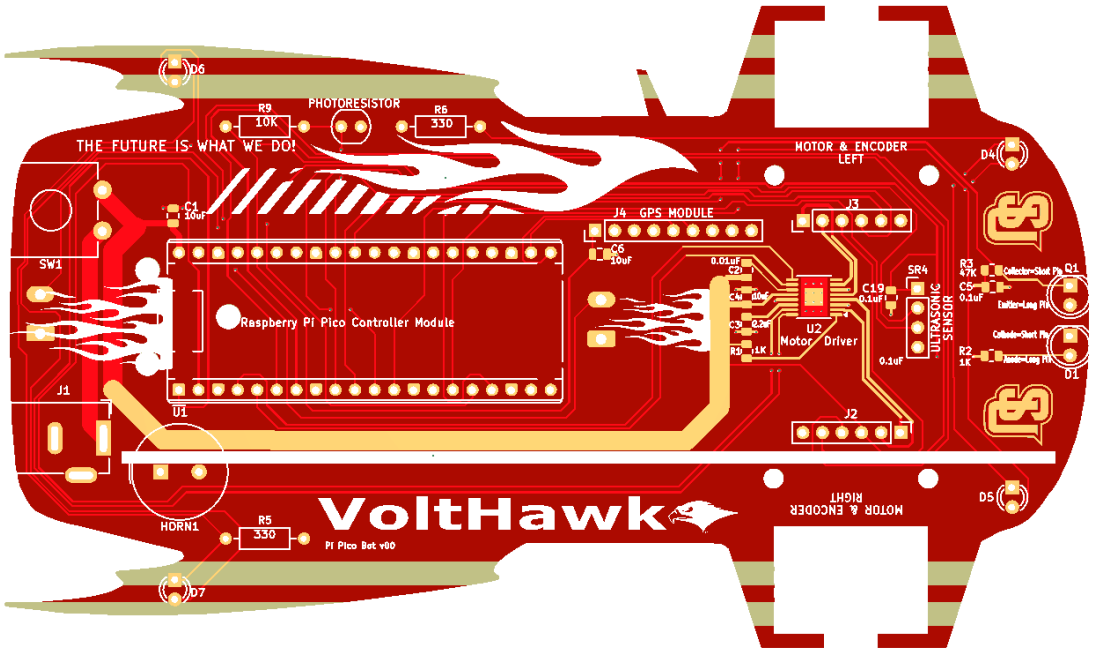

Figure 5: Custom-designed printed circuit board used in an advanced Innovation Lab workshop, illustrating a robotic system that integrates sensing, actuation, and control. Identifying information has been redacted.

Figure 6: Innovation Lab outreach activity conducted at a community college, where current ECE students lead a hands-on electronics workshop for prospective transfer students.

artifacts. Together with academic-year workshops and outreach activities, these internships illustrate how the Innovation Lab functions as a flexible platform for experiential learning across

Figure 7: Artwork created by high school students participating in a six-week summer internship in the Innovation Lab through the Seattle Youth Employment Program (SYEP), integrating engineering concepts, creativity, and hands-on fabrication.

educational stages.

6 Observations, Lessons Learned, and Transferability

The sustained operation of the Innovation Lab over multiple academic years has yielded a set of observations that inform both its continued evolution and its potential adoption by other ECE departments. While the Innovation Lab was developed as a practice-focused educational space rather than a research intervention, recurring patterns of participation and engagement across workshops, outreach activities, and summer programs provide insight into how department-based makerspaces can support experiential learning, community building, and professional formation.

6.1 Observations from Practice

One consistent observation is that low-barrier, hands-on activities broaden participation in experiential learning. Soldering and PCB-based workshops attract students with a wide range of backgrounds and confidence levels, including first-year students, non-majors, prospective

students, and pre-college participants. The ability to begin working quickly, combined with the production of a tangible artifact, appears to reduce hesitation and encourages sustained engagement even among participants who initially report limited technical experience.

Another recurring pattern is the effectiveness of using the same core activities across multiple contexts. Soldering and PCB-based workshops have been successfully adapted for use with current students, prospective students during university open houses, community college outreach visits, and extended summer internship programs. This reuse of activity designs reduces development overhead while reinforcing continuity between learning, recruitment, and outreach.

6.2 Lessons on Design and Operation

Experience with the Innovation Lab has highlighted several lessons related to makerspace design and sustainability. First, physical space and equipment alone are insufficient to create an active and inclusive learning environment. Consistent staffing, availability of consumable materials, and intentional programming are critical to maintaining momentum and ensuring that the lab remains accessible rather than intimidating.

