Embedding Innovation and Entrepreneurial Capacity in Engineering Education: The EPIIC Initiative at Seattle University

Dr. Amit Shukla, Seattle University

Amit Shukla, PhD, is a Professor of Mechanical Engineering and most recently served as the Dean of the College of Science and Engineering (2022-2025). Dr. Shukla's leadership of the college resulted in major progress in Seattle University's STEM programs, as the university embraces new institutional partnerships and students explore their potential in the new Center for Science and Innovation.

Dr. Shukla's career as an academic and administrator has been marked by a commitment to innovation, transparency, collaboration and inclusion. Prior to Seattle University, he served in various leadership roles at Miami University, Ohio, for two decades. He has extensive experience in supporting student success and faculty development, fostering multidisciplinary teaching and research, fundraising, engaging with alumni and forging mutually enriching partnerships with industry. Dr. Shukla was also the founding director of the Miami University Center for Assistive Technology, which identifies socially relevant problems and develops engineering solutions by engaging students in interdisciplinary research.

Dr. Peter Rowan, Seattle University

Peter Rowan is the Lawrence K Johnson Chair in Entrepreneurship and Executive Director of the Innovation and Entrepreneurship Center at the Albers School of Business and Economics at Seattle University. As a member of the Management Department faculty, Peter oversees the undergraduate minor in Entrepreneurship & Innovation, as well as the Graduate Certificate in Entrepreneurship & Innovation, teaching required courses for both those programs. His research interests include risk taking among early-stage entrepreneurs, entrepreneurship education and the role of entrepreneurship support organizations like university accelerators in impacting entrepreneurial intention and new venture survival. Previously, he was the Executive Director, Pacific Asian Center for Entrepreneurship, and a Senior Lecturer at the Shidler College of Business at UH Manoa. Prior to joining academia, Peter was Corporate Vice President, New Ventures at Coinstar from 2001-2010. During his tenure, the company grew from $150 million to $1.3 billion in revenue, entered new lines of business and introduced innovative growth initiatives like its DVD kiosks, money transfer, and e-payment programs. At Coinstar, Peter led more than 20 acquisitions, investments, and divestitures, including its investment in Redbox. Peter has taught entrepreneurship and new venture strategy since 2005. He is active in the entrepreneurial community as an advisor, mentor, and investor. He has a BA in Russian History from Cornell University, an MA in International Policy Studies and an MBA from Middlebury Institute of International Studies, and a PhD in Business Administration from the Shidler College of Business.

John J Ostlund, Seattle University

JJ Ostlund is a seasoned high-tech executive whose career bridges the scale, discipline, and operational rigor of Fortune 100 companies with the agility, risk-taking and inventive drive of early-stage startups. Over three decades he has led major business units and global operations at prominent technology organizations, delivering innovation-differentiated growth and building high-performance teams. In parallel, he has advised and coached mission-driven startups, supported university-linked ventures, and engaged in philanthropic initiatives designed to expand talent, opportunity and engineering innovation. His track record spans delivering double-digit growth, leading transformations, and unleashing talent in cross-functional, high-velocity environments.

JJ's leadership style is inspirational and inclusive: he builds and mentors top-tier engineering, commercial, and product teams, fosters a culture of accountability and creativity, and consistently develops leaders of the next generation. He is recognized for turning vision into action—translating strategy into tangible business outcomes while keeping people fully engaged.

As the EPIIC Initiative at Seattle University seeks to embed innovation and entrepreneurial capacity into engineering education, JJ's blend of high-tech leadership, operational mastery, startup know-how

and talent development makes him uniquely positioned to support such transformational work—bridging the worlds of engineering, enterprise and entrepreneurship to forge the next generation of engineering innovators.

Embedding Innovation and Entrepreneurial Capacity in Engineering Education: The EPIIC Initiative at Seattle University

Abstract

Seattle University participated in the National Science Foundation funded Enabling Partnerships to Increase Innovation Capacity (EPIIC) initiative to strengthen innovation and entrepreneurial capacity across engineering education. This paper presents an institutional implementation case study of how the university organized this work through four coordinated pillars: Foundation, Education, Programs, and Partnerships. Grounded in the institutional hypothesis that innovation shaped by humanistic values can distinguish the university as a place where innovation meets humanity, the initiative combined infrastructure development, curricular integration, experiential programming, and external engagement. The paper documents the development of an Innovation Hub, planning for an Innovation Lab, modular innovation lessons in core courses, mentoring and Innovator-in-Residence activities, and a dashboard-based approach to tracking progress. Early outcomes reported in the initiative materials indicate stronger institutional coordination, broader access to innovation resources, increased experiential participation, and growing partner engagement. The case contributes a practical framework for institutions seeking to embed innovation in engineering education while remaining aligned with mission, student development, and regional impact.

Keywords: innovation education, engineering education, institutional transformation, experiential learning, innovation competencies, partnerships, EPIIC

Introduction

Engineering programs are being asked to prepare graduates who can do more than solve well-structured technical problems. Employers and communities increasingly expect engineers to navigate ambiguity, work across disciplines, and create solutions that respond to social and organizational needs [1]-[4]. These expectations have pushed institutions to move innovation and entrepreneurship from the margins of co-curricular programming into the core of engineering education. Rather than treating innovation as a single course or an extracurricular add-on, a growing body of literature emphasizes the need for intentional structures that connect curriculum, culture, partnerships, and student experience [1], [3], [4].

This paper examines one such institutional effort at Seattle University. Supported through the NSF EPIIC initiative, the university organized its work around a four-pillar framework spanning Foundation, Education, Programs, and Partnerships. The initiative was motivated by three conditions identified in the project materials: strong student interest in innovation and entrepreneurship, fragmented innovation-related activities across campus, and a need for more coordinated external engagement. Seattle University framed the effort through its mission of preparing leaders for a just and humane world and through the working hypothesis that innovation grounded in humanistic values could differentiate the institution as a place where innovation meets humanity.

The contribution of this paper is a technical description of the framework, implementation strategy, and early outcomes of the initiative. Because the current evidence base consists primarily of institutional planning artifacts, dashboard indicators, and implementation milestones, the paper focuses on program architecture and early-stage results rather than causal claims about student

learning. In that respect, the paper is best understood as a structured implementation case study intended to support replication and adaptation at other institutions.

Institutional Context and Rationale

Seattle University undertook this work to better align engineering education with contemporary innovation practice and with the university's broader mission. The project materials describe a landscape in which innovation-related activity already existed, but it was distributed across courses, student experiences, and external relationships without a shared structure, common language, or unified assessment model. The EPIIC initiative provided both an external catalyst and a cohort-based context for organizing that work into a more durable institutional system.

Within this context, innovation was defined not as spontaneous creativity alone, but as a structured, multidisciplinary process requiring both technical skill and human capacities such as curiosity, collaboration, resilience, and adaptability. Those competencies became shared outcomes across the initiative. This framing allowed the university to connect innovation with curricular learning, mentoring, prototyping, competitions, sponsored projects, and regional partnerships rather than locating it in any single unit or course.

Project Approach

The initiative employed a four-pillar implementation model. Each pillar addressed a different component of institutional capacity while reinforcing the others. Table 1 summarizes the role of each pillar and the main activities described as depicted in Figure 1.

Table 1. Seattle University EPIIC framework by implementation pillar.

Pillar	Primary purpose	Illustrative activities described in the draft
Foundation	Strategic and operational infrastructure	Innovation Hub, Innovation Lab planning, KPI dashboard, competency definitions, student journey mapping, maturity model.
Education	Curricular integration and faculty support	Innovation modules for first-year engineering and capstone, faculty workshops, and exploration of graduate-level pathways in computer science and cybersecurity.
Programs	Applied and experiential learning	Hackathons, business competitions, undergraduate research, Venture Studio pathway development, and mentorship linked to innovation and intellectual property awareness.
Partnerships	External engagement and ecosystem building	Innovators-in-Residence, industry mentors, sponsored projects, donor coordination, alumni engagement, and regional relationship development.