Second, emphasizing creativity alongside technical rigor has expanded engagement. Workshops that incorporate visual design, personalization, or interdisciplinary elements lower perceived barriers to entry and invite participation from students with diverse interests. This framing has proven particularly effective in outreach and recruitment settings, where participants may have limited familiarity with electronics or engineering more broadly.

Third, embedding the Innovation Lab within the department, rather than positioning it as a centralized or standalone facility, has supported integration with both curricular and co-curricular activities. Faculty can reference the lab naturally in courses, students encounter the space early in their academic careers, and the lab becomes part of the department's shared identity rather than an optional add-on.

6.3 Student Leadership and Professional Formation

An important outcome of the Innovation Lab model is the development of leadership and professional skills among students who facilitate activities and workshops. Students who serve as workshop leaders or student assistants take on responsibilities that extend beyond technical support, including guiding participants through unfamiliar tasks, communicating with diverse audiences, and responding flexibly to questions and challenges in real time.

Leading hands-on activities for peers, prospective students, and community members requires student facilitators to articulate technical concepts clearly, model problem-solving strategies, and normalize trial-and-error learning. In doing so, these students reinforce their own understanding of foundational concepts while gaining experience in mentoring, teaching, and public engagement. During recruitment events and community college visits, student facilitators also act as representatives of the department, sharing their academic pathways and perspectives on student life.

Informal feedback and patterns of repeated participation suggest that these leadership roles

contribute to increased motivation and ownership among student facilitators. Students who lead workshops often return to support additional activities, take on mentoring roles for newer facilitators, or contribute to the development of new workshop content. These experiences provide authentic, low-stakes opportunities to practice communication, teamwork, and leadership skills that complement formal coursework and align with professional expectations in both industry and academia.

6.4 Transferability to Other ECE Departments

The Innovation Lab model is intentionally designed to be transferable to institutions with varying resources and constraints. While specific equipment, staffing structures, and physical layouts may differ, the underlying principles that support the lab's success are broadly applicable. These include prioritizing low-barrier entry points, leveraging student leadership, designing adaptable hands-on activities, and aligning makerspace efforts with departmental goals for learning, community, and outreach.

Departments considering similar initiatives need not begin with a fully outfitted makerspace. Experience with the Innovation Lab suggests that starting with a small set of well-designed activities and a modest physical footprint can be sufficient to build momentum. Over time, programming can expand in response to student interest, outreach needs, and available resources. Partnerships with alumni, community organizations, and local industry can further support sustainability and growth.

By focusing on how activities are designed, facilitated, and integrated into departmental life—rather than on the scale of facilities—ECE departments can create impactful experiential learning environments that support students, strengthen community, and extend engagement beyond campus.

7 Conclusion and Future Work

The Innovation Lab demonstrates how a department-based makerspace can serve as a flexible and impactful platform for experiential learning, community building, and outreach within electrical and computer engineering. By embedding hands-on activities directly within the department and designing them to be accessible, authentic, and adaptable, the Innovation Lab supports student engagement across multiple stages, from early undergraduate exploration to pre-college and transfer pathways.

Central to the lab's success is the use of low-barrier, artifact-centered activities that allow participants to engage quickly with real engineering tools and practices. These activities support not only technical skill development, but also creativity, confidence, and a sense of ownership. The reuse of core activities across academic-year programming, university recruitment events, community college outreach, and summer internships illustrates how a single set of well-designed experiences can serve multiple educational and institutional goals.

Equally important is the role of student leadership in sustaining and scaling the Innovation Lab. By positioning current students as facilitators and mentors, the lab creates opportunities for professional formation while reinforcing a welcoming, peer-supported learning environment.

These leadership roles complement formal coursework and contribute to a departmental culture that values collaboration, communication, and experiential learning.

The Innovation Lab model is intentionally designed to be transferable to other ECE departments, including those with limited space or resources. By focusing on design principles rather than scale, and by aligning makerspace activities with departmental priorities, institutions can create meaningful experiential learning environments that extend beyond the classroom. As engineering programs continue to seek effective ways to engage students, build community, and strengthen outreach, department-based makerspaces such as the Innovation Lab offer a practical and adaptable approach.

The recent merger of Cornish College of the Arts with Seattle University creates new opportunities for interdisciplinary collaboration at the intersection of art and engineering. We plan to partner with faculty and students to integrate electronics into visual arts courses and performance-based projects.

While the Innovation Lab is widely used, it has the potential for even greater impact. Prior research shows that many students leave engineering during or immediately after their first year[8]. We therefore plan to expand access to the lab to engage all first-year students, rather than the current subset who participate. In addition, we will conduct a comprehensive assessment of the lab's impact on recruitment, retention, and students' sense of belonging.

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