The Foundation pillar established the operating backbone for the initiative. According to the draft, this work included articulating the central hypothesis, defining innovation competencies, creating shared physical and digital spaces, mapping student touchpoints, and building a dashboard and maturity model to track progress over time. These efforts are important because they transform

innovation from an aspirational value into something that can be organized, communicated, and measured.

The Education pillar focused on embedding innovation into the student learning experience without displacing core technical content. The project team identified integration points in first-year engineering and senior capstone courses, developed plug-and-play innovation modules with real-world examples and guided activities, and supported faculty adoption through workshops and shared materials. The draft also notes exploratory integration within computer science and cybersecurity, suggesting that the model was designed for broader diffusion beyond a single department.

The Programs pillar translated curricular intent into authentic experiences. The initiative materials describe hackathons, research participation, business competitions, and faculty-mentored interdisciplinary work as the primary mechanisms for application. This pillar also connected students with Innovators-in-Residence and mentors who could provide expertise related to startup development, technology transfer, and provisional patent processes. In effect, the Programs pillar served as the bridge between classroom exposure and practice-based learning.

The Partnerships pillar expanded capacity through relationships with industry, mentors, donors, alumni, and other external collaborators. The draft highlights guest lectures, coaching, mentoring, and the centralization of sponsor and donor information as mechanisms for strengthening institutional coordination. This pillar matters because innovation education typically depends on expertise and opportunities that extend beyond the campus itself.

Figure 1: Seattle University Innovation Capacity Framework.

Assessment and Evaluation Structure

A dual-track evaluation strategy that combines dashboard indicators with qualitative judgment about organizational maturity is utilized. Rather than relying on a single outcome measure, the initiative tracked progress across infrastructure, curriculum, participation, and partner engagement. Table 2 consolidates the KPI structure. The initiative also defined a competency

rubric for student development which includes curiosity, creative problem-solving, resilience and adaptability, collaboration, and analytical thinking. These categories are notable because they blend entrepreneurial mindset attributes with capacities already valued in engineering problem solving. Table 3 presents the rubric in condensed form.

Table 2. Multi-pillar KPI framework used to monitor implementation progress.

Pillar	Key performance indicator	Target metric	Frequency
Foundation	Innovation literacy rate	Percent of students and faculty identifying core competencies	Annual
Foundation	Digital engagement	Monthly active users on the Innovation Hub	Monthly
Education	Curricular reach	Number of courses with integrated innovation modules	Per semester
Education	Faculty participation	Number of faculty attending development workshops	Annual
Programs	Experiential participation	Number of students in hackathons and competitions	Per event
Programs	Research output	Number of undergraduate research and development projects funded	Annual
Partnerships	Mentor engagement	Number of active industry mentors and Innovators-in-Residence	Ongoing
Partnerships	External funding	Donor and industry sponsorship dollars	Annual

Table 3. Condensed innovation competency assessment rubric.

Competency	Emerging (1)	Developing (2)	Proficient (3)	Exemplary (4)
Curiosity	Relies only on provided information.	Asks clarifying questions within known bounds.	Seeks new information and diverse perspectives.	Frames use-inspired questions that challenge the status quo.
Creative problem-solving	Identifies one standard solution.	Brainstorms a few alternatives with guidance.	Generates multiple viable, non-obvious solutions.	Connects disparate ideas to create novel value.
Resilience and adaptability	Becomes discouraged by setbacks.	Needs substantial support to pivot after failure.	Treats failure as data and adjusts with modest support.	Proactively changes strategy in response to feedback or failure.
Collaboration	Works largely independently.	Contributes to team tasks but avoids conflict.	Values diverse team roles and contributes actively.	Leads multidisciplinary work and mediates conflict.
Analytical thinking	Accepts data at face value.	Performs basic analysis but struggles with nuance.	Draws evidence-based conclusions from data.	Synthesizes complex data to anticipate future trends.

Finally, the project used a maturity model to interpret institutional progress. The model moves from ad hoc activity to pilot implementation, then scaling, and finally embedded practice. This is a useful complement to the dashboard because a numerical indicator alone cannot fully capture

whether innovation has become part of the institution's operating culture. Table 4 presents the maturity stages.

Table 4. Innovation maturity stages used to judge institutional progress.

Dimension	Level 1: Ad Hoc	Level 2: Pilot	Level 3: Scaling	Level 4: Embedded
Curriculum	No formal innovation content.	Isolated modules in elective courses.	Innovation integrated into core first-year and capstone courses.	Innovation is a required learning outcome across degrees.
Culture	Innovation is seen as extra work.	A small group of early adopters participates.	Broader faculty and staff awareness and organized task force activity.	Innovation is central to institutional identity.
Partnerships	Transactional relationships such as job postings.	Guest speakers and occasional mentors.	Structured Innovator-in-Residence activity and sponsored projects.	Industry co-creates research and curriculum.

Early Results

The early outcomes across the four pillars were realized. On the infrastructure side, the Innovation Hub became the central repository for innovation resources, and usage indicators showed growing monthly engagement. The physical Innovation Lab is under active development. Within the academic domain, faculty gained access to modular innovation lessons that could be inserted into existing courses. The innovation competencies were integrated into Canvas to support more consistent tracking of student development. This is an important implementation step because it moves innovation assessment from informal observation toward programmatic documentation. Programmatic activity expanded to include hackathons, business competitions, undergraduate research, Innovators-in-Residence, and an Innovation and Entrepreneurship residence learning community as visible components of the initiative. It further reports that some competition winners advanced to national levels, that recurring talks and newsletters increased campus visibility, and that a Venture Studio model began to clarify the path from idea generation to venture development. Collectively, these elements suggest movement from isolated pilot events toward a more connected innovation ecosystem.

Partner engagement increased as well to approximately 50 active mentors, expanded coaching by external experts, and early-stage donor and industry support. Using the maturity model described in the draft, Seattle University was positioned between early adoption and scaling. That assessment is consistent with the pattern of evidence presented: foundational structures are in place, curricular and co-curricular elements are active, and the primary task has shifted from invention to institutionalization.

An example of the Maturity Model for the Foundation track can be depicted as follows, where the status/score evolves over time and is a judgement based on various key performance indicators (KPI). It is expected that the status score will improve as the program develops:

Phase	Innovation Components for the Foundation	Status / Score
0	• University Innovation principles (open) • Innovation Program resourcing (active) • Program Design & Strategic Framework (active) - Unified, federated? • Active Program w/ Agile process (active) • Key metrics dashboard w/ aligned goals (open) - Capacity?	2/ 5 3 / 5 3 / 5 4 / 5 2 / 5
1	• Website & Intranet development (open) • Innovation News-Media support (open) • Innovation Lab(s) resources & support (open) • STEM Industry Mentoring program (open)	0 / 5 1 / 5 3 / 5 0 / 5
2	• Student - Career support center (open) • Faculty - Culture alignment * motivation strategies (open)	1 / 5 1 / 5
3	• Per Track SWOT analysis & tracking (active) • Playbook design & documentation (active) • University maturity model & certification (active)	0 / 5 1 / 5 1 / 5

The Education pillar ensures innovation becomes an integral part of the student learning experience. This is achieved through curriculum, innovation modules, faculty development and graduate pathways where:

- Curricular Strategy: Identifying integration points in First-Year Engineering (101) and senior capstone courses.
- Innovation Modules: Creating "plug-and-play" lessons with real-world examples and activity prompts.
- Faculty Development: Offering workshops and training resources to support scalable integration.
- Graduate Pathways: Exploring innovation modules within Computer Science and Cybersecurity programs.

The Program pillar translate learning into authentic, applied opportunities via faculty mentored research and interdisciplinary collaborations; adding signature events like the SeattleU Hackathon and CSE SharkTank while providing mentoring by connecting students with "Innovators-in-Residence" for expertise and education related to tech transfer providing IP education and provisional patent guidance.

The Partnership pillar expands institutional capacity through external relationships by bringing industry experts to campus for coaching and guest lectures as Innovators-in-Residence (IIR); pairing students with professionals for STEM mentorship, centralizing data on sponsors, donors, and alumni for improved coordination and advancing sponsored research and regional grant development.

Challenges and Lessons Learned

The project materials identify several implementation challenges that are common in engineering education change efforts. First, faculty bandwidth and curriculum crowding limited adoption when innovation was perceived as an additional responsibility layered on top of accreditation-driven course content. The implication is that innovation modules must be designed for seamless integration into existing courses rather than as stand-alone additions.

Second, student awareness of the initiative was initially low. Student Innovation Journey Map became an important communication mechanism for showing students how courses, programs, events, and mentoring opportunities connect over time. This lesson highlights the importance of visibility and pathway design in institutional change: capacity-building efforts are less effective when students experience them as isolated opportunities instead of as a developmental sequence.

Third, scaling required professional operations support. The ad hoc volunteerism was insufficient as the initiative grew. This is a critical technical lesson for institutions seeking replication. Innovation ecosystems require coordination, data management, communication, and relationship stewardship; those functions must be resourced if the work is expected to persist beyond an enthusiastic pilot stage.

Finally, the initiative surfaced the difficulty of tracking distributed partnerships and sponsorships. The need for a centralized directory became evident as external activity expanded. This challenge reinforces a broader point: ecosystem-oriented educational innovation depends not only on pedagogy but also on information architecture and organizational systems.

Discussion

Taken together, the implementation described in this case suggests that innovation education is most durable when treated as an institutional system rather than as a collection of disconnected opportunities. The four-pillar structure gives a practical way to separate and coordinate the work of infrastructure, curriculum, student programming, and external engagement. That architecture also provides a useful language for diagnosing gaps. For example, an institution may already have active programs but lack the foundational dashboard, competency framework, or partner coordination needed for scale.

A second contribution of the case is its explicit coupling of innovation with humanistic mission. In the Seattle University framing, innovation is not only about commercial outcomes or startup formation; it is also about preparing students to challenge the status quo responsibly and to generate solutions with community relevance. This framing may be especially useful for institutions that want to expand innovation education without separating it from mission, equity, or service-oriented educational values.

The case also reveals the limits of early-stage evidence. Many of the outcomes reported here are implementation outcomes: the creation of infrastructure, the launch of modules and programs, the growth of participation, and the strengthening of coordination. Those are meaningful

accomplishments, but they are not the same as validated impact on learning, retention, entrepreneurial behavior, or post-graduation outcomes. Future work should therefore extend the current dashboard toward longitudinal assessment that links participation and competency development with downstream student and institutional results.

Conclusion

Seattle University's EPIIC initiative offers a structured example of how a university can embed innovation and entrepreneurial capacity within engineering education through coordinated work across foundation, education, programs, and partnerships. Based on the evidence reported in the draft materials, the initiative has already improved institutional coherence, expanded the visibility of innovation opportunities, and built mechanisms for curricular and co-curricular integration. Its most transferable feature is not any single event or resource, but the operating model that connects competencies, infrastructure, faculty support, experiential learning, and external relationships.

For institutions pursuing similar goals, the case suggests a phased pathway: define competencies and a shared institutional rationale, build lightweight but visible infrastructure, integrate modular learning experiences into existing courses, create applied student opportunities, and establish systems for measuring and coordinating growth. The next stage for the Seattle University initiative is to institutionalize these practices through sustained funding, broader graduate-level integration, and stronger outcome evidence. Those next steps will determine whether the current momentum becomes an embedded and resilient component of engineering education.

References

[1] R. S. Adams and J. A. Siddiqui, "The challenge of change in engineering education," Journal of Engineering Education, 2013.

[2] N. E. R. Lyngdorf, D. Jiang, and X. Du, "Frameworks and models for digital transformation," International Journal of STEM Education, 2024.

[3] N. X. Mashwama and B. Madubela, "Innovations in pedagogy and technology," Global Journal of Engineering Education, 2025.

[4] I. Zergout, S. Ajana, C. Adam, and S. Bakkali, "Modelling innovation in engineering," International Journal of Emerging Technologies in Learning, 2019